Managing Risks in Federal Government Technology Projects: Does Process Maturity Matter?

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Motivation: Federal IT Projects

Federal IT initiatives organized in the form of large IT projects

- Healthcare Marketplace Implementation
  Department of Health & Human Services

- Navigation systems for missiles
  Department of Defense (DOD)

- Web-based SCM system
  Department of Agriculture (USDA)

Federal IT Portfolio
26 Agencies, 7248 IT investments

Annual Budget $79 Billion

Office of Mgmt. & Budget (OMB) 2011 Report
Motivation: Project Risks in Federal IT Projects

Risk management presents a dominant challenge in Federal IT projects (McKinsey 2012 Study)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Number of major federal technology projects</th>
<th>Associated Budget ($ in Billions)</th>
<th>Number of Management Watch List projects</th>
<th>Associated Budget ($ in Billions)</th>
<th>% of federal technology projects on Management Watch List</th>
<th>% of budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1400</td>
<td>$59.0</td>
<td>771</td>
<td>$20.9</td>
<td>55%</td>
<td>35%</td>
</tr>
<tr>
<td>2005</td>
<td>1200</td>
<td>60.0</td>
<td>621</td>
<td>22.0</td>
<td>52</td>
<td>37%</td>
</tr>
<tr>
<td>2006</td>
<td>1087</td>
<td>65.0</td>
<td>342</td>
<td>15.0</td>
<td>31</td>
<td>23%</td>
</tr>
<tr>
<td>2007</td>
<td>857</td>
<td>64.0</td>
<td>263</td>
<td>9.9</td>
<td>31</td>
<td>15%</td>
</tr>
<tr>
<td>2008</td>
<td>840</td>
<td>65.0</td>
<td>346</td>
<td>14.0</td>
<td>41</td>
<td>22%</td>
</tr>
<tr>
<td>2009</td>
<td>810</td>
<td>70.7</td>
<td>585</td>
<td>27.0</td>
<td>72</td>
<td>38%</td>
</tr>
</tbody>
</table>

White House targets $30 Billion (72%) in high-risk IT programs (Federal Computer Week 2010)
## Motivation: Legislations and Standards

<table>
<thead>
<tr>
<th>Year</th>
<th>Legislations/Standards</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Government Performance &amp; Results Act (GPRA)</td>
<td>To set goals, measure results, and report progress</td>
</tr>
<tr>
<td>1993</td>
<td>Federal Acquisition Streamlining Act (FASA)</td>
<td>For bidding and the contracting process for Federal investments</td>
</tr>
<tr>
<td>1996</td>
<td>Clinger-Cohen Act (CCA)</td>
<td>To clearly link IT investments and accomplishments</td>
</tr>
<tr>
<td>1998</td>
<td>ANSI/EIA-748 Earned Value Management Standard</td>
<td>For evaluating project progress and performance</td>
</tr>
<tr>
<td>2002</td>
<td>E-Government Act</td>
<td>Establishes a Federal CIO within the OMB</td>
</tr>
</tbody>
</table>

“As the Obama administration steps up oversight...contracting organizations must take greater responsibility...That is where one of the latest offerings from the Software Engineering Institute can help” (Federal Computer Week 2010)
Motivation: Focus on Process Maturity

- Key criteria for awarding Federal IT contracts (Brown 2007)
- Recognized as a measure of vendors ability to deliver mission-critical IT solutions (Ramasubbu et al. 2008, Krishnan et al. 2000)

Capability Maturity Model
Integrated - Formal process model for managing IT projects

<table>
<thead>
<tr>
<th>SEI CMMI Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
</tr>
<tr>
<td>Level 2</td>
</tr>
<tr>
<td>Level 3</td>
</tr>
<tr>
<td>Level 4</td>
</tr>
<tr>
<td>Level 5</td>
</tr>
</tbody>
</table>
Purpose of the Study

1. Identify Key Risks in Federal Technology Projects, and
2. Examine the Role of Process Maturity in Mitigating Project Risks

- **Complexity Risk**: arises due to technical challenge/scope of the project
- **Contracting Risk**: arises due to scale of contracting work
- **Execution Risk**: arises from disruptions/uncertainties during project execution
Conceptual Framework: Hypotheses

