Assessing Enterprise Resource Planning (ERP) Cost, Schedule and Size Growth

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Outline

- Introduction
- ERP Overview
- Data Analysis Approach
- Data Demographics
- Cost Growth
- Schedule Growth
- Cost Benchmarks
- Schedule Benchmarks
- Conclusion
Problem Statement

- Program Office estimates of Enterprise Resource Planning (ERP) implementation costs and schedules are inaccurate, despite increased oversight
- All major DoD ERP deployed programs experienced cost growth
- All major DoD ERP deployed programs experienced schedule delays

As of Dec. 2016, DoD has invested more than $16B in their deployed nine ERP programs!
Purpose of Study

- Analyze performance of nine (9) ERP programs in terms of cost and schedule growth at each Authority to Proceed (ATP) event

- Establish cost and schedule benchmarks to crosscheck early estimates, such as Business Case Analysis and/or Special Studies
Overview
Enterprise Resource Planning (ERP) systems are typically **commercial software systems** that **integrate** an organization’s **core business functions** around a **unified data base**.

ERP definition, in terms of cost characteristics, is related to the **scope and integration of multiple business systems/processes**.
How is ERP implemented?

Business processes are automated via an integrated COTS software application:

- **Microsoft Dynamics**
- **SAP**
- **Oracle**

**2010 Vendor Market Share**
- Microsoft Dynamics: 11%
- Oracle: 18%
- SAP: 24%
- Tier II: 11%
- Tier III and others: 36%

**Current Major Deployed DoD ERP Programs**
- SAP: 56%
- Oracle: 44%

Integration is typically done by a 3rd Party Vendor
New Defense Business System (DBS) Acquisition Cycle uses the Authority to Proceed (ATP) decision points roughly equivalent to Milestones in the previous DODI release.

PDR = Preliminary Design Review; CDR = Critical Design Review; IOC = Initial Operational Capability; FD = Full Deployment;
Business Capability Acquisition Cycle (Future)*

Authority to Proceed (ATP) are “milestone-like events”

*Adapted from DoDI 5000.75, February 2, 2017, pp 5, Figure 1
Data Analysis Approach
• Dataset normalized to “account for sizing units, application complexity, and content so they are consistent for comparisons” (source: GAO)
Data Sources

Cost, Schedule, and Technical Data from Authoritative Sources:

**Cost**
- Approved Cost Estimate
- Final Cost Model

**Schedule**
- MAIS Annual Report (MAR)
- MAIS Quarterly Report

**Technical**
- Cost Analysis Requirements Document (CARD)
- Software Resources Data Report (SRDR)

Data analysis is based on nine ERP deployed programs
Cost Assumptions

Milestones
- Solution Analysis
- Functional Requirements
- Acquisition
- Limited Deployment
- Full Deployment

Activities
- Development
- Procurement
- Fielding

Cost Group
- Development Cost
- Deployment Cost

System Acquisition*
* Acquisition includes all associated costs from Solution Analysis ATP throughout Full Deployment ATP

Cost Elements*
- Design/Configuration/Customization
- Program Management
- Systems Engineering
- Change Management
- Training Development
- Development Test & Evaluation

- Deployment Software Licenses
- Deployment Hardware Procurement

- User Training
- Site Installation/Activation
- Data Conversion
- Execution Cut-over
- Interim Sustainment
- Operational Test & Evaluation

Assumptions
- Cost in Base Year 2016 Dollars

*Adapted from MIL-STD-881D Appendix K (unpublished draft as of March 6, 2017)

Authority to Proceed (ATP) are "milestone-like events"
Schedule Assumptions
Current vs. Future Acquisition Process

Current Acquisition Cycle
DoDI 5000.02

Milestone A

Milestone B

Milestone C

Full Deployment Decision

Full Deployment

Future Acquisition Cycle
DoDI 5000.75

Solution Analysis ATP

Functional Requirements ATP

Acquisition ATP

Limited Deployment ATP

Full Deployment ATP

ATP = Authority to Proceed
Data Demographics
Project Characteristics

DoD Component
- DoD 20%
- NAVY 20%
- AIR FORCE 20%
- ARMY 40%

Functional Area
- Financial 33%
- Logistics 34%
- HR 11%
- Multiple 22%

Program Heritage
- New 33%
- Follow-on 67%

✓ Analysis based on 9 deployed ERP programs
An average ERP acquisition costs approximately $0.9 billion, with 70% of the programs ranging between $0.6 B and $1.9 B.

