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# Advancing EVM with a Modernized Framework

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# Contributors

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Senior Analyst

Aaron works as a Senior Analyst with experience providing EVM, Schedule Analysis, Life Cycle Estimating, and program management support on multiple programs. He has supported DoD and DHS clients. He has his B.S. in Industrial and Systems Engineering from Virginia Tech and a Masters Degree in Systems Engineering from Virginia Tech.

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Senior Analyst

Mr. Maples has experience providing independent cost estimates on military vehicles as well as a growing list of Canadian Proposal Evaluations. He currently supports multiple shipbuilding programs providing EVM analysis and support. He has his BS in Industrial and Systems Engineering from Virginia Tech and is a Certified Cost Estimator/Analyst through ICEAA.

**Scott Campbell**

Lead Analyst

Scott is a Lead Analyst that has supported several Navy programs over the last three years. He has experience providing life cycle cost estimating, proposal evaluations, EVM, and data tool development. He holds a B.S. in Integrated Mechanical Design Engineering with minors in Business and Engineering Management from the University of Colorado Boulder.

# Agenda

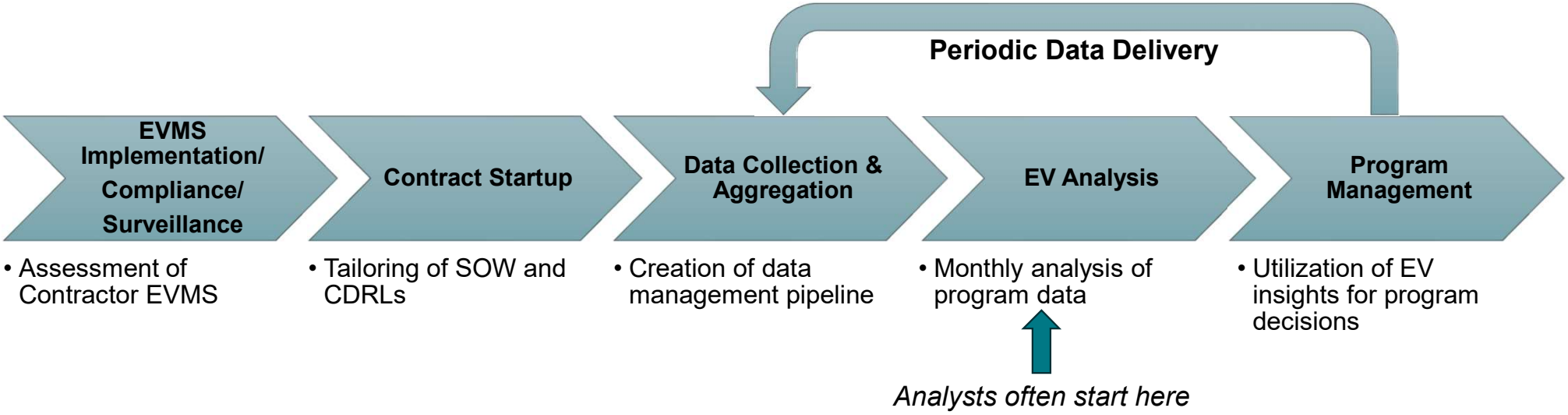
- EVM Framework Overview
- EVMS Implementation/Compliance
- Contract Startup
- Data Collection/Aggregation & Periodic Data Delivery
- EV Analysis
- Program Management

# Introduction

- Government acquisitions are growing in size and complexity to procure technologically advanced systems
- Effective program management is necessary to ensure efficient program cost, schedule, and technical success
- EVM is a proven method to support the management of programs
  - Requires program managers to think critically about their future cost, schedule, and risk through the IBR process
  - Provides the means to measure cost and schedule progress against a baseline
  - Allows for estimating cost at completion to support program budgeting
- EVM's effectiveness has been criticized throughout the years, often called costly and ineffective
  - Missteps in CDRL development negatively impacting data value
  - Inefficient data management and analysis processes
  - Lack of use of historical data to provide insights on current programs
- **EVM requires a holistic approach to view the entire lifecycle and practice effective and efficient program management**

