

Efficiency Based Forecasting of Defense Acquisition Programs for Improved Decision Making (Enhanced Earned Value Management (E2VM))

Raymond Jones

Chair, Department of Defense Management

Naval Postgraduate School

619-335-0872

Key Terms

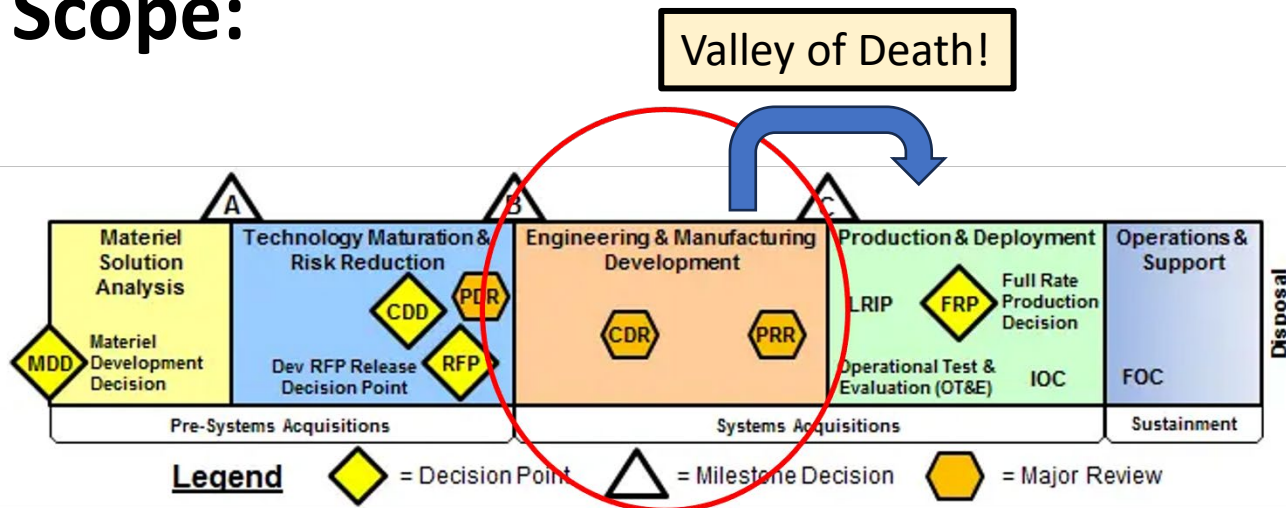
- **Return on Investment** - Return on Investment (ROI) is metric used to evaluate the value of an investment relative to its cost. It is typically calculated as the ratio of net value to cost and is expressed as a percentage. ROI measures the efficiency of an investment in generating value compared to its cost.
- **Cost Performance Index** - cost efficiency and financial effectiveness of a specific project
- **Program of Record** - a formalized program established by a government agency, typically the Department of Defense (DoD) in the United States, to develop, procure, and sustain a specific military capability or system (DAG, 2023)
- **Output Efficiency (O_e)** –The measure of how effectively inputs such as time, money, materials, and energy are utilized to produce desired outputs, products, or services. It assesses the ability of a system or process to maximize output while minimizing resource consumption and waste.
- **Earned Value Management** - a project management technique used to measure progress of a project in terms of its budget and schedule. It integrates scope, schedule, and cost data to provide a view of project performance. (DAG, 2023)
- **Knowledge Value Added (KVA)** - a concept that measures the value created through knowledge-based activities. It represents the incremental value generated by leveraging knowledge, expertise, and intellectual assets to improve products, services, processes, or decision-making capabilities (Housel T., Kanevsky V. 2006)
- **Valley of Death** – Phase in the lifecycle of a project where it faces significant challenges in securing advocacy to bridge the gap between development and production. (Blank, S. Dorf, B. 2012)