FD = Full Deployment Authority to Proceed (ATP)
• 80% of programs between 50 and 115 months
• Median Acquisition Duration: 98 months
• Median Development Duration: 39 months
• Median Deployment Duration: 53 months

~60% of programs experienced critical breach for time (failure to meet Limited Deployment ATP within five years of Solution Analysis ATP)

FD = Full Deployment Authority to Proceed (ATP)
Technical Requirements at FD

- **RICE Counts** median: 413
- **User Estimates** median: 26,600

**RICE**: Reports, Interfaces, Conversions, Extensions

Majority of Deployed ERP systems have fewer than 40,000 Users
Cost Growth
Cost Growth Overview

- **Milestones**
  - ATP1
  - ATP2
  - ATP3
  - ATP4
  - ATP5

- **Activities**
  - Development
  - Procurement
  - Fielding

- **Cost Group**
  - Development
  - Deployment

- **Cost Elements included**
  - **Development**
    - ERP Configuration/Customization
    - Program Management
    - Systems Engineering
    - Change Management
    - Training Development
    - Development Test & Evaluation
  - **Procurement**
    - Deployment Software Licenses
    - Deployment Hardware Procurement
  - **Fielding**
    - User Training
    - Site Installation/Activation
    - Data Conversion
    - Execution Cut-over
    - Interim Sustainment
    - Operational Test & Evaluation

- **Key Metric:**
  - Development Cost Growth
  - Procurement Cost Growth
  - Fielding Cost Growth

- **Usefulness**
  - Use as secondary method to adjust point estimate for cost growth
  - Use descriptive statistics (as last resort) for defining cost risk/uncertainty bounds
Cost growth in ATP1 and ATP2 was primarily driven by schedule delays.

Delays were triggered by ERP software customization, including scope creep and re-work.

Schedule delays extend the “standing-Army” personnel, up to 50% of total development cost.
Lower procurement cost volatility due to stable user counts and negotiated license fees
Acquisition Cost Growth (Planned to Actual at each ATP)

Acquisition Cost includes Development, Procurement and Fielding costs

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<table>
<thead>
<tr>
<th>Descriptive Statistics</th>
<th>ATP1</th>
<th>ATP2</th>
<th>ATP3</th>
<th>ATP4</th>
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<tbody>
<tr>
<td>Mean (Average)</td>
<td>110%</td>
<td>51%</td>
<td>2%</td>
<td>3%</td>
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<tr>
<td>Std Dev</td>
<td>132%</td>
<td>65%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>Min</td>
<td>3%</td>
<td>3%</td>
<td>-22%</td>
<td>-7%</td>
</tr>
<tr>
<td>Max</td>
<td>340%</td>
<td>176%</td>
<td>24%</td>
<td>24%</td>
</tr>
</tbody>
</table>
Reasons for Cost Growth

1. Failure to implement Business Process Reengineering (BPR) best practices: Difficult to change business processes / culture to exploit ERP strengths.

2. Engineering: Inexperience with Oracle/SAP customization and configuration led to scope and requirements growth.

3. Estimation: Optimistic acquisition planning contributed to underestimation of both effort and duration at Solution Analysis ATP.