# EVM Framework

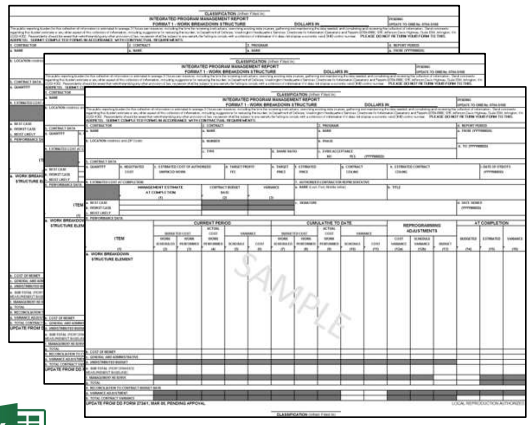
- The EVM Framework divides the process into key components to facilitate efficient and effective program management
  - Defines each component & importance
  - Identifies downstream impacts
  - Implements modern tools and processes to streamline
- Executing each step in the framework, understanding its importance, and driving efficiency creates a repeatable process that ensures analysis and program management is not hindered by early missteps.



# Transition to Modern Data Schemas

- Data deliverables are transitioning to more modern, data focused schemas
- IPMDARs represent this modernization through its relational schema and lack of human readable formats
  - Necessitates the use of modern tools to digest and extract performance data
  - Emphasizes the importance of early steps in the framework (i.e., Contract Startup)
- Deeper insights are possible, but gated behind additional ETL processes

## IPMR




Formats 1-4 and 7( IPMR)

## IPMDAR

IPMDAR CPD Submission.zip
506 KB

| Name | Type |
|---|---|
| ACWP_ToDate | JSON File |
| BCWP_ToDate | JSON File |
| BCWS_ToComplete | JSON File |
| BCWS_ToDate | JSON File |
| ContractData | JSON File |
| ControlAccountCustomFieldDefinitions | JSON File |
| ControlAccountCustomFieldValues | JSON File |
| ControlAccounts | JSON File |
| CustomSummaryPerformance | JSON File |
| DatasetConfiguration | JSON File |
| DatasetMetadata | JSON File |
| EST_ToComplete | JSON File |
| OBS | JSON File |
| ReportingCalendar | JSON File |
| ReprogrammingAdjustments | JSON File |
| SourceSoftwareMetadata | JSON File |
| Subcontractors | JSON File |
| SummaryIndirectPerformance_ToComplete | JSON File |
| SummaryIndirectPerformance_ToDate | JSON File |
| SummaryPerformance | JSON File |
| WBS | JSON File |
| WorkPackageCustomFieldDefinitions | JSON File |
| WorkPackageCustomFieldValues | JSON File |
| WorkPackages | JSON File |
| FileType | Text Document |

IPMDAR SPD Submission.zip
253 KB

| Name | Type |
|---|---|
| CalendarExceptions | JSON File |
| Calendars | JSON File |
| CalendarWorkShifts | JSON File |
| DatasetMetadata | JSON File |
| ProjectCustomFieldDefinitions | JSON File |
| ProjectCustomFieldValues | JSON File |
| ProjectScheduleData | JSON File |
| ResourceAssignments | JSON File |
| ResourceCustomFieldValues | JSON File |
| Resources | JSON File |
| ResourcesCustomeFieldDefinition | JSON File |
| SourceSoftwareMetadata | JSON File |
| TaskConstraints | JSON File |
| TaskCustomFieldDefinitions | JSON File |
| TaskCustomFieldValues | JSON File |
| TaskOutlineStructure | JSON File |
| TaskRelationships | JSON File |
| Tasks | JSON File |
| TaskScheduleData | JSON File |
| FileType | Text Document |

