

A QUANTITATIVE ACQUISITION PROCESS MODELING APPROACH TOWARD EXPEDITING SYSTEMS ENGINEERING

Yvette Rodriguez

06 April 2017

USC Center for Systems and Software Engineering
2017 Annual Research Review

Research Motivation: Better Buying Power (BBP) 3.0

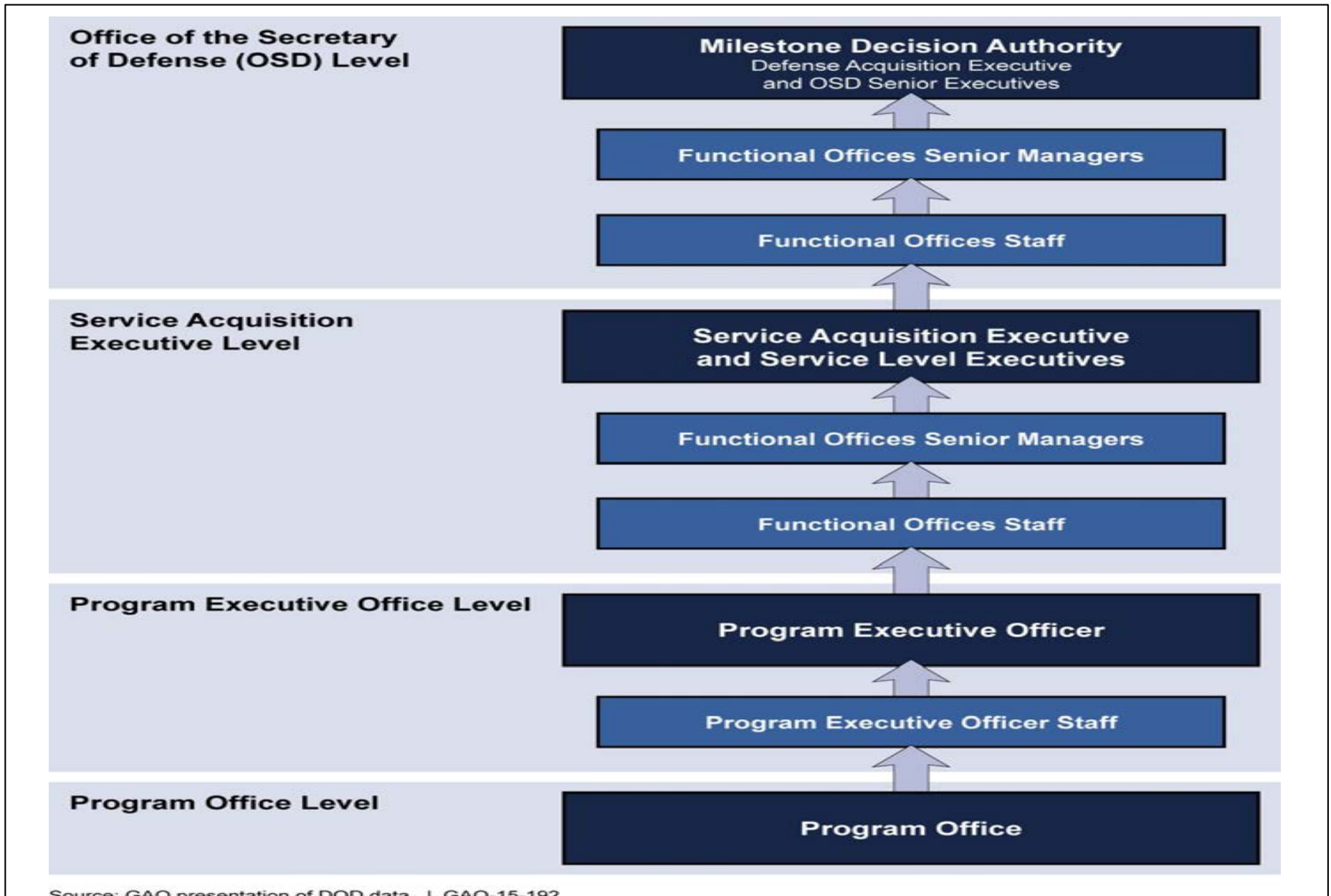
- BBP 3.0 Initiative to Eliminate Unproductive Processes and Bureaucracy by means of streamlining processes and reducing cycle time.
- BBP 3.0 Initiative: **Eliminate Unproductive Processes and Bureaucracy**
 - Unnecessary and low-value added processes and document requirements are a significant drag on acquisition productivity and must be aggressively identified and eliminated.

“Better Buying Power (BBP) is the implementation of best practices to strengthen the Defense Department's buying power, improve industry productivity, and provide an affordable, value-added military capability to the Warfighter.”

Research Focus: Pre-Milestone B Data

- Department of Defense (DoD) decision-making during early (pre-Milestone B) systems engineering processes have lasting impacts, both positive and negative, throughout the lifecycle.
- Sources of data on DOD systems engineering timelines and decision processes provided quantitative improvement insights.

