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Challenges in DoD Acquisition

GAO-09-362T - Actions Needed to Overcome Long-standing Challenges with Weapon Systems Acquisition and Service Contract Management

- “costs … increased 26% and development costs increased by 40% from first estimates”
- “programs … failed to deliver capabilities when promised —often forcing warfighters to [maintain] legacy systems”
- “current programs experienced, on average, a 21-month delay in delivering initial capabilities to the warfighter”

Although DoD is the largest acquirer in the world, acquisition troubles remain

Root Cause of Poor Program Performance

Inadequate Systems Engineering!

- Finding from *Performance of the Defense Acquisition System 2013 Annual Report*
  - Dominant root cause of MDAP Cost Growth
- Finding from GAO-09-362T
  - “… managers rely heavily on assumptions about system requirements, technology, and design maturity, which are consistently too optimistic. These gaps are largely the result of a lack of a disciplined systems engineering analysis prior to beginning system development …”

<table>
<thead>
<tr>
<th>Dominant</th>
<th>MDAP Cost Growth: PARCA Root Cause Analysis¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 of 18 (56%)</td>
<td>Poor management performance</td>
</tr>
<tr>
<td>5 of 18 (28%)</td>
<td>Baseline cost and schedule estimates</td>
</tr>
<tr>
<td>4 of 18 (22%)</td>
<td>Change in procurement quantity</td>
</tr>
<tr>
<td>1 of 18</td>
<td>Immature technology, excessive manufacturing, or integration risk</td>
</tr>
<tr>
<td>2 of 18</td>
<td>Unrealistic performance expectations</td>
</tr>
<tr>
<td>1 of 18</td>
<td>Unanticipated design, engineering, manufacturing or technology issues</td>
</tr>
<tr>
<td>None</td>
<td>Funding inadequacy</td>
</tr>
</tbody>
</table>

¹. “Performance of the Defense Acquisition System 2013 Annual Report” Table 2-3, page 34
Why Do We Fail to Utilize Good SE Practices?

It’s difficult to justify the costs of SE in terms that project managers and corporate managers can relate to.

- The costs of SE are evident
  - Cost of resources
  - Schedule time

- The benefits are less obvious and less tangible
  - Cost avoidance (e.g., reduction of rework from interface mismatches)
  - Risk avoidance (e.g., early risk identification and mitigation)
  - Improved efficiency (e.g., clearer organizational boundaries and interfaces)
  - Better products (e.g., better understanding and satisfaction of stakeholder needs)

We need to quantify the effectiveness and value of SE by examining its effect on project performance?
The 2012 SE Effectiveness Study

Purpose

• Strengthen the business case for SE by relating project performance to the use of SE practices.

Method

• Contact development projects using the resources of NDIA, AESS, and INCOSE.

• Survey projects to assess their
  – SE activities
  – Project performance
  – Degree of challenge

• Process responses to identify statistical relationships between parameters.

Survey Tenets

• All data is submitted anonymously and handled confidentially by the SEI.

• Only aggregated non-attributable data is released.
The Bottom Line: \( \text{SE} = \text{Performance} \)

Across ALL projects, 1/3 are at each performance level

For Lower SEC projects, only 15\% deliver higher performance

For Middle SEC projects, 24\% deliver higher performance

For Higher SEC projects, 57\% deliver higher performance

Gamma = 0.49 represents a VERY STRONG relationship
For Challenging Projects
SE is even MORE important

Perf vs. SEC_Total (Low PC)

<table>
<thead>
<tr>
<th>SEC Level</th>
<th>Lower SEC (n=22)</th>
<th>Middle SEC (n=26)</th>
<th>Higher SEC (n=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perf</td>
<td>45%</td>
<td>58%</td>
<td>36%</td>
</tr>
<tr>
<td>Total SEC</td>
<td>32%</td>
<td>19%</td>
<td>12%</td>
</tr>
</tbody>
</table>

Gamma = 0.34  p-value = 0.029

A STRONG relationship between Total SE and Project Performance for LOWER CHALLENGE projects

Perf vs. SEC_Total (High PC)

<table>
<thead>
<tr>
<th>SEC Level</th>
<th>Lower SEC (n=26)</th>
<th>Middle SEC (n=23)</th>
<th>Higher SEC (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perf</td>
<td>69%</td>
<td>39%</td>
<td>12%</td>
</tr>
<tr>
<td>Total SEC</td>
<td>8%</td>
<td>23%</td>
<td>62%</td>
</tr>
</tbody>
</table>

Gamma = 0.62  p-value = 0.000

A VERY STRONG relationship between Total SE and Project Performance for HIGHER CHALLENGE projects
Study Participants

Participant Solicitation

- Contacted key members of major defense contractors to promote study participation
- Contacted the memberships of NDIA SE Division, IEEE AESS, and INCOSE

Collected 148 valid responses

Which of these best describes your industry or service?