What is the Problem

Problem

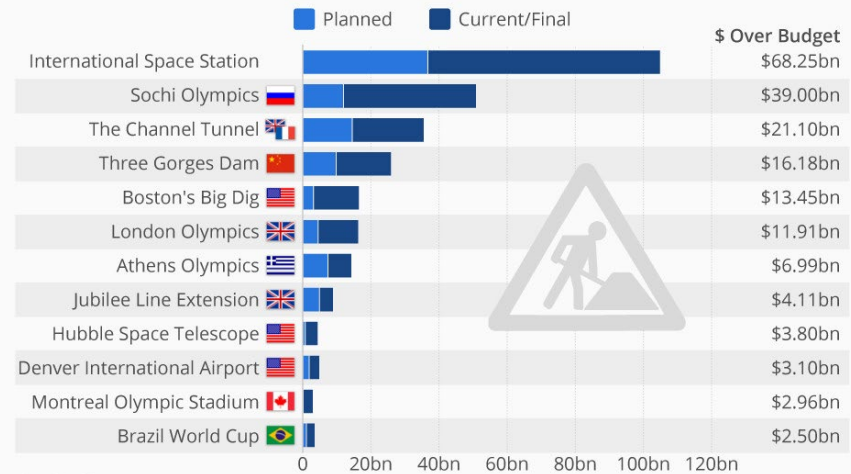
Current Program Management Budget v. Cost Earned Value Management methods do not provide reliable forecasting information resulting in programs failing to transition from development to production.

Scope:



Major Projects That Went Catastrophically Over-Budget

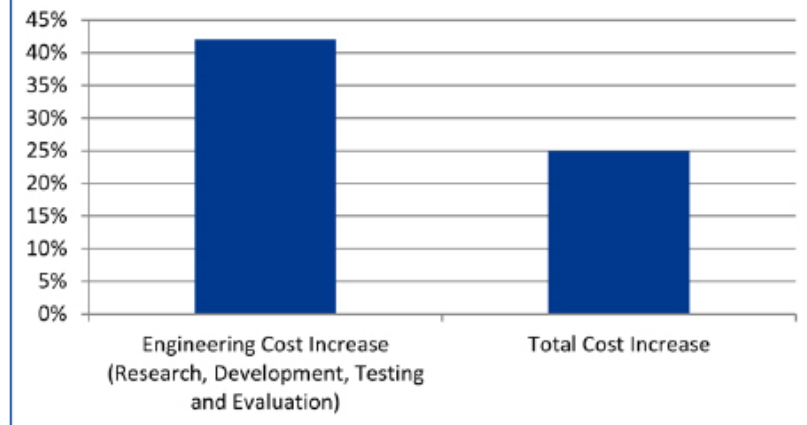
Selected over-budget construction projects worldwide (billion U.S. dollars)*



* Converted to U.S. dollars and adjusted for inflation. Source: Podio.com

statista

Cost Increase of Largest 96 Acquisition Programs of the U.S. Department of Defense



Purpose: Improved Decision Making

The purpose of this research is to improve current Earned Value Management methods for program decision making by showing that output efficiency is a more effective way to forecast the performance of a program during the developmental phase of its lifecycle than current EVM methods.