DoD Review Cycle



US Air Force Review Process Example

Office of the Secretary of Defense (OSD) Level	
Defense Acquisition Executive	Assistant Secretary of Defense (Research & Engineering)
Vice Chairman of the Joint Chiefs of Staff	Deputy Assistant Secretary of Defense, Strategic & Tactical Systems
Under Secretary of Defense (Policy)	Deputy Assistant Secretary of Defense, Space & Intelligence
Under Secretary of Defense (Comptroller)	Deputy Assistant Secretary of Defense, Communication, Command, and Control Cyber
Under Secretary of Defense (Personnel & Readiness)	Director, National Geospatial-Intelligence Agency
Under Secretary of Defense (Intelligence)	Deputy Director, Cost Assessment
Chief Information Officer	Director, Defense Pricing
Director, Operational Test & Evaluation	Director, Systems Engineering
Director, Cost Assessment and Program Evaluation	Director, Developmental Test & Evaluation
Director, Acquisition Resources & Analysis	Deputy Assistant Secretary of Defense, Manufacturing & Industrial Base Policy
Principal Deputy Under Secretary of Defense (Acquisition, Technology, & Logistics)	Director, International Cooperation
Assistant Secretary of Defense (Acquisition)	Director, Performance Assessment and Root Cause Analysis
Assistant Secretary of Defense (Logistics & Material Readiness)	Assistant Secretary of Defense (Legislative Affairs)
Deputy Under Secretary of Defense (Installations and Environment)	Director, Defense Procurement and Acquisition Policy
Deputy General Counsel (Acquisition & Logistics)	Assistant Secretary of Defense (Operational Energy Plans and Programs)

Service Acquisition Executive (SAE) Level	
Assistant Secretary of the Air Force for Acquisition (Service Acquisition Executive)	Air Force Logistics, Installations & Mission Support (Logistics)
Assistant Secretary of the Air Force Installations & Environment	Assistant Secretary of the Air Force Installations & Environment (Logistics)
Air Force Logistics, Installations, & Mission Support	Air Force Intelligence, Surveillance, & Reconnaissance (Strategy, Plans, Doctrine & Force Readiness)
Air Force Operations, Plans, & Requirements	Assistant Secretary of the Air Force Chief Information Officer (Policy & Resources)
Air Force Intelligence, Surveillance, & Reconnaissance	Assistant Secretary of the Air Force Deputy General Counsel for Acquisition
Air Force Financial Management & Comptroller	Air Force Financial Management and Comptroller Deputy Assistant Secretary (Cost and Economics)
Air Force Test & Evaluation	Air Force Financial Management and Comptroller Deputy Assistant Secretary (Budget)
Assistant Secretary of the Air Force Small Business Programs	Assistant Secretary of the Air Force Directorate of Science, Technology & Engineering
Assistant Secretary of the Air Force Chief Information Officer	Assistant Secretary of the Air Force Directorate Management Policy & Program Integration
Assistant Secretary of the Air Force Test & Evaluation (Policy and Programs)	Assistant Secretary of the Air Force Directorate of Contracting
Air Force Operations, Plans & Requirements (Operational Capability Requirements)	Air Force Acquisition Capability Directorate

Program Executive Office	
Program Executive Office	Finance Functional Staff
Deputy Program Executive Officer	Engineering Functional Staff
Contracting Functional Staff	Program Executive Officer Execution Group
Logistics Functional Staff	

- 30 Levels of Office of the Secretary of Defense (OSD) Reviews
- 22 Service Levels of Acquisition Executive (SAE) Reviews
- 7 Levels of Program Executive Office (PEO) Reviews

Program Executive Office (PEO) Level Reviews

1. Program Executive Office
2. Finance Functional Staff
3. Deputy Program Executive Officer
4. Engineering Functional Staff
5. Contracting Functional Staff
6. Program Executive Officer Execution Group
7. Logistics Functional Staff

Service Acquisition Executive (SAE) Level Reviews

1. Assistant Secretary of the Air Force for Acquisition (Service Acquisition Executive)
2. Assistant Secretary of the Air Force Installations & Environment
3. Air Force Logistics, Installations, & Mission Support
4. Air Force Operations, Plans, & Requirements
5. Air Force Intelligence, Surveillance, & Reconnaissance
6. Air Force Financial Management & Comptroller
7. Air Force Test & Evaluation
8. Assistant Secretary of the Air Force Small Business Programs
9. Assistant Secretary of the Air Force Chief Information Officer
10. Assistant Secretary of the Air Force Test & Evaluation (Policy and Programs)
11. Air Force Operations, Plans & Requirements (Operational Capability Requirements)
12. Air Force Logistics, Installations & Mission Support (Logistics)
13. Assistant Secretary of the Air Force Installations & Environment (Logistics)
14. Air Force Intelligence, Surveillance, & Reconnaissance (Strategy, Plans, Doctrine & Force Development)
15. Assistant Secretary of the Air Force Chief Information Officer (Policy & Resources)
16. Assistant Secretary of the Air Force Deputy General Counsel for Acquisition
17. Air Force Financial Management and Comptroller Deputy Assistant Secretary (Cost and Economics)
18. Air Force Financial Management and Comptroller Deputy Assistant Secretary (Budget)
19. Assistant Secretary of the Air Force Directorate of Science, Technology & Engineering
20. Assistant Secretary of the Air Force Directorate Management Policy & Program Integration
21. Assistant Secretary of the Air Force Directorate of Contracting
22. Air Force Acquisition Capability Directorate