- Ind. Mfg & Svc: defense: 116
- Ind. Mfg & Svc: Electronic...: 7
- Ind. Mfg and Svc: Other: 2
- Transportation: 0
- Energy: 2
- Communications: 9
- Consumer Goods & Svc: 0
- Health Care: 1
- Other: 10

Please enter the country in which most of the design and development engineering will be/was performed.

- USA: 130
- UK: 6
- South Africa: 3
- Australia: 2
- Canada: 2
- India: 1
- The Netherlands: 1
- Sweden: 1
- Finland: 1
SE Deployment and Performance

SYSTEMS ENGINEERING DEPLOYMENT

PROJECT PERFORMANCE
Total SE vs. Project Performance

Project Performance vs. Total SE (defense)

- Lower SEC (n=23): 61% Higher (9%), 30% Middle (35%), 15% Lower (54%)
- Middle SEC (n=26): 23% Higher, 42% Middle, 31% Lower
- Higher SEC (n=26): 10% Higher, 23% Middle, 61% Lower

Gamma = 0.57

A Very Strong relationship between applied SE and Project Performance for both Defense and non-Defense Projects

Project Performance vs. Total SE (non-defense)

- Lower SEC (n=12): 67% Higher (8%), 38% Middle, 9% Lower (55%)
- Middle SEC (n=8): 38% Higher, 25% Middle, 36% Lower
- Higher SEC (n=11): 38% Higher, 25% Middle, 36% Lower

Gamma = 0.66

BCSE: Defense vs. Non-Defense Projects
Architecture vs. Project Performance

Perf vs. SEC_ARCH (defense)

- Projects delivering HIGHER performance:
  - Lower SEC (n=19): 16%
  - Middle SEC (n=33): 37%
  - Higher SEC (n=23): 47%

- Projects delivering MIDDLE performance:
  - Lower SEC (n=19): 33%
  - Middle SEC (n=33): 33%
  - Higher SEC (n=23): 33%

- Projects delivering LOWER performance:
  - Lower SEC (n=19): 48%
  - Middle SEC (n=33): 17%
  - Higher SEC (n=23): 17%

Gamma = 0.38

Perf vs. SEC_ARCH (non-defense)

- Projects delivering HIGHER performance:
  - Lower SEC (n=14): 14%
  - Middle SEC (n=6): 29%
  - Higher SEC (n=11): 57%

- Projects delivering MIDDLE performance:
  - Lower SEC (n=14): 33%
  - Middle SEC (n=6): 33%
  - Higher SEC (n=11): 33%

- Projects delivering LOWER performance:
  - Lower SEC (n=14): 45%
  - Middle SEC (n=6): 18%
  - Higher SEC (n=11): 18%

Gamma = 0.54

A Strong relationship between Architecture activities and Project Performance for Defense Projects

A Very Strong relationship for non-defense projects
Requirements Dev’t & Mg’t vs. Performance

Perf vs. SEC_REQ (defense)

Lower SEC (n=22)  Middle SEC (n=26)  Higher SEC (n=27)

- Projects delivering HIGHER performance: 23%, 54%, 56%
- Projects delivering MIDDLE performance: 19%, 27%, 26%
- Projects delivering LOWER performance: 55%, 23%, 19%

Gamma = 0.46

Perf vs. SEC_REQ (non-defense)

Lower SEC (n=12)  Middle SEC (n=10)  Higher SEC (n=9)

- Projects delivering HIGHER performance: 8%, 33%, 58%
- Projects delivering MIDDLE performance: 20%, 30%, 50%
- Projects delivering LOWER performance: 0%, 0%, 33%

Gamma = 0.6

A **Very Strong** relationship between Requirements activities and Project Performance for both Defense and non-Defense Projects.
Risk Management vs. Project Performance

Perf vs. SEC_RSKM (defense)

A **Moderate** relationship between Risk Management activities and Project Performance for Defense Projects

A **Very Strong** relationship for non-defense projects

Perf vs. SEC_RSKM (non-defense)
Trade Studies vs. Project Performance

Perf vs. SEC_TRD (defense)