Power BI

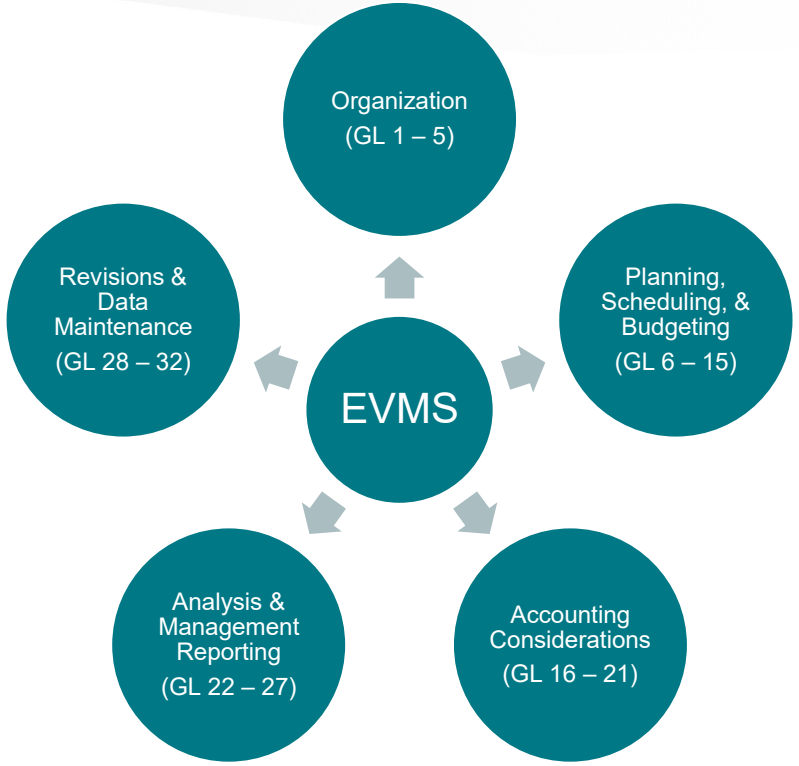
tableau

Power Query

# EVMS Implementation



- Implementation of an EVMS that complies with the 32 guidelines
- Maintaining the system past initial implementation is critical
  - Regular review of system description
  - System updates to comply with changes to EVM DIDs
  - Implementation of modern tools within the system
- DECMs, logic checks, and regular tests are utilized to ensure compliance



# EVMS Surveillance/Compliance



- Reviewing contractor systems and data to determine if system complies with 32 guidelines
- Typically, the responsibility of oversight organizations (e.g., DCMA)
  - Performed on a periodic basis
  - Not guarantee data between surveillance reviews will be error free
- Compliance checks must be a regular part of monthly analysis
  - Ensure data quality
  - Highlight areas that could impact analysis
- Analysts should understand data format rules and schemas to strengthen approach to EVM process

| Indicator | Definition |
|---|---|
| 1 | BCWS_C > BAC |
| 2 | BCWP_C > BAC |
| 3 | ACWP_C > 0 & BAC = 0 |
| 4 | ACWP_P > 0 & BAC = 0 |
| 5 | BAC < 0 |
| 6 | BAC = 0 |
| 7 | LOE EVT w/ SV != 0 |
| 8 | BCWP_C > 0 & ACWP_C = 0 |
| 9 | Completed Work (BCWP_C = BAC) w/ ETC > 0 (ACWP_C > EAC) |
| 10 | Incomplete Work (BCWP_C < BAC) w/ ETC = 0 (ACWP_C = EAC) |
| 11 | Completed Work (BCWP_C = BAC) w/ ACWP_P > 0 & BCWP_P = 0 |
| 12 | CPI - TCPI > 0.1, implying overly pessimistic EAC |
| 13 | CPI - TCPI < -0.1, implying overly optimistic EAC |
| 14 | ACWP_C > EAC |
| 15 | BCWS_C < 0 or BCWS_P < 0 |
| 16 | BCWP_C < 0 or BCWP_P < 0 |
| 17 | Reported PC > 0 w/ BCWP_C = 0 or PC = 0 w/ BCWP_C > 0 |

# Contract Start Up



- Step where the Government defines their EVM needs through the SOW and CDRL
- Opportunity for the Program Office to tailor EV deliverables to enhance analysis
  - EV data format such as IPMDAR
  - Granularity of data
  - Frequency of deliverables
  - End item reporting
- Neglecting this step can lead to:
  - Lack of insight into lower levels of data
  - Inability to track areas of interest
  - Inconsistent data formats