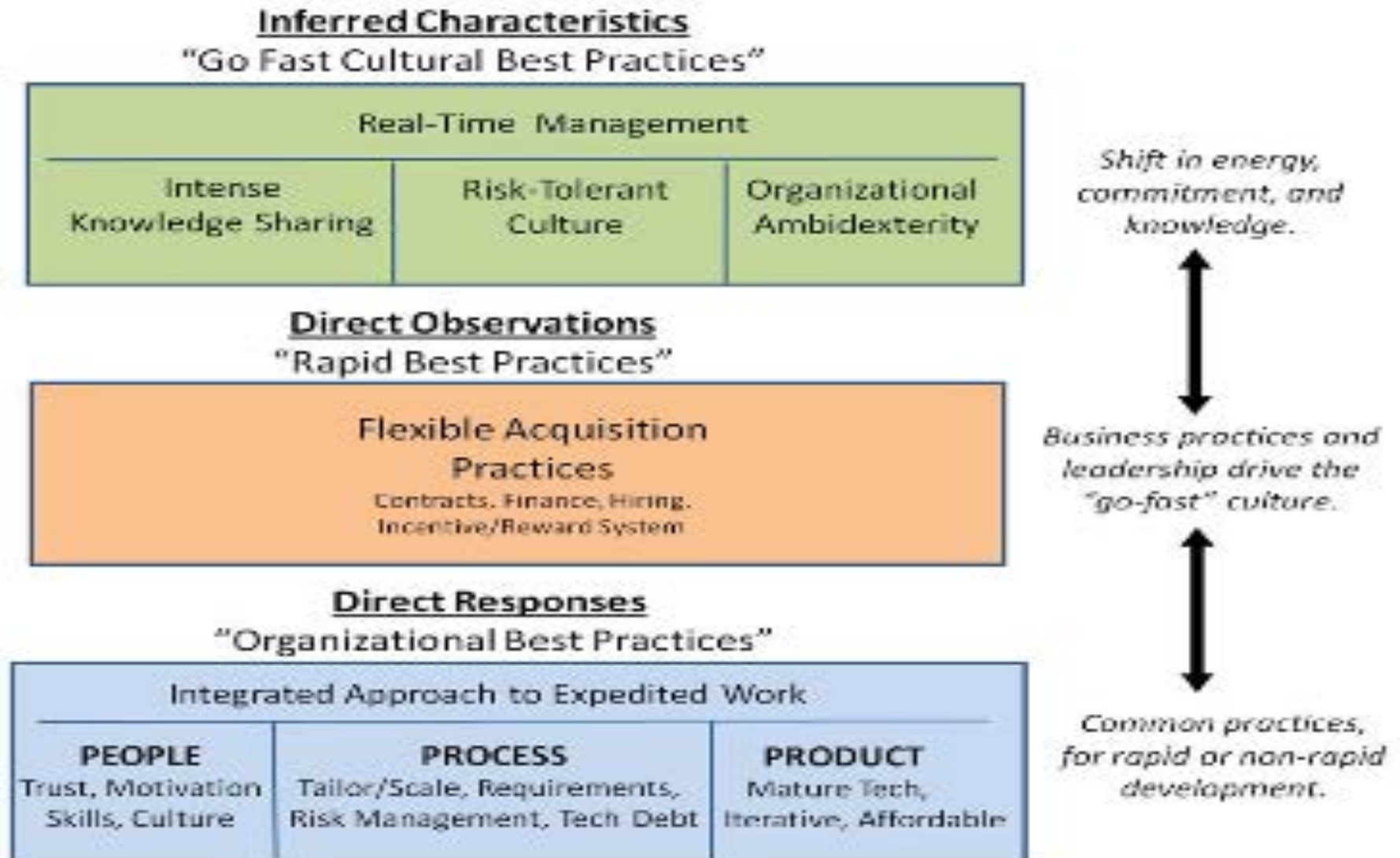
Office of the Secretary of Defense (OSD) Level Reviews

1. Defense Acquisition Executive
2. Assistant Secretary of Defense (Research & Engineering)
3. Vice Chairman of the Joint Chiefs of Staff
4. Deputy Assistant Secretary of Defense, Strategic & Tactical Systems
5. Under Secretary of Defense (Policy)
6. Deputy Assistant Secretary of Defense, Space & Intelligence
7. Under Secretary of Defense (Comptroller)
8. Deputy Assistant Secretary of Defense, Communication, Command, and Control Cyber
9. Under Secretary of Defense (Personnel & Readiness)
10. Director, National Geospatial-Intelligence Agency
11. Under Secretary of Defense (Intelligence)
12. Deputy Director, Cost Assessment
13. Chief Information Officer
14. Director, Defense Pricing
15. Director, Operational Test & Evaluation
16. Director, Systems Engineering
17. Director, Cost Assessment and Program Evaluation
18. Director, Developmental Test & Evaluation
19. Director, Acquisition Resources & Analysis
20. Deputy Assistant Secretary of Defense, Manufacturing & Industrial Base Policy
21. Principal Deputy Under Secretary of Defense (Acquisition, Technology, & Logistics)
22. Director, International Cooperation
23. Assistant Secretary of Defense (Acquisition)
24. Director, Performance Assessment and Root Cause Analysis
25. Assistant Secretary of Defense (Logistics & Material Readiness)
26. Assistant Secretary of Defense (Legislative Affairs)
27. Deputy Under Secretary of Defense (Installations and Environment)
28. Director, Defense Procurement and Acquisition Policy
29. Deputy General Counsel (Acquisition & Logistics)
30. Assistant Secretary of Defense (Operational Energy Plans and Programs)

