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Total quality management: an analysis and evaluation of the effectiveness of performance metrics for ACAT III programs of record

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JOINT APPLIED PROJECT

TOTAL QUALITY MANAGEMENT: AN ANALYSIS AND EVALUATION OF THE EFFECTIVENESS OF PERFORMANCE METRICS FOR ACAT III PROGRAMS OF RECORD

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September, 2014

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This project studies the metrics of a sample United States Army Aviation Acquisition Category (ACAT) III program. This program reports weekly metrics across the functional areas of logistics, business, and technology (software development and risk management), which are reviewed in functional-management staff calls. This project investigates whether these metrics align with total quality management (TQM) best-practice standards. The framework for the study is the National Institute of Standards and Technology's Baldrige criteria, which identify ways for organizations to reach performance excellence. Seven categories combine to achieve this goal: leadership; strategic planning; customer focus; measurement, analysis, and knowledge management; workforce focus; process management; and results. While the study of metrics is an aspect of the measurement, analysis, and knowledge-management criteria, a holistic approach is used to survey the overall organization and identify whether the organization and its metrics are aligned to reach performance excellence, the lodestar of TQM. The implementation of details and organizational structure is discussed with a final recommendation.

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN PROGRAM MANAGEMENT

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ABSTRACT

This project studies the metrics of a sample United States Army Aviation Acquisition Category (ACAT) III program. This program reports weekly metrics across the functional areas of logistics, business, and technology (software development and risk management), which are reviewed in functional-management staff calls. This project investigates whether these metrics align with total quality management (TQM) best-practice standards. The framework for the study is the National Institute of Standards and Technology's Baldrige criteria, which identify ways for organizations to reach performance excellence. Seven categories combine to achieve this goal: leadership; strategic planning; customer focus; measurement, analysis, and knowledge management; workforce focus; process management; and results. While the study of metrics is an aspect of the measurement, analysis, and knowledge-management criteria, a holistic approach is used to survey the overall organization and identify whether the organization and its metrics are aligned to reach performance excellence, the lodestar of TQM. The implementation of details and organizational structure is discussed with a final recommendation.

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	acquisition center
ACAT	acquisition category
ACT	actual
AED	Aviation Engineering Directorate
AFTD	Aviation Flight Test Directorate
AIC	Army Interoperability Certification
AMCOM	Aviation and Missile Command
ANMP	Aviation Networks & Mission Planning
APM	assistant product manager
AS	aviation systems
ATEC	Army Test and Evaluation Command
ATO	authority to operate
CDRL	contract data requirements list
CON	certificate of networthiness
CPU	central processing unit
CRP	contract requirements package
CTSF	Central Technical Support Facility
C/T	cycle time
DA	Department of the Army
DAG	Defense Acquisition Guidebook
DIACAP	DOD Information Assurance Certification and Accreditation Process
DMAIC	define measure analyze improve control
DoN	Department of the Navy
DPD	deputy product director
EAC	estimate at completion
EVAL/FUND	proposal evaluation & funding
FMS	foreign military sales
FMR	foundation matrix review
FS	finish to start

FS	functional staffing
FSR	Field Service Representative
FY	fiscal year
G6	Assistant Chief of Staff or Information Management
IA	information assurance
IAVM	information assurance vulnerability management
IGE	independent government estimate
IPT	integrated product team
ISO 9000	international organization standards
KPP	key performance parameter
LSL	lower spec limit
LSS	lean six sigma
MTOE	modified table of organization and equipment
N/A	not applicable
NIST	National Institute of Standards and Technology
NPS	Naval Postgraduate School
NVA	non-value added
OBT	Office of Business Transformation
OGA	other government agency
PBL	performance based logistics
PD	product manager
PD	product director
PEO	program executive office
PI	program integrator
PM	program manager
POP	period of performance
PPM	parts per million
PRO RCD	proposal received
PSF	Product Support Facility
REQ	required
RB	re-baseline
SC	software certification

SED	Software Engineering Directorate
SIPOC	suppliers inputs processes outputs and customers
SEI	Software Engineering Institute
SMART	specific measurable attainable realistic timely
Spec	specification
SOL ISD	solicitation issued
SOP	standing operating procedures
SOW	statement of work
SS	six sigma
SSR	System Support Representative
SR	software release
SQL	sigma quality level
SW	software
TDA	table of distribution and allowances
TE	technical estimate
TDP	technical data package
TQM	total quality management
USL	upper spec limit
VA/T	value added time
VM	virtual machine
VSM	value stream map

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Thank you to my parents for your constant support. This project is dedicated to my late father, Wilfred P. Pekrul (1931–2014), who served in the U.S. Navy from 1950 to 1954 on the U.S.S Pine Island. He loved the Navy, and he loved the sea. His faith and spirit are reflected in the Navy Hymn:

Eternal Father, strong to save,
Whose arm has bound the restless wave,
Who bids the mighty ocean deep
Its own appointed limits keep;
O hear us when we raise our plea
For those in peril on the sea.