CONTRACT DATA REQUIREMENTS LIST

Form Approved OMB No. 0704-0188

A. CONTRACT LINE ITEM No. [Insert CLIN(s)] | B. EXHIBIT N/A | C. CATEGORY TDP ☐ TM ☐ Other ■ Administrative/Management

D. SYSTEM / ITEM [Insert Program Name] | E. CONTRACT/PR No. [Insert Contract Number] | F. CONTRACTOR [Insert Contractor Name]

1. Data Item No. A097 | 2. Title of Data Item: Integrated Program Mgmt Data & Analysis Report (IPMDAR) | 3. Subtitle N/A

4. Authority (Data Acquisition Document No.) NRO IPMDAR DID (Rev 0, 14 Aug 2020) | 5. Contract Reference [Insert SOW Paragraph Number(s)] | 6. Requiring Office [Insert Program Office]

7. DD 250 Req N/A | 8. Dist Statement Required | 9. Frequency Monthly | 12. Date of First Submission See Block 16 | 14. Distribution: a. Addressee | b. Copies: Draft, Final (Reg, Repro)

10. App Code N/A | 11. As Of Date See Block 16 | 13. Date of Subsequent Submission See Block 16

16. Remarks

Block 4:
Submission shall be in accordance with the NRO IPMDAR Data Item Description (Rev 0, 14 Aug 2020). See the Contractor Bidder's Library (CBL).

The following tailoring and clarification apply to the DID:

- Per IPMDAR DID paragraphs 1.4.1, the Direct Reporting Contractor is the prime contractor.
- Per IPMDAR DID paragraph 1.6, the CPD and SPD shall be delivered electronically in JSON format (or equivalent, e.g., EOZ) in accordance with the NRO-approved FFS and DEI. Contract and calendar names within the CPD and SPD files shall include the program name and remain consistent across submissions. The contractor shall coordinate the names and structure of any custom data/fields with the government to maintain integrity of the government databases. Custom data/fields are defined as anything that does not follow the naming convention and relational structure defined in the FFS and DEI.
- Per IPMDAR DID paragraph 2.3.2.3, if contractor Elements of Cost are different than those listed in this paragraph, describe the EOCs used in the Performance Narrative Report.
- Per IPMDAR DID paragraph 2.4.2.8, provide the physical schedule percent complete values.
- Per IPMDAR DID paragraph 2.4.2.20, the Data Dictionary may be a stand-alone document or be included as a part of the Performance Narrative Report.
- Per IPMDAR DID paragraph 2.4.2.21, unless otherwise directed by the Government, the following shall apply to the Schedule Risk Assessment:
  - Provide individual three-point duration estimates for all tasks/activities on driving paths to contractual milestones/events and for all tasks/activities on the critical path to the end of the contract.
  - Individual, rather than global, estimates and rationale shall be developed and applied to all tasks on the following paths:
    - Primary critical path to the final major program milestone
    - Driving path and near driving path(s) with less than or equal to 10 days of float or as directed by Government.
    - High-risk tasks/activities in the Contractor's risk management plan
  - Remaining tasks' three-point estimates and rationale shall be individually or globally applied.
- Per IPMDAR DID paragraph 2.5.3.4, the contractor shall report and address the 15 most significant program variances.

Block 11:
The following tailoring and clarification apply to the As of Date:

- Per IPMDAR DID paragraph 1.8.1, IPMDAR submissions shall be ~~delayed~~ as of the contractor's accounting period cutoff date. Subcontractor and inter-divisional transfer data will be submitted for the same accounting period as that of the prime's, regardless of when the subcontractor's accounting period ends.

| G. PREPARED BY COR | H. DATE | I. APPROVED BY Contracting Officer | J. DATE |
|---|---|---|---|