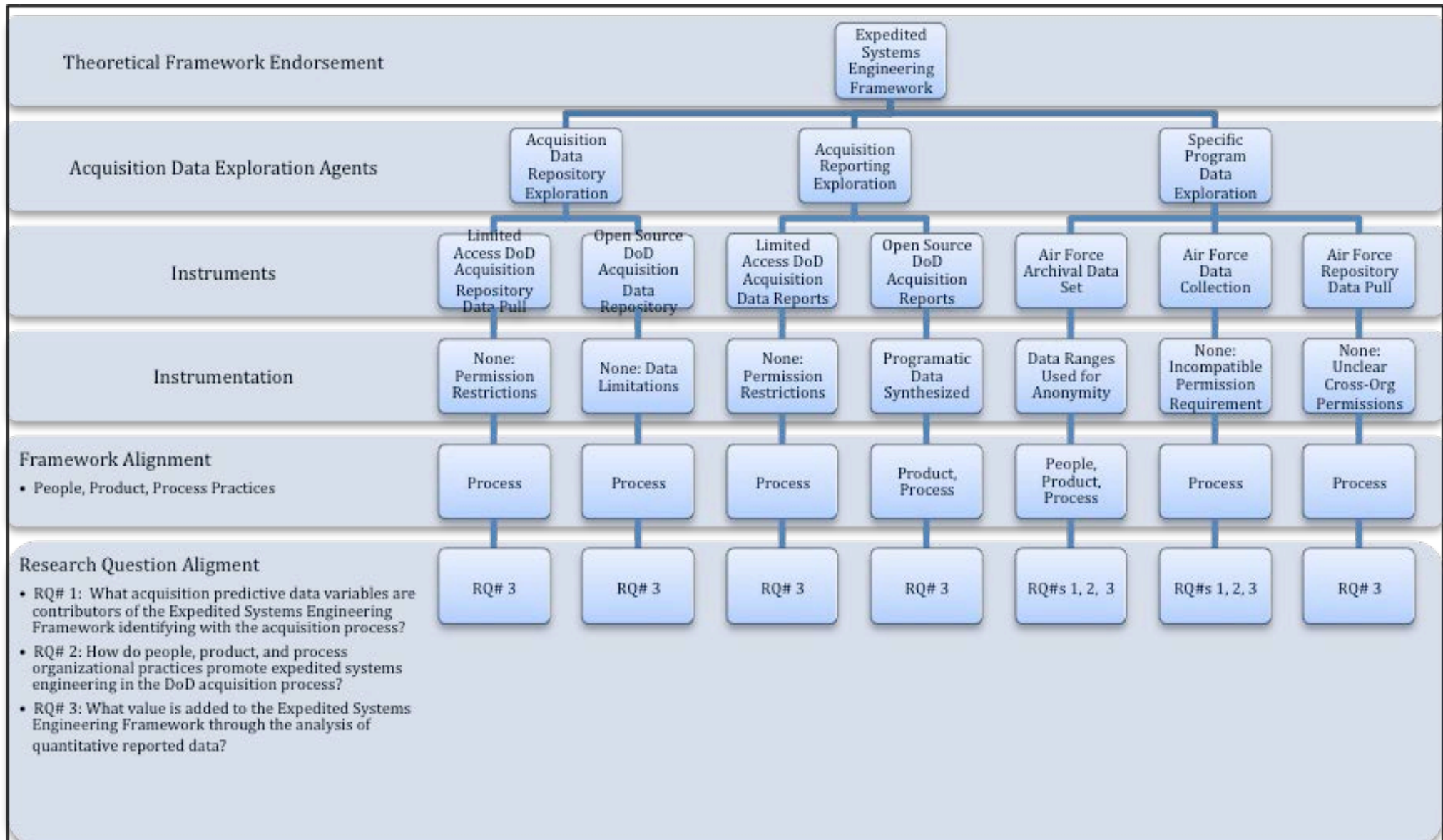
Hypothesis & Research Questions

- Hypothesis: There exists a baseline set of critical success factor data variables that identify early DOD Acquisition programs likely to experience delays.
- Research Questions:
 - RQ1: What early acquisition predictive data variables act as critical success factors in distinguishing previous Expedited versus Delayed early-SE acquisition processes?
 - RQ2: How can the people, product, and process organizational practices identified in the ESEF framework better promote expedited systems engineering throughout the early-SE DoD acquisition process?
 - RQ3: What value is added to the Expedited Systems Engineering Framework through the analysis of quantitative reported data?