O Trinity of love and power,
Your children shield in danger's hour.
From rock and tempest, fire and foe,
Protect them where so e'er they go.
And then shall rise with voices free
Glad praise from air and land and sea.

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I. INTRODUCTION

This project is an analysis of total quality management (TQM) within a sample U.S. Army Aviation acquisition category (ACAT) III program. The organization historically uses metrics to track and identify problem areas within individual product teams. This research investigates whether these metrics, intended as indicators of total quality, are actually valid and useful to product managers within Army Aviation Systems and align with the principles of total quality. The author seeks to answer, “Is the right data collected?” “Is the data analyzed and used by leadership to make decisions?” “Are there performance issues?” “Is there poor execution?” And “do our leaders know what information they need or don’t need to make well-informed decisions?” The quality framework, based on the Baldrige criteria, informs the project as it analyzes the organization and metrics collected.

The Aviation Systems organization implements Lean Six Sigma (LSS) projects and tools as a means of improving itself and creating a quality culture. The Deputy Project Manager for Aviation Systems requested an implementation of an Army LSS green-belt project to coincide with this project. Thus, this research features an application of LSS as a means of evaluating TQM within the organization by evaluating the metrics for this project. The author uses the metrics for Department of the Army Lean Six Sigma and includes the findings in this project.

A. WHY CARE ABOUT TOTAL QUALITY?

Performance metrics should be constructed to encourage performance improvement, effectiveness, efficiency, and appropriate levels of internal goals. They should incorporate “best practices” related to the performance being measured and cost/risk/benefit analysis, where appropriate (“Total Quality Management,” n.d.).

TQM best practices for Army acquisition should focus on the performance measurement of cost, schedule, performance (technical) and quality. This study determines whether, using these metrics, customer requirements and needs are met.

1. Total-Quality Management Definitions

Total-quality management (TQM) consists of organization-wide efforts to install and make permanent a climate in which an organization continuously improves its ability to deliver high-quality products and services to customers. While there is no widely agreed-upon approach, TQM efforts typically draw heavily on the previously-developed tools and techniques of quality control. TQM enjoyed widespread attention during the late 1980s and early 1990s before being overshadowed by ISO 9000, Lean manufacturing, and Six Sigma ("Total Quality Management," n.d.).

According to quality-control expert and businessman Armand V. Feigenbaum,

> Total quality control is an effective system for integrating the quality development, quality maintenance, and quality improvement efforts of the various groups in an organization so as to enable production and service at the most economical levels which allow full customer satisfaction. ("Armand V. Feigenbaum." n.d.)

In *Total Quality Management: A Guide for Implementation* , the authors describe TQM within the Department of Defense (DOD) as the following:

> Total Quality Management (TQM) in the Department of Defense is a strategy for continuously improving performance at every level, and in all areas of responsibility. It combines fundamental management techniques, existing improvement efforts, and specialized technical tools under a disciplined structure focused on continuously improving all processes. Improved performance is directed at satisfying such broad goals as cost, quality, schedule, and mission need and suitability. Increasing user satisfaction is the overriding objective. The TQM effort builds on the pioneering work of Dr. W. E. Deming, Dr. J. H. Juran, and others, and benefits from both private and public sector experience with continuous process improvement. (DOD, 1989)

2. The History of TQM

TQM dates back to the early 1920s, when statistical theory was first applied to product quality control in Japan. The concept was further developed by the Japanese in the 1940s, with the focus widened from product quality to the quality of all aspects of an organization's performance ("History of Quality," n.d.).

In the late 1970s and early 1980s, TQM burst into prominence as Japan's economy challenged those of North America and Western Europe. Japan was able to produce high-quality products at competitive costs, stirring economic turmoil as, for the first time ever, the United States and United Kingdom struggled to keep up with the industrial development of Japan.

The American response was a "system" to study Japanese manufacturing and develop similar total-quality-management methods. Armand V. Feigenbaum's multi-edition book, *Total Quality Control* and Kaoru Ishikawa's *What Is Total Quality Control? The Japanese Way* illuminated key concepts and identified methodologies and techniques that could be applied to companies and organizations in the U.S. ("Total Quality Management," n.d.).

In the spring of 1984, the United States Navy asked civilian researchers to assess statistical process control and the work of prominent quality consultants and make recommendations for applying these approaches to naval operations. The study recommended the precepts of W. Edwards Deming. The Navy branded the effort "total-quality management" in 1985 (Houston & Dockstader, 1997). From the Navy, TQM spread throughout the federal government, resulting in the establishment of highly recognized programs, as displayed in Table 1.

Table 1. U.S. Government Quality Programs

U.S. Government Quality Programs	
Year	Development
August 1987	Creation of the Malcolm Baldrige National Quality