# Example: IPMDAR CDRL Tailoring

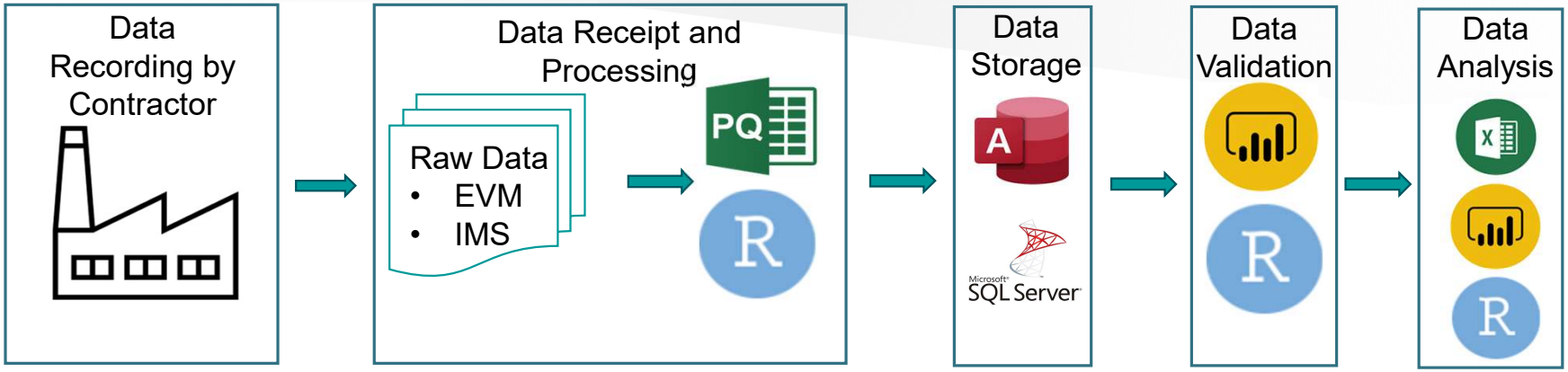

- The IPMDAR is the current DoD EV reporting format
- It contains a variety of dataset configurations that allow the Government to dictate the granularity of data
- Custom fields provide an option to map work packages, control accounts, or schedule activities to areas of interest
  - NRE/Recurring
  - Risk IDs
  - End items – ship set, variant, etc.
- Opportunity to translate program office needs to data deliverables, increasing value of later analysis

| Configuration Option |
|---|
| **Time Phased or Cumulative To Date** |
| **Direct Values in Detail Data** |
| **Indirect Values in Detail Data** |
| **Work Package or Control Account Reporting** |
| **Element of Cost Data** |
| **OH, COM, and G&A Burdening** |

| Work Package | Custom Field 1 |
|---|---|
| WP_1.1 | Unit 1 |
| WP_1.2 | Unit 1 |
| WP_1.3 | Unit 2 |
| WP_1.4 | Unit 2 |

# Data Collection and Aggregation






- One of the most time intensive steps within the Framework
  - Collection and storage of data
  - Verification & Validation Efforts
  - Data integration
- Step includes both the processes of the OEM and Government
- Utilize of modern tools R, Python, or Power Query to streamline process
- Consistent implementation allows data for completed programs to be used to inform future analysis/studies
- This step is typically repeated monthly as new data is delivered and must be designed with this in mind

# Government and Contractor Efforts



- Government
  - Validating and approving IPMDAR submissions from the contractor
  - Enforcing DEI and FFS compliance across IPMDAR submissions
  - Automating validation efforts and providing timely and actionable responses to contractors
  - Managing submitters and reviewers assigned to efforts
- Contractor (OEM)
  - Implementing custom fields per contract requirements
  - V&V of IPMDAR submissions against schema and DID to ensure compliance prior to delivery
  - Responding to Government comments on IPMDAR submissions in timely manner
  - Submission of validated IPMDARs to EVM-CR or another repository


*OSD ADA IPM - EVM-CR Submitters Guide*[1]