IT Project Risks
- Complexity Risk
- Contracting Risk
- Execution Risk

IT Project Performance
(Schedule-Cost Performance Index)

Process Maturity
CMMI Levels 3-5

H1a, H2a, H3a

H1b, H2b, H3b

Control Variables

Impact of Process Maturity
- Enables **codification** of an organization’s information and risk management practices, enables ease of **information retrieval** and **information processing**
- Provides guidelines for vendor selection – reduces adverse selection issues
- **Systematic monitoring** of problem solving efforts by project team
Research Context: Lockheed Martin

- Fortune 100 High-Tech Firm
- Defense, Aerospace and Security Systems
- Domestic presence (500 facilities)
- Global presence (75 countries)

82 IT Projects over 519 quarters

Project Characteristics (Median values)
- Project Team Size – 40 (FTE)
- Project Budget – $35 million (Max = $1.5 Billion)
- Project Duration – 5 Quarters (~15 months)
- Project Subcontracting – 20%
- Number of Subcontractors – 2
Research Design: Key Variables

<table>
<thead>
<tr>
<th>Schedule-Cost Performance Index (SCPI)</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Schedule Performance Index</td>
<td>0.91</td>
<td>0.13</td>
</tr>
<tr>
<td>• Cost Performance Index</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Complexity Risk

| • Project Uncertainty                  | 3.10  | 1.19     |
| (1 = Low, 3 = Med, 5 = High)           |       |          |
| • Project Scope                        |       |          |
| (1 = Assembly, 3 = System, 5 = Array)  |       |          |

Contracting Risk

| • Sub-contracting %                    | 1.18  | 2.28     |
| • Number of Sub-contractors            |       |          |

Execution Risk

| • Number of execution risks on risk register | 17.70 | 20.21 |
|                                             |       |       |

Process Maturity

| • CMMI Level 3, CMMI Level 4, CMMI Level 5 |       |       |
|                                            |       |       |

1993 Government Perf. & Results Act (GPRA)

1998 ANSI/EIA-748 Earned Value Management Standard

Control Variables

- Project Team Size
- Project Budget
- Project Labor
- Project Priority
- Customer Review
- Change Order

Research Design: Key Variables

5/09/2014
## Econometric Analysis: Results

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Program Risks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity Risk</td>
<td>-1.158***</td>
<td>-4.203**</td>
<td></td>
</tr>
<tr>
<td>Contracting Risk</td>
<td>0.633</td>
<td>-1.625†</td>
<td></td>
</tr>
<tr>
<td>Execution Risk</td>
<td>-4.288**</td>
<td>-4.453**</td>
<td></td>
</tr>
<tr>
<td><strong>Process Maturity Level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMMI Level 4</td>
<td>-0.345*</td>
<td>-0.353</td>
<td></td>
</tr>
<tr>
<td>CMMI Level 5</td>
<td>-2.827***</td>
<td>-3.082***</td>
<td></td>
</tr>
<tr>
<td><strong>Interaction Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity Risk × CMMI4</td>
<td></td>
<td></td>
<td>4.358***</td>
</tr>
<tr>
<td>Complexity Risk × CMMI5</td>
<td></td>
<td></td>
<td>3.660***</td>
</tr>
<tr>
<td>Contracting Risk × CMMI4</td>
<td></td>
<td></td>
<td>8.414***</td>
</tr>
<tr>
<td>Contracting Risk × CMMI5</td>
<td></td>
<td></td>
<td>2.813**</td>
</tr>
<tr>
<td>Execution Risk × CMMI4</td>
<td></td>
<td>-1.056</td>
<td></td>
</tr>
<tr>
<td>Execution Risk × CMMI5</td>
<td></td>
<td>2.695**</td>
<td></td>
</tr>
<tr>
<td><strong>Chi-Square</strong></td>
<td>149.87***</td>
<td>313.64***</td>
<td>342.06***</td>
</tr>
<tr>
<td>df</td>
<td>8</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Δ Chi-Square</td>
<td>--</td>
<td>163.77***</td>
<td>28.42***</td>
</tr>
<tr>
<td>Program-Quarter</td>
<td>519</td>
<td>519</td>
<td>519</td>
</tr>
<tr>
<td>Program</td>
<td>82</td>
<td>82</td>
<td>82</td>
</tr>
</tbody>
</table>