Expedited Systems Engineering Framework



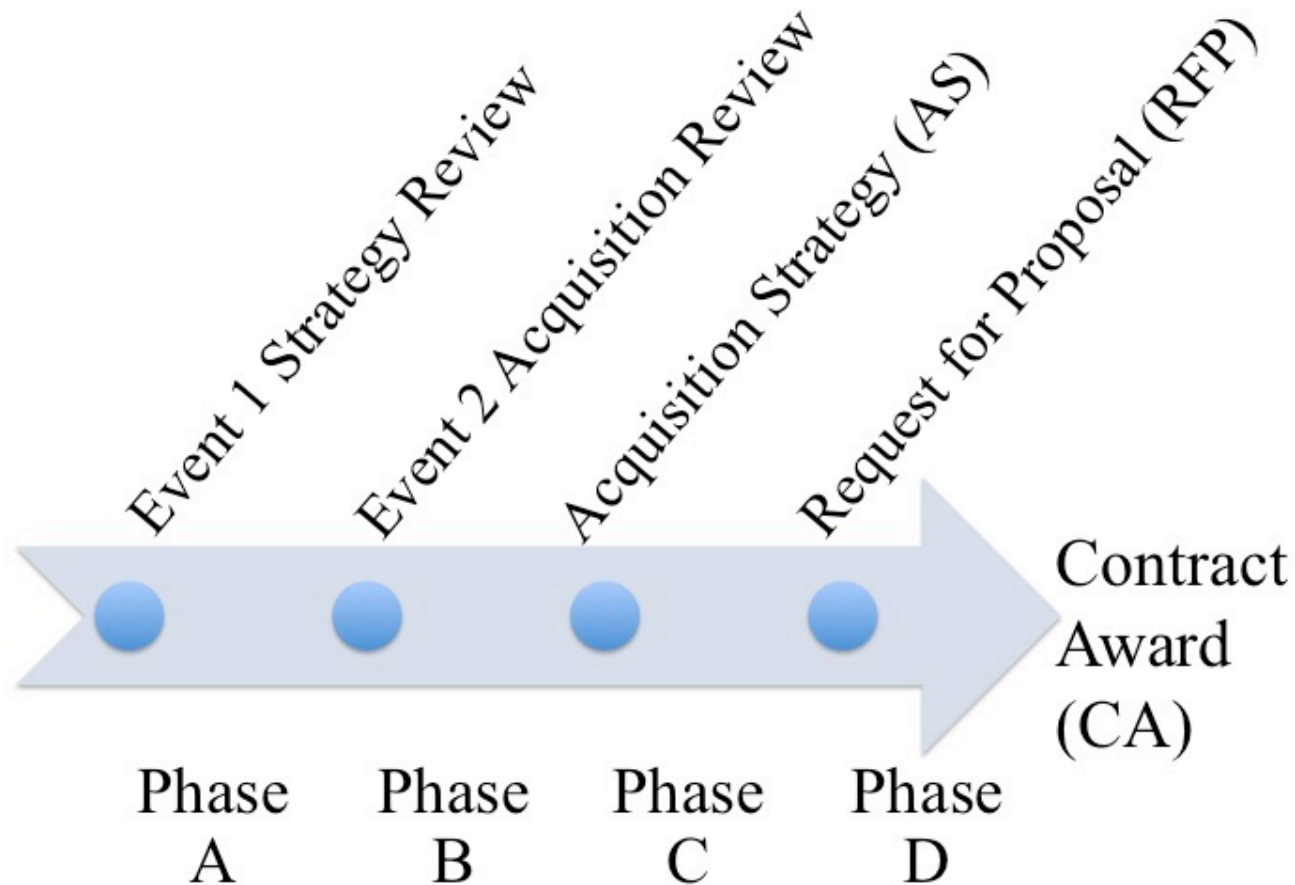
Theoretical Framework