# Earned Value Analysis

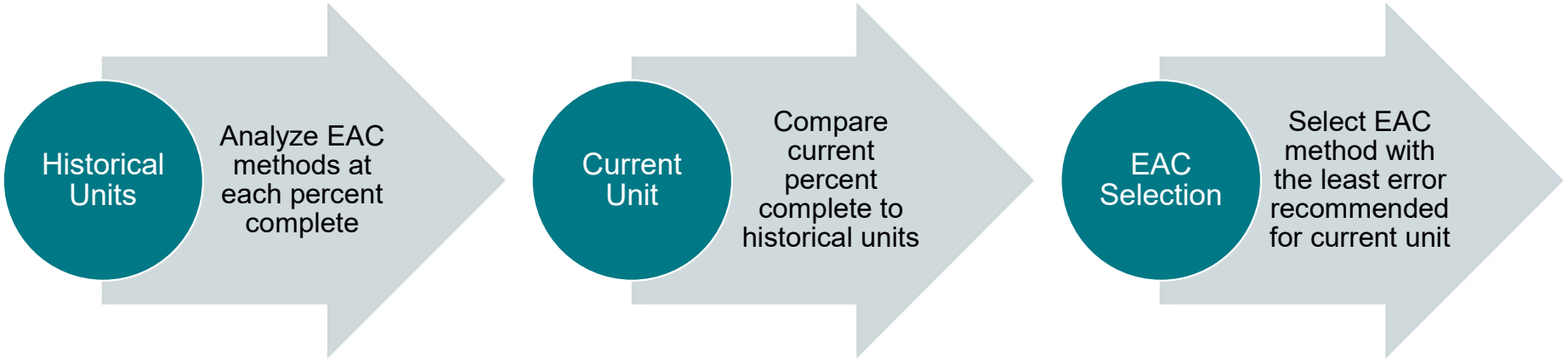

- Delivers the necessary analysis that's made possible by the Data Collection and Aggregation step
- Includes typical cost and schedule performance metrics broken down by WBS level or further depending on the type of program (CPI, SPI, EAC, VAC, TCPI, etc.)

**Modernized Framework**

- The EV Analysis step naturally flows from the Data Collection and Aggregation step by utilizing scripts to retrieve periodic data and perform analysis
- Choosing and integrating a platform within a modernized framework allows the analyst to take advantage of the entirety of the EVM dataset

# Earned Value Analysis Example (R EAC Tool)


- Evolution from a previously utilized EVM tool created in Microsoft Excel, The Performance Metrics Model and Study (PMMS).
- Modernizes the PMMS to incorporate analysis with the EVM Framework
  - Raw data stored in a MS Access
  - Statistical analysis performed in R
  - MS Excel tool created in R using all data and analysis



# Earned Value Analysis Example (R EAC Tool)



**Model View** – Identifies the inputs for the estimated unit and for the historical data

| Model | | | | |
|---|---|---|---|---|
| As of Date | Lead Effort | Sub Effort | Unit | WBS |
| 01/01/2001 | Contractor A | Contractor B | 22 | 01.01.01 |
| 01/01/2001 | Contractor A | Contractor B | 22 | 01.01.02 |
| 01/01/2001 | Contractor A | Contractor B | 22 | 01.01.03 |
| 01/01/2001 | Contractor A | Contractor B | 22 | 01.01.04 |

**Metrics View** – EVM metrics for each WBS element of a unit giving the user insight into the cost performance

| Metrics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| WBS | BAC | BCWS | BCWP | BCWR | ACWP | SPI | CPI | % Complete |
| 01.01.01 | 1,119.14 | 887.00 | 825.28 | 293.86 | 1,109.87 | 0.93 | 0.74 | 73.74% |
| 01.01.02 | 0.37 | 0.37 | 0.00 | 0.37 | 0.00 | 0.00 | 0.00 | 0.00% |
| 01.01.03 | 2,759.20 | 2,486.07 | 2,412.36 | 346.85 | 3,235.89 | 0.97 | 0.75 | 87.43% |
| 01.01.04 | 305.32 | 304.12 | 297.77 | 7.56 | 390.72 | 0.98 | 0.76 | 97.52% |
| 01.01.05 | 575.34 | 575.12 | 574.24 | 1.10 | 751.27 | 1.00 | 0.76 | 99.81% |

**Working Estimate** – EAC selection with the REACT recommended method

| Working Estimate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| WBS | Estimation Method | EAC | TCPI | VAC | CPI @ Complete | CPI @ Complete (Recommended) | Previous CPI @ Complete | Recommended Method |
| 01.01.01 | BAC / (6 Month CPI) | 1,774.29 | 0.44 | -655.16 | 0.63 | 0.64 | 0.71 | % Complete |
| 01.01.02 | BAC / 1.0 (Math Ext) | 0.38 | 0.95 | -0.02 | 0.95 | | 1.00 | |
| 01.01.03 | % Complete | 4,495.07 | 0.28 | -1735.86 | 0.61 | 0.69 | 0.65 | Historical |
| 01.01.04 | BAC / (3 Month CPI) | 419.77 | 0.26 | -114.45 | 0.73 | 0.73 | 0.75 | BAC / (CPI*SPI) |
| 01.01.05 | BAC / (CPI*SPI) | 790.55 | 0.03 | -215.21 | 0.73 | 0.73 | 0.76 | BAC / (CPI*SPI) |