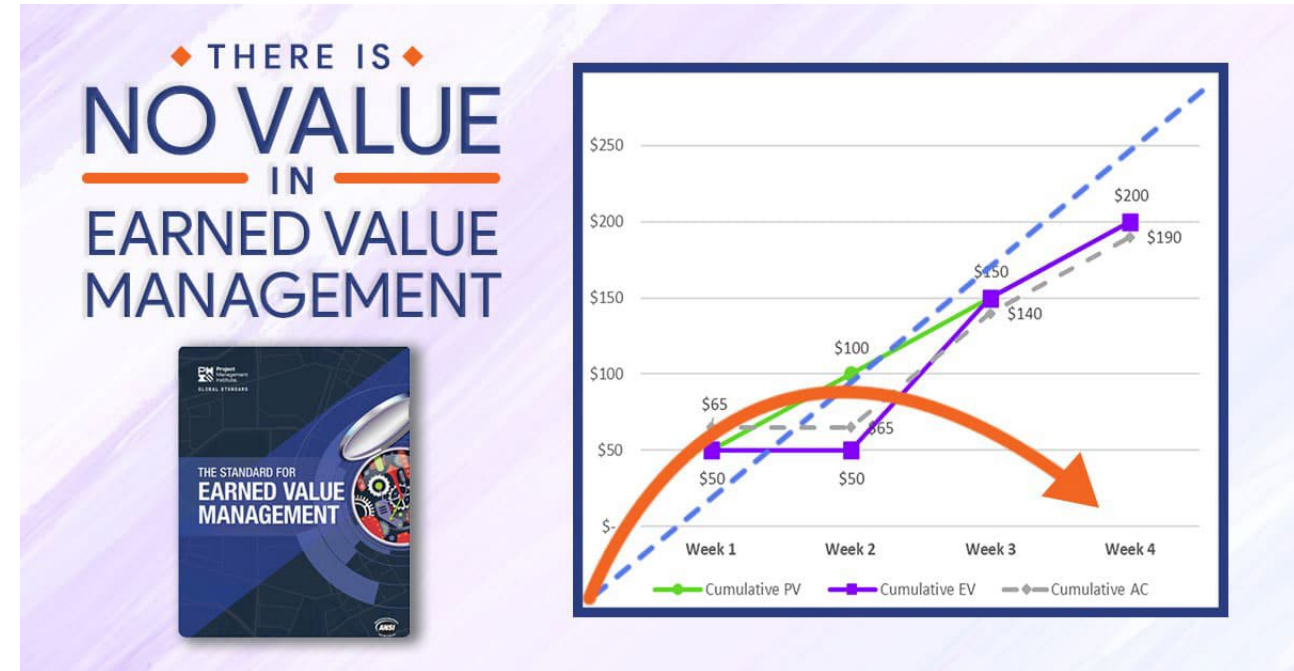
Hypothesis: Output efficiency is a more effective measure to forecast program of record performance during the developmental phase of its lifecycle providing resulting in more informed decision making.

This is important because it will provide a more accurate measure of how efficient a development program is performing and provide the program manager with more accurate information on the root cause of program challenges.

EVM **ignores activity duration variability** it always results in optimistic completion dates which may be very difficult to meet in the real projects. EV increases as more activities are finished, irrespective of whether the order of execution was the most appropriate. (Pabo, B, Kael M. 2018)

Limitations of Earned Value Management

- **Subjectivity in Measurement:** Determining the "earned value" of completed work can sometimes be subjective, leading to discrepancies in the assessment of project progress.
- **Assumption of Linearity:** EVM assumes that the relationship between cost, schedule, and work performed is linear, which may not always hold true in real-world projects.
- **Difficulty in Forecasting:** While EVM provides valuable insights into project performance to date, it may not always be effective in predicting future outcomes accurately.
- **Inflexibility:** EVM is based on predefined formulas and metrics, which may not be adaptable to all types of projects or organizational structures.
- **Limited Focus on Non-Financial Metrics:** EVM primarily focuses on cost and schedule performance metrics, which may not capture the full spectrum of project success factors.



Current Decision Support Systems Provide Limited Insight into Program Performance Issues and Future Outcomes

Research Summary

Problem

Current Program Management Budget v. Cost *Earned Value Management* methods do not provide reliable forecasting information resulting in programs failing to transition from development to production.

My Theory

Return on Investment is a more effective measure to forecast program of record performance during the developmental phase of its lifecycle leading to better decision making .

Method (How?)

- Define an economic surrogate for O_e that can be used to determine efficiency at any point of the development lifecycle.
- Use a model that replicates the DoD acquisition process to test the theory that ROI is a better performance rather than Budget/Cost comparison.
- Compare Model derived ROI to Earned Value (EVM) for historical programs that have been completed.