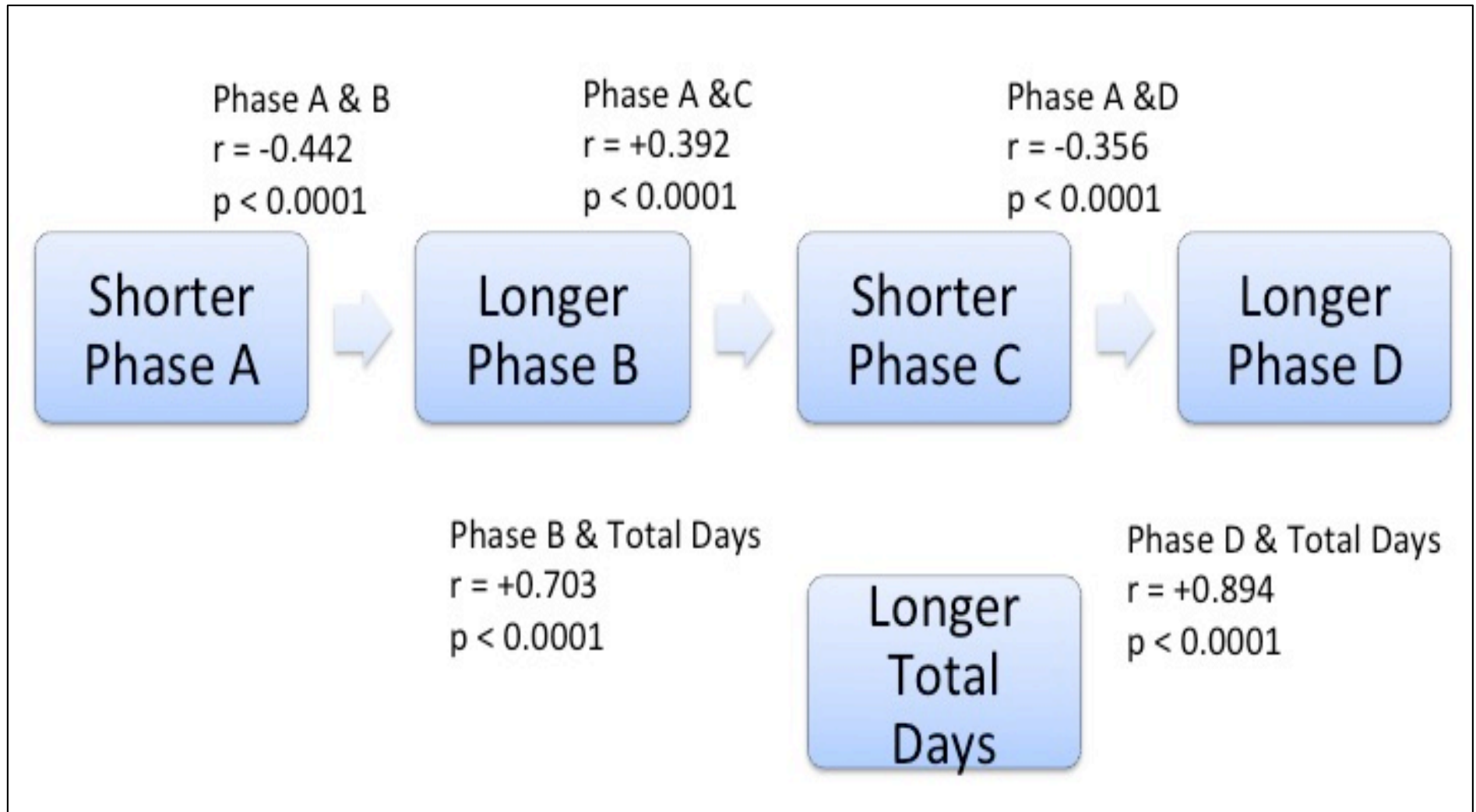
Pre-Milestone B Process of Interest: Generic DoD Contract Award Process