# Program Management

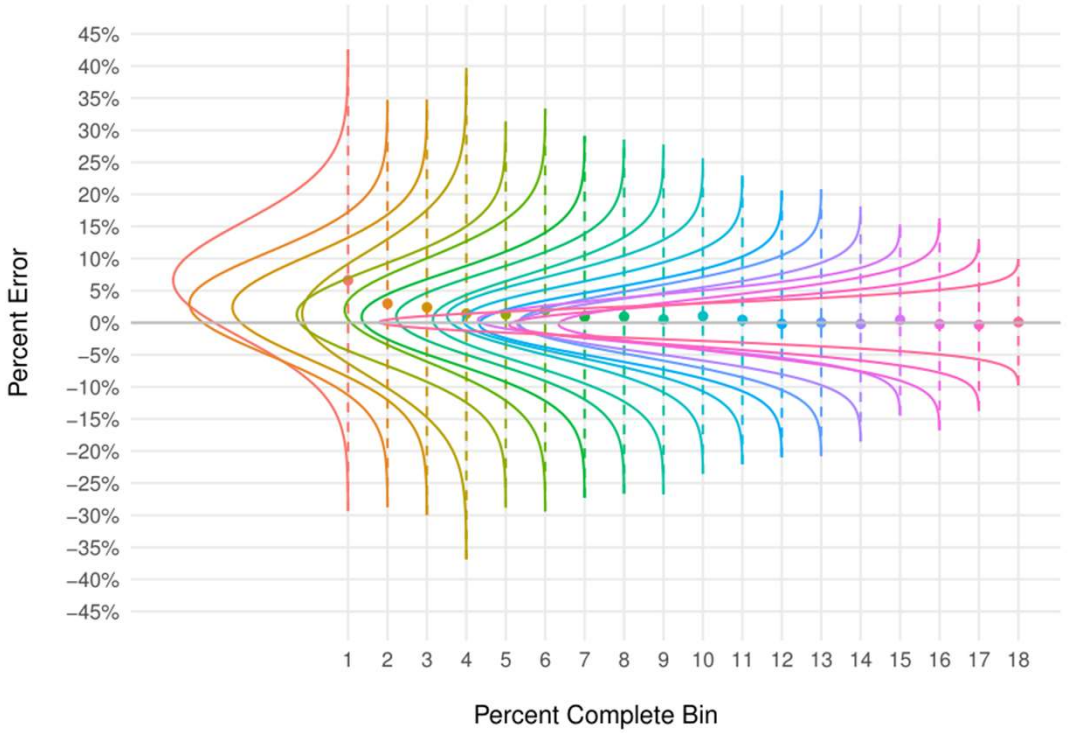

- This step uses various pieces of program data to provide the program office with high level insight

| | |
|---|---|
| Budgeting and Financial Analysis | EACs and historical actuals |
| Contract Management | Analyzing past requirements and noting short falls |
| Risk Management | Past performance risk and issues |
| Systems Engineering | Using actuals to create Technical Performance Measures |

# Program Management Example (Estimated Price at Complete)



Step 1: Determine the percent error of the delivered EACs based on the price at complete



# Program Management Example (Estimated Price at Complete)



Step 2: Determine and apply the percent error based on the percent complete bin and confidence bound