4. Schedule: Limited budgets forced delays and extended fixed staffing cost; not meeting user expectations generated unanticipated rework.
Schedule Growth
Schedule Growth Overview

**Key Schedule metrics:**
- Program Length (in months)
- Program Length (in months)

**What does this measure?**
- Actual vs Planned Duration (at ATP1 or ATP2)
- Actual vs Planned Duration (at ATP4 or ATP5)

**Usefulness**
- To adjust deployment duration using the schedule growth factors
- For defining schedule risk/uncertainty bound
Deployed ERP programs have slipped an average of 47 months from the original schedule, ranging between 9 to 97 months
At Functional Requirements ATP, deployed ERP programs experienced an average of 25 months schedule slip. Schedule slip is lower than at Solution Analysis ATP as scope is better defined/identified.
Reasons for Schedule Growth

1. Premature fielding: Failing to meet user expectations generated unanticipated rework.

2. Developmental Testing: Significant system deficiencies to fix before fielding.

3. Engineering: Inexperience with Oracle/SAP Configuration and Customization led to underestimation of delivery timeline. Difficulty changing business processes to exploit ERP.

4. Quantity: War-fighter needs led some program offices to reassess user and implementation requirements.

5. Schedule Uncertainty Analysis: Recommended now, but in the past, Program Office’s optimistic schedule was a ground rule.
Cost Benchmarks
Cost Factors Overview

Activities
- Development
  - Solution Analysis ATP
  - Functional Requirements ATP
- Procurement
  - Acquisition ATP
- Fielding
  - Limited Deployment ATP
  - Full Deployment ATP

Cost Elements
- Development:
  - Design/Configuration/Customization
  - Program Management
  - Systems Engineering
  - Change Management
  - Training Development
  - Development Test & Evaluation
- Procurement:
  - Deployment Software Licenses
  - Deployment Hardware Procurement
- Fielding:
  - User Training
  - Site Installation/Activation
  - Data Conversion
  - Execution Cut-over
  - Interim Sustainment
  - Operational Test & Evaluation

Key Cost metrics:
- Development:
  - Development Cost per RICE*
  - Development Cost per Requirement
- Procurement:
  - Procurement Cost per User
- Fielding:
  - Fielding Cost per User

What this measures?
- Development:
  - Volume of development work units addressed by a number of either RICE or requirement
- Procurement:
  - IT Hardware and Software License Costs addressed by a number of users
- Fielding:
  - Volume of deployment & fielding work units addressed by a number of users

Rationale for metric
- Development:
  - Interfaces and requirements often available at Solution Analysis ATP
  - RICE often available at Functional Requirements ATP
- Procurement:
  - Number of users are available at early ATP and tends to be stable throughout life cycle
- Fielding:
  - Number of users are available at early ATP and tends to be stable throughout life cycle

Authority to Proceed (ATP) are “milestone-like events”

*RICE = reports, interfaces, conversions, and extensions of software objects
Development Cost per RICE

Formula:

\[
\text{Development Cost Factor} = \frac{(\text{Cost})_{FD}}{(\text{RICE})_{ATP1}} \frac{(\text{Cost})_{FD}}{(\text{RICE})_{ATP2}} \frac{(\text{Cost})_{FD}}{(\text{RICE})_{FD}}
\]

\(\text{COST}_{FD} = \text{Actual Development Cost at FD}\); \(\text{RICE}_{ATP1} = \text{Estimated RICE at ATP1}\); \(\text{RICE}_{ATP2} = \text{Estimated RICE at ATP2}\); \(\text{RICE}_{FD} = \text{Actual RICE at FD}\)
Development Cost per Requirement

Formula:
Development Cost Factor = \frac{(\text{Cost})_{FD}}{(\text{REQ})_{ATP1}} = \frac{(\text{Cost})_{FD}}{(\text{REQ})_{ATP2}} = \frac{(\text{Cost})_{FD}}{(\text{REQ})_{FD}}

\text{COST}_{FD} = \text{Actual Development Cost at FD}; \quad \text{REQ}_{ATP1} = \text{Estimated Requirements at ATP1}; \quad \text{REQ}_{ATP2} = \text{Estimated Requirements at APT2}; \quad \text{REQ}_{FD} = \text{Actual Requirements at FD}
Procurement Cost per User