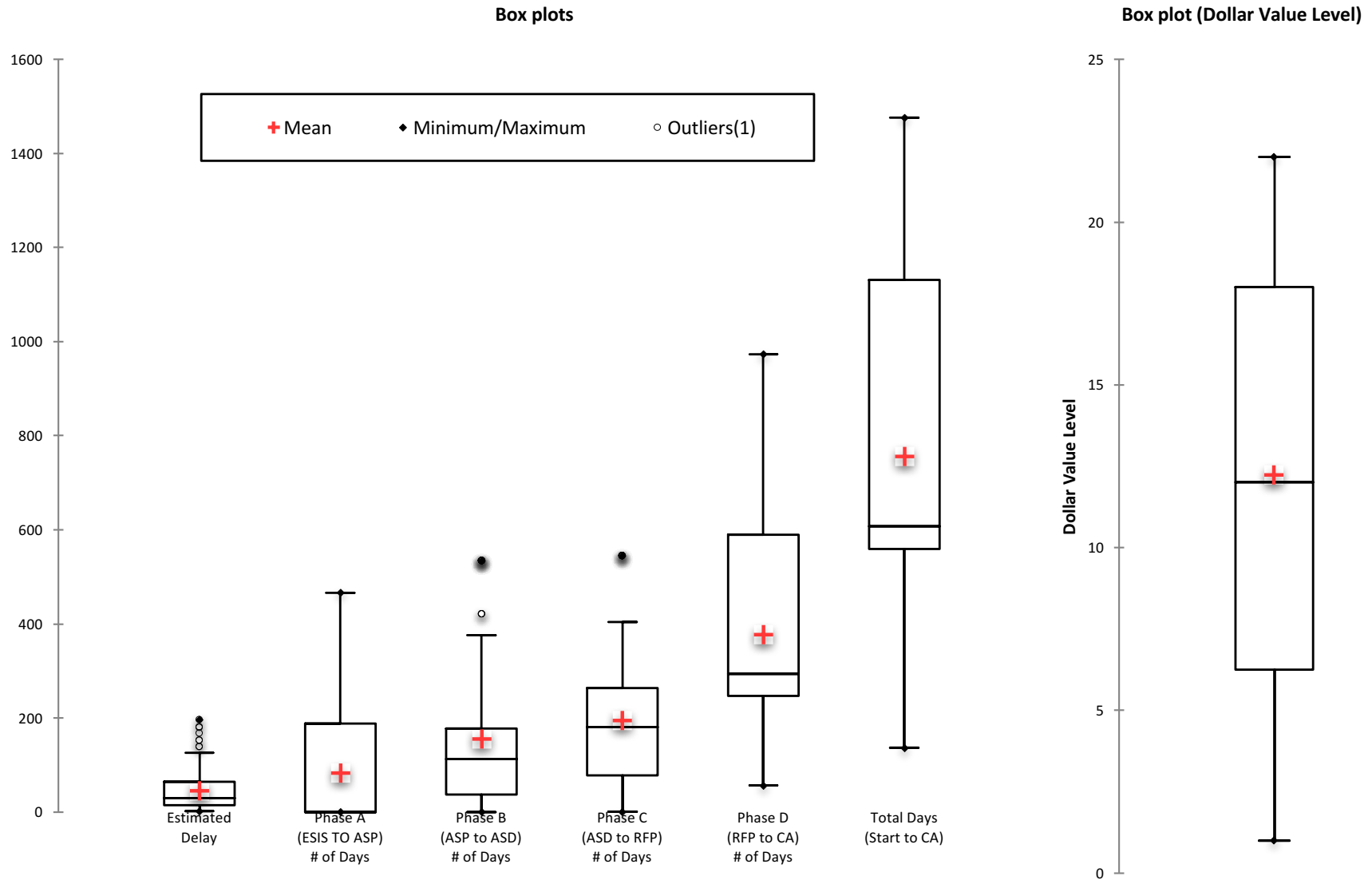
Military Contract Award Process



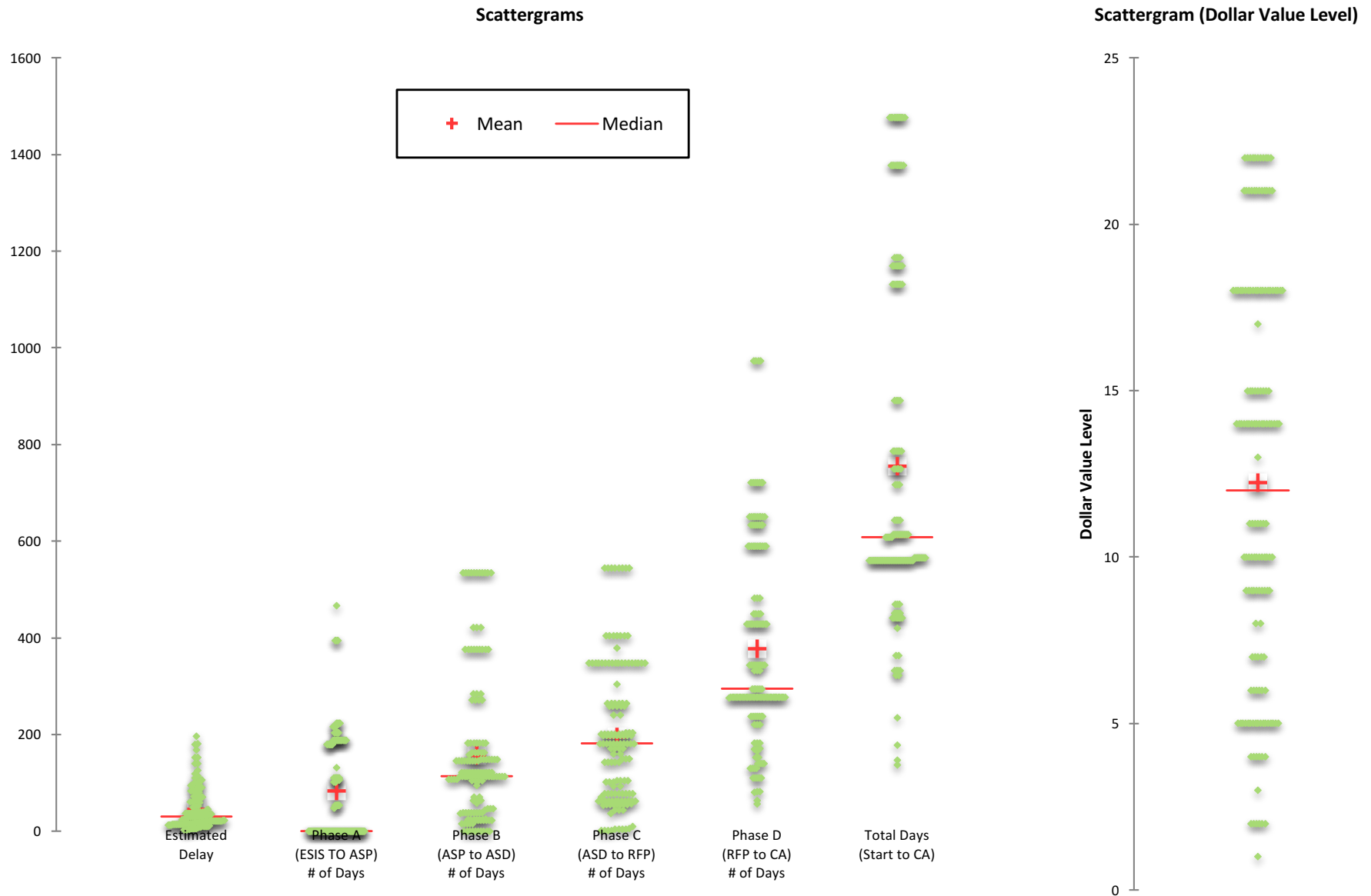
Findings



Box Plot Outliers



Scatter Plot Outliers



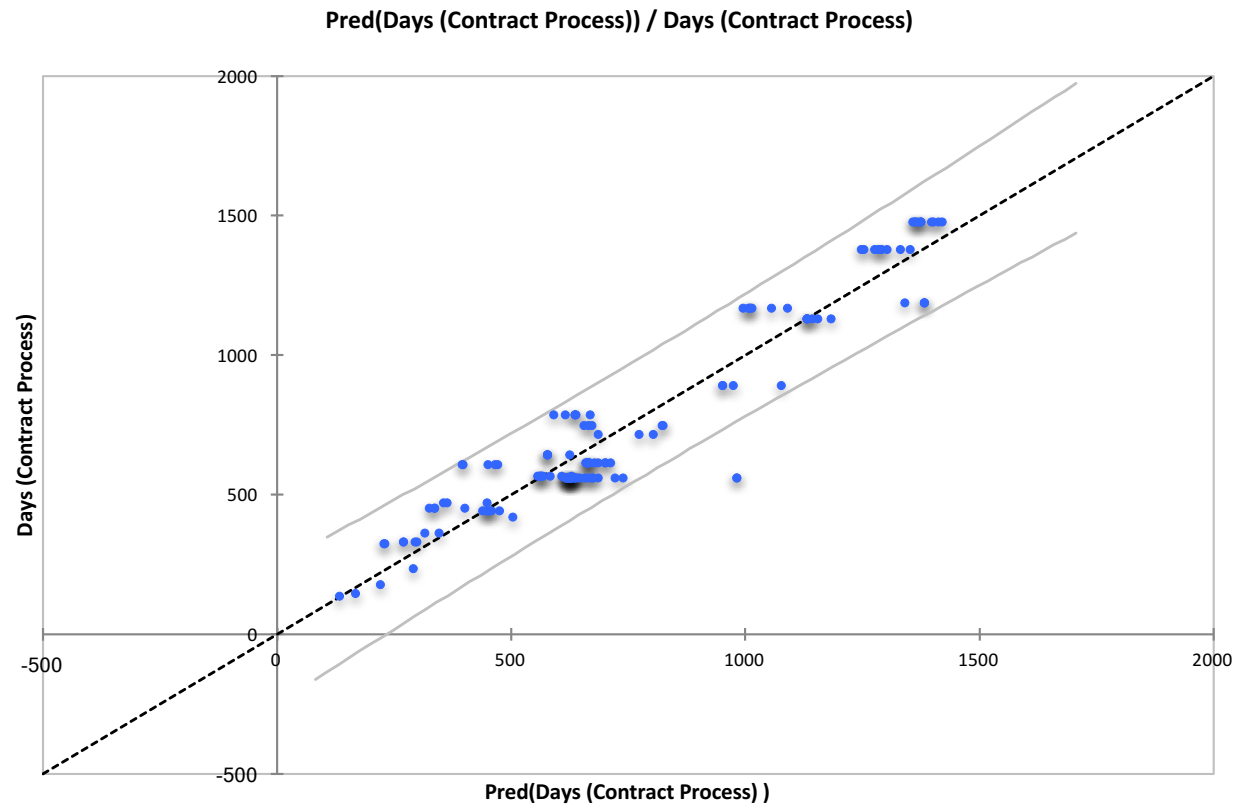
Regression Results

$$\Sigma D_{\text{Contract Process}} = 55.4 + 0.8 * D_{\text{Estimated Delay}} - 8.1 DV_{\text{Contract}} + 0.6 D_{\text{Phase A}} + 1.4 D_{\text{Phase B}} + 0.4 D_{\text{Phase C}} + 1.2 D_{\text{Phase D}}$$

D = Number of Days

DV = Dollar Value Level

Given the R^2 , 91% of the variability of the dependent variable $D_{\text{Contract Process}}$ is explained by the 6 explanatory variables.



Conclusions

- **Quantitative Results:** The results support the hypothesis identifying that there exists a baseline set of critical success factors data variable to provide evidence-based decision-making in expediting systems engineering.
- **Study Results:** The results addresses findings specific to the ESEF process by identifying process phase trends.
- **DoD Acquisition Data Collection Practices:** An extensive search was conducted to find an appropriate set of data to conduct a significant quantitative study across multiple programs and data limitations continue to make quantitative analysis particularly challenging.
- **Early Systems Engineering Practices:** The practices explored specifically focused on the contract award process with observations based on expert opinion.

Levels of Knowledge Distribution



Final Recommendations

- An earlier understanding of the wider systemic view of the mission objective can provide a wider and more effective range of true alternatives (trade-space) in early systems engineering processes.
- Proposed solutions approved at lower levels can have belated rejections and delays later in the process, therefore early communication between higher authoritative levels and the program office is recommended.
- Identification of the specific dangers in expediting predecessor phases and concurrently accomplishing tasks in multiple phases to will provide an improved understanding of risks and opportunities.