- Projects delivering HIGHER performance
- Projects delivering MIDDLE performance
- Projects delivering LOWER performance

A **Very Strong** relationship between Trade Study activities and Project Performance for Defense Projects

A **Strong** relationship for non-defense projects

Perf vs. SEC_TRD (non-defense)

A **Very Strong** relationship between Trade Study activities and Project Performance for Defense Projects

A **Strong** relationship for non-defense projects
Summary of Relationships

Performance vs. SE Capability

- Total SEC
- Early SE
- Project Planning
- Req'ts Dev't & Mg't
- Verification
- Product Architecture
- Configuration Mg't
- Trade Studies
- Monitor & Control
- Validation
- Product Integration
- Risk Management
- Integ Product Teams
- Project Challenge
- Experience

Moderate Weak Moderate Strong Very Strong

DEF NonD

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Next Steps: Investigate the differences between SE deployment / effectiveness in defense and non-defense domains to find “transplantable” best practices.
Questions for Further Study

On non-defense projects, why are SE activities in Requirements, Architecture, Risk Management, and Verification more effective than those on defense-related projects?

On defense projects, why are SE activities in Trade Studies, IPTs, and Project Monitoring and Control more effective than those on non-defense projects?

Why is the relationship between Project Challenge and Project Performance stronger for non-defense projects?

Why is the relationship between Prior Experience and Project Performance stronger for non-defense projects?
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1-888-201-4479

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References


IPT Utilization vs. Project Performance

Perf vs. SEC_IPT (defense)

A Strong relationship between IPT Utilization and Project Performance for Defense Projects

A Moderate relationship for non-defense projects

Perf vs. SEC_IPT (non-defense)
A Very Strong relationship between Project Planning activities and Project Performance for both Defense and non-Defense Projects.
Verification vs. Project Performance

Perf vs. SEC_VER (defense)

A Very Strong relationship between Verification activities and Project Performance for both Defense and non-Defense Projects
Validation vs. Project Performance

Perf vs. SEC_VAL (defense)

A Very Strong relationship between Validation activities and Project Performance for both Defense and non-Defense Projects
Configuration Mg’t vs. Project Performance

Perf vs. SEC_CM (defense)

A **Very Strong** relationship between Configuration Management activities and Project Performance for both Defense and non-Defense Projects.

Perf vs. SEC_CM (non-defense)

Gamma = 0.47

BCSE: Defense vs. Non-Defense Projects
27-Oct-2014
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Monitoring & Control vs. Project Performance

Perf vs. SEC_PMC (defense)

A **Very Strong** relationship between Project Monitoring and Control activities and Project Performance for Defense Projects

A **Strong** relationship for non-defense projects

Perf vs. SEC_PMC (non-defense)
Prior Experience vs. Project Performance

Perf vs. EXP (defense)

A \textbf{Weak} relationship between Prior Experience and Project Performance for Defense Projects

A \textbf{Strong} relationship for non-defense projects
Project Challenge vs. Project Performance

Perf vs. PC (defense)

- **Projects delivering HIGHER performance**
  - Lower PC (n=20): 40%
  - Middle PC (n=29): 31%
  - Higher PC (n=26): 31%

- **Projects delivering MIDDLE performance**
  - Lower PC (n=20): 35%
  - Middle PC (n=29): 31%
  - Higher PC (n=26): 38%

- **Projects delivering LOWER performance**
  - Lower PC (n=20): 25%
  - Middle PC (n=29): 38%
  - Higher PC (n=26): 31%

\[ \text{Gamma} = -0.08 \]

A **Weak Negative** relationship between Project Challenge and Project Performance for Defense Projects

Perf vs. PC (Non-defense)

- **Projects delivering HIGHER performance**
  - Lower PC (n=12): 17%
  - Middle PC (n=8): 67%
  - Higher PC (n=11): 18%

- **Projects delivering MIDDLE performance**
  - Lower PC (n=12): 63%
  - Middle PC (n=8): 0%
  - Higher PC (n=11): 64%

- **Projects delivering LOWER performance**
  - Lower PC (n=12): 17%
  - Middle PC (n=8): 38%
  - Higher PC (n=11): 64%

\[ \text{Gamma} = -0.24 \]

A **Moderate Negative** relationship for non-defense projects
Early SE vs. Project Performance

Perf vs. Early_SE (defense)

A Very Strong relationship between Early SE activities and Project Performance for both Defense and non-Defense Projects

Early SE

- Project Planning
- Requirements Development
- Trade Studies
- Product Architecture

Perf vs. Early_SE (non-defense)