**Formula:**

\[ \text{Procurement Cost Factor} = \frac{(\text{Cost})_{FD}}{(\text{User})_{ATP1}} \cdot \frac{(\text{Cost})_{FD}}{(\text{User})_{ATP2}} \cdot \frac{(\text{Cost})_{FD}}{(\text{User})_{FD}} \]

- \( (\text{Cost})_{FD} \) = Actual Procurement Cost at FD
- \( (\text{User})_{ATP1} \) = Estimated users at ATP2
- \( (\text{User})_{ATP2} \) = Estimated users at ATP2
- \( (\text{User})_{FD} \) = Actual users at Full Deployment
Schedule Benchmarks
Schedule Factors Overview

**Events**
- ATP1: Solution Analysis
- ATP2: Functional Requirements
- ATP3: Acquisition
- ATP4: Limited Deployment
- ATP5: Full Deployment

**Activities**
- Development
- Procurement
- Fielding

**Phases**
- Development Phase
- Deployment Phase

**Key Schedule metrics:**
- RICE per Month
- Requirements per Month
- Users per Month

**What this measures?**
- Development phase duration using number of RICE or requirements
- Deployment phase duration based on the number of users

**Rationale for metric**
- Interfaces and requirements often available at Solution Analysis ATP
- RICE often available at Functional requirements ATP
- Number of users often available at Solution Analysis ATP
- Percent change in user count is very low throughout FD
RICE per Development Months

Development Schedule Factors

Formula:
Development Schedule Factor = \frac{(RICE)_{ATP1}}{(Month)_{FD}} \quad \frac{(RICE)_{ATP2}}{(Month)_{FD}} \quad \frac{(RICE)_{FD}}{(Month)_{FD}}

MONTH_{FD} = Actual Development Duration at FD; \quad RICE_{ATP1} = Estimated RICE at ATP1; \quad RICE_{ATP2} = Estimated RICE at ATP2; \quad RICE_{FD} = Actual RICE at Full Deployment
Requirements per Development Months

Formula:

Development Schedule Factor = \( \frac{REQ_{ATP1}}{(Month)_{FD}} \)

\( \frac{REQ_{ATP2}}{(Month)_{FD}} \)

\( \frac{REQ_{FD}}{(Month)_{FD}} \)

MONTH_{FD} = Actual Development Duration at FD;  
REQ_{ATP1} = Estimated requirements at ATP1;  
REQ_{ATP2} = Estimated requirements at ATP2;  
REQ_{FD} = Actual requirements at FD
Users per Deployment Months

Formula:

\[
\text{Deployment Schedule Factor} = \frac{\text{USER}_{\text{ATP1}}}{\text{MONTH}_{\text{FD}}} \times \frac{\text{USER}_{\text{ATP2}}}{\text{MONTH}_{\text{FD}}} \times \frac{\text{USER}_{\text{FD}}}{\text{MONTH}_{\text{FD}}}
\]

MONTH_{FD} = Actual Deployment Duration at FD; \quad \text{USER}_{\text{ATP1}} = Estimated users at ATP1; \quad \text{USER}_{\text{ATP2}} = Estimated users at ATP2; \quad \text{USER}_{\text{FD}} = Actual requirements at FD
Conclusion
Primary Findings

• All major deployed ERP programs in DoD experienced cost and schedule growth from initial estimates
  ▪ Actual data suggests cost and duration are always underestimated at ATP1 and ATP2

• Cost and schedule overruns were each over 100% from Solution Analysis ATP

• Most ERP programs exceeded five years guideline to limited deployment

• Deployment Schedule overruns were greater than Development overruns
Lessons Learned

• Adjust your point estimate for growth, as all ERP programs have exceeded original estimates, account for the uncertainty

• Add growth according to the program’s maturity

• Cost factors should be developed using initial size estimates to minimize estimating error and account for growth

• Cost analysts should add uncertainty to schedule as it is the primary contributor to cost overruns
QUESTIONS?

Thank you for your attention