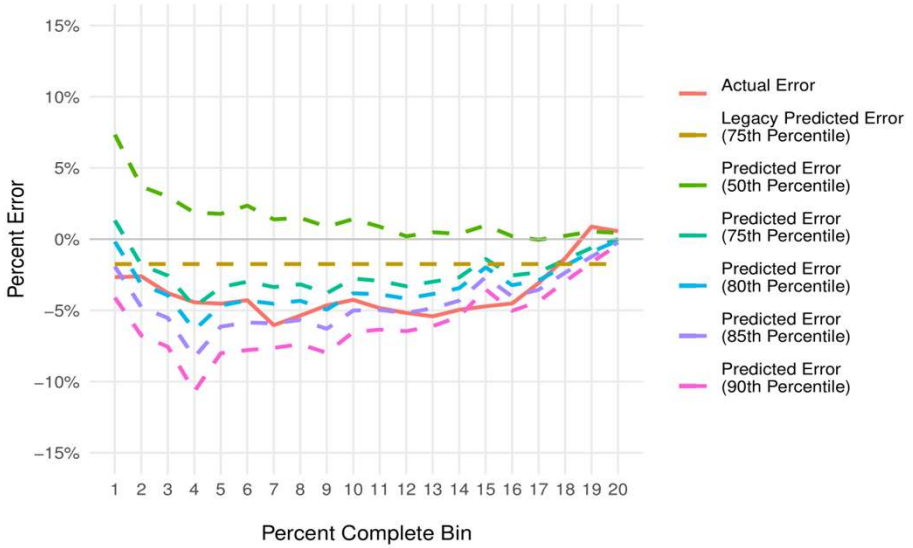
$$EAC_{EPAC} = \frac{EAC_{Base}}{1 + E_{0.75}}$$, where $E_{0.75}$ is the estimation error at the 75th percentile

$$Factor_{EPAC} = \frac{EAC_{EPAC} - EAC_{Base}}{EAC_{Base}}$$

# Program Management Example (Estimated Price at Complete)



## Step 3: Compare Actual Error to the EPAC Adjusted Error




| | Effective EPAC Risk Adjustment Percentage | | | | | |
|---|---|---|---|---|---|---|
| Unit | Legacy EPAC Model Error Percentile = 75% | EPAC Model Error Percentile = 50% | EPAC Model Error Percentile = 75% | EPAC Model Error Percentile = 80% | EPAC Model Error Percentile = 85% | EPAC Model Error Percentile = 90% |
| 1 | 0.01% | 0.00% | 0.00% | 0.08% | 0.20% | 0.35% |
| 2 | 0.02% | 0.00% | 0.00% | 0.08% | 0.20% | 0.35% |
| 3 | 0.08% | 0.00% | 0.00% | 0.08% | 0.20% | 0.35% |
| 4 | 0.08% | 0.00% | 0.00% | 0.08% | 0.20% | 0.35% |
| 5 | 0.14% | 0.00% | 0.49% | 0.76% | 1.06% | 1.44% |
| 6 | 0.27% | 0.00% | 0.49% | 0.76% | 1.06% | 1.44% |
| 7 | 0.37% | 0.33% | 2.60% | 3.18% | 3.85% | 4.68% |
| 8 | 0.50% | 0.24% | 3.05% | 3.76% | 4.60% | 5.65% |
| 9 | 0.62% | 0.19% | 3.32% | 4.11% | 5.05% | 6.22% |
| 10 | 0.81% | 0.00% | 3.54% | 4.44% | 5.51% | 6.86% |

# Implementing the Framework

- Approach EVM for the program through the lens of the Framework
  - Highlight key decision points and documents at each step
  - Understand what is needed from the data to effectively manage the program – involve analysts in CDRL development
  - Identify areas to automate and plan accordingly – utilize schema documents and sample data to design process early
  - Develop methods and analyses that provide program offices with actionable insights
  - Implement effective tools to communicate findings
- Each step serves a purpose, address them appropriately to make EVM an asset instead of a hindrance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# Publicly Available Resources

Add more resources

- Resources from www.acq.osd.mil
  - EVM-CR
  - Validation Utilities
  - Conversion Utilities
  - Sample Datasets
  - DEI and FFS standards
- Resources from https://www.dcma.mil/HQ/EVMS/
  - DECMs
  - EVMS Compliance Procedures
  - Organization and Contacts

# References


- 1. “Earned Value Management Central Repository (EVM-CR) User Guide: Submitter.” *EVM-CR Resources*, OSD ADA Integrated Program Management Division, 1 Feb. 2022, www.acq.osd.mil/asda/ae/ada/ipm/docs/user-resources/EVM-CR%20Submitter%20Guide.pdf.