*H1a: Complexity Risk  
H1b: Contracting Risk  
H1c: Execution Risk  

*H2a: Complexity Risk  
H2b: Contracting Risk  
H2c: Execution Risk  

*p<0.1, **p< 0.05, ***p < 0.01
Analysis: Interaction Effects

Stronger –ve effect at CMMI 3 compared to CMMI 4 and 5

CMMI 4 and 5 outperform CMMI 3 as risk increases

Stronger –ve effect at CMMI 3 compared to CMMI 4 and 5
## Analysis: Financial Implications

### Potential Overrun/Underruns:
Median Project Budget = $35 Million

<table>
<thead>
<tr>
<th>Risk Levels (in Mean ± SD)</th>
<th>Project Performance (in SCPI)</th>
<th>ΔSCPI</th>
<th>ΔEAC*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CMMI 3</td>
<td>CMMI 4</td>
<td>CMMI 5</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>-2.00</td>
<td>112.86</td>
<td>89.09</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.00</td>
<td>92.30</td>
<td>91.95</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>2.00</td>
<td>71.74</td>
<td>94.81</td>
</tr>
</tbody>
</table>

*ΔEAC* – Estimated Savings at Completion
Conclusion – Key Findings and Contributions

- Develop a Framework for Examining Risks in Federal IT Projects
  - Contributes to the scant empirical literature on Federal IT projects
  - Complexity Risks and Execution Risks have significant negative impact on Project Performance

- Examining the Role of Process Maturity Model in Mitigating Performance Risks
  - Questions the notion that mature processes are always better
  - Significant negative direct effects of process maturity
  - Benefits of process maturity manifest when project risks are high
Maturity Levels and Federal IT Projects

Project Risks
- Complexity Risk
- Contracting Risk
- Execution Risk

Low Risk
Where CMMI 3 is more likely to be beneficial
- **Fiber-optic Motion Sensor** for Joint Strike Fighter, Hubble Telescope
- **GPS Module** for Surface-to-Air Missile
- **Web interface** for 2013 Health Insurance Marketplace

High Risk
Where CMMI 4, 5 is more likely to be beneficial
- **Navigation System** for Joint Strike Fighter, Hubble Telescope
- **Altitude Control System** for Surface-to-Air Missile
- **Implementation** of 2013 Health Insurance Marketplace
Stay at CMMI Level 3? Or Move to Levels 4 and 5?

- Beyond Level 3, organizational processes are onerous
  - Tail wags the dog (large Program Management Office)
- Large overheads tax Federal IT projects
- Many government agencies (and clients) cannot participate at Level 5
- Moving to Levels 4 and 5—Is it worth it during “sequestration”?

Decision should be based on project risk portfolio
Problems with Project Assessment Systems

• In Practice Managerial Reporting of Risk
  - Primarily uses Traffic Light Approach (R,Y,G)
• Balanced Scorecard Approach
  - Trade-off consistency and relevance to programs
• Sifting data to get at the right data
• Management, Risk Process are linked but vary
  - depending upon management perspective:
    - strategic, tactical, or sponsor

Over reliance on CMMI Metrics can be Counterproductive
Evolution of IT and PM Processes

Complexity, Contracting, and Execution Risks will Persist!

• Evolution of IT Processes
  Agile emphasis (today)
  - Focus on demonstrated value “up-front”
  - Can CMMI be tailored to Agile?

• Evolution of PM Processes
  - Firms need to use a portfolio of PM processes
  - New methods require organizational “tailoring”

Federal Contractors needs to assess both IT and PM processes to remain competitive

PM processes must be aligned with IT processes and risk
Prescriptions for Practice

• Study provides insights into the context of Federal IT projects
  • which are largely understudied in research and practice
  • $80 billion/year of tax-payer contributions invested in federal IT projects

• Identify a Framework for Classifying Project Risks
  • Use an intuitive framework for identifying project risks
  • Focus on Complexity and Execution Risks as they have strong negative effects on performance

• Does Process Maturity Matter? Higher CMMI levels reduce these negative effects
  • CMMI 3 is more likely to be beneficial at low risk projects
  • CMMI 4 and 5 are more beneficial at high risk projects

Get to level 3. Then decide on going to higher levels – based on project risk portfolio
Questions

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