Scope

The scope of this research is to derive and measure value during the Engineering Manufacturing and Development phase of the lifecycle and compare it with EVM cost metrics .

Expected Results (Why is this Important)

ROI is a better predictor of program performance than existing methods and will provide more informed choices to decision makers that reveal the relationship between cost and value of financial investments in a program of record.



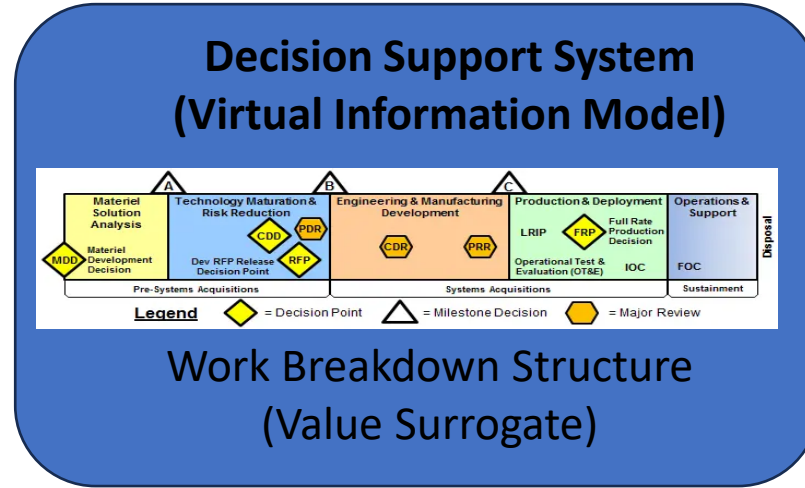
Crossing the "Valley of Death"

Conceptual Framework and Data (Level of Analysis: Program Manager)

Independent Variable
(Cost Variance)

Threshold	Impacts	Minor	Moderate	Major	Catastrophic
Cost	Cost is within approved budget	Cost is up to 10% of schedule	Cost is up to 20% of schedule	Cost is up to 30% of schedule	Cost is up to 40% of schedule
Quality	Quality is within approved process	Quality is up to 10% of budget	Quality is up to 20% of budget	Quality is up to 30% of budget	Quality is up to 40% of budget
Scope	Scope is within approved process	Scope is up to 10% of budget	Scope is up to 20% of budget	Scope is up to 30% of budget	Scope is up to 40% of budget
Time	Time is within approved process	Time is up to 10% of budget	Time is up to 20% of budget	Time is up to 30% of budget	Time is up to 40% of budget

RISK REGISTER
Project



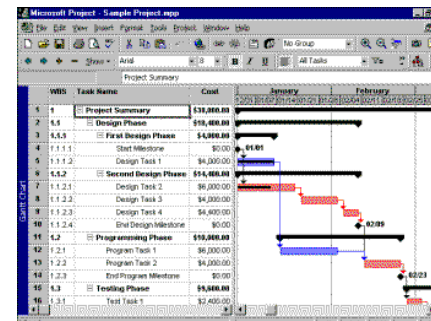
Dependent Variable

Output Efficiency (O_e)



Work Breakdown Structure

L1	L2	L3	L4	L5	L6	L7	L8	WBS #	Description
1								1	Airborne and Maritime/Fixed Station (AMF)
1	1							1.1	AMF Joint Tactical Radio System PMP
1	1	1						1.1.1	Subsystem 1 (JTR)
1	1	1	1					1.1.1.1	Development Stations
1	1	1	1	2				1.1.1.2	JTR-M Unique
1	1	1	1	2	5			1.1.1.2.5	JTR M Subsystem Systems Engineering / Program Management
1	1	1	1	2	5	1		1.1.1.2.5.1	JTR-M Program Management
1	1	1	1	2	5	2		1.1.1.2.5.2	JTR-M Systems Engineering
1	1	1	1	2	6			1.1.1.2.6	HW1100 INFOSEC/Processor, Red, Dual
1	1	1	1	2	6	1		1.1.1.2.6.1	Pre-EDM HW1100 INFOSEC/Processor, Red, Dual
1	1	1	1	2	6	2		1.1.1.2.6.2	EDM HW1100 INFOSEC/Processor, Red, Dual
1	1	1	1	2	7			1.1.1.2.7	HW1300 Transceiver Module, Dual
1	1	1	1	2	7	1		1.1.1.2.7.1	Pre-EDM HW1300 Transceiver Module, Dual
1	1	1	1	2	7	2		1.1.1.2.7.2	EDM HW1300 Transceiver Module, Dual
1	1	1	1	2	8			1.1.1.2.8	HW1400 I/F Module Mezzanine Card
1	1	1	1	2	8	1		1.1.1.2.8.1	Pre-EDM HW1400 I/F Module Mezzanine Card
1	1	1	1	2	8	2		1.1.1.2.8.2	EDM HW1400 I/F Module Mezzanine Card
1	1	1	1	2	9			1.1.1.2.9	HW1401 I/O Adapter, Ethernet
1	1	1	1	2	9	1		1.1.1.2.9.1	Pre-EDM HW1401 I/O Adapter, Ethernet
1	1	1	1	2	9	2		1.1.1.2.9.2	EDM HW1401 I/O Adapter, Ethernet
1	1	1	1	2	10			1.1.1.2.10	HW1402 I/O Adapter, RS-530A



Method

Using a Model that replicates the DoD Acquisition Process, measure the output at discrete levels of the WBS throughout the lifecycle from contract award at milestone B (Development Decision) to Milestone C (Production Decision).

- **Decision making** encompasses a wide range of concepts, **models, and frameworks** designed to explain and ***predict how humans, organizations***, and increasingly AI systems make choices when faced with uncertainty, risk, and complexity (Fraser, R.B., 1984).
- Trist and Bamforth (1951) argue that increasing technological advances integrated into the human centric process has shown to lead to **improved efficiency and performance**.
- We must design fuse information technology and human resource management to improve business performance (Davenport, 1993).

Method

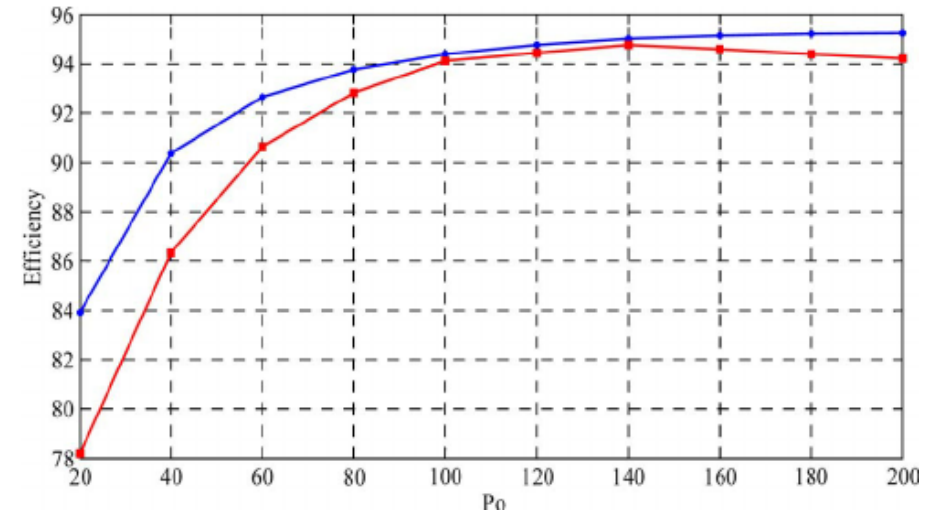
Anchored in Value Based Management and Knowledge Value Added theory, correlate output to value at discrete points for at least three information systems network programs of record from program start to production decision.

- Previous research on Value Based Management (VBM) suggested that having an **unambiguous quantitative value metric** would allow decision makers to measure the performance of their company from a value maximization perspective which is the ultimate economic objective for an organization. VBM takes this a step further by requiring targets to be translated into shorter-term, more objective financial performance targets. (Koller, 1994).
- In the history of economics and physics, economists borrowed the energy concept from physics to develop their **value theory based on the energy concept** (Beinhocker, 2006; Mirwoski, 1989).
- Mirowski (1989) documented the use of the **energy concept from physics to develop the value concept in economics over four centuries**. "...there is no way of understanding economics and social theory in the twentieth century without first understanding 'energy' in some detail."
- In the context of a non-monetized quantitative value theory, there was a need to create new categories for common units of value. One promising common unit candidate for **proto-value is a unit of complexity** (Housel and Kanevsky, 1995; Housel and Bell, 2001).
- KVA provides a way to count management activities within the estimates of the overall output of the organization at a given point in time (Housel, T. Kanevsky, V. 2006)
- Basic KVA theory is designed specifically for all processes, activities that are algorithmically definable a priori that have predetermined outputs (Housel, T. Kanevsky, V. 1995)

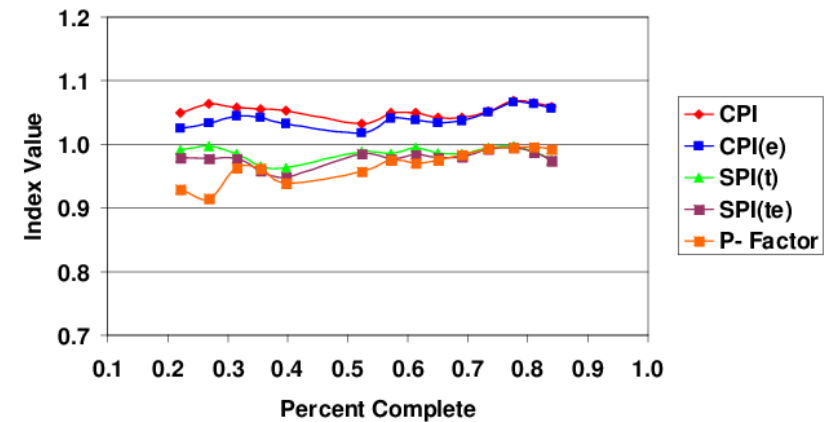
Method

Generate output efficiency (O_e) plots to show investment efficiency of work packages over time and compare to EVM data for the same period to compare the relative difference between the two methods.

Output Efficiency



Cost/Schedule Performance Index



Why is This Important

This study will extend decision support and economics because there is currently no reliable forecasting method in the defense acquisition process that accurately reflects the effects of programmatic decisions and processes. Showing that value theory can be used to help forecast product development processes will further extend value theory into the management discipline.

- Virtual replicas are being used in disciplines to **predict performance of discrete processes** (Glaessgen & Stargel, 2012)
- Virtual models facilitate simulations for understanding how physical systems and processes operate under varying conditions. The interconnectedness allows for the optimization of physical systems and processes in real or near real time (Tao et al., 2018).
- Provide insights into potential risks and their consequences and **empower decision-makers** to develop robust strategies for risk mitigation and contingency planning (Maharjan et al., 2020).
- inform policymakers of potential risks supporting decision-making processes (Batty et al., 2021).
- By comprehensively understanding the socio-technical components and their interdependencies, one can provide a foundational framework for explaining the process (Trist & Bamforth, 1951).

Secondary Benefit

- Provides opportunity for new theory and practice in financial and management professions

Expected Results

- Using virtual modeling of the defense acquisition process will provide an improved decision-making tool for predicting the performance of complex information centric developmental programs.
- Predicting output efficiency will provide insight into other management disciplines that could influence future budgeting and financial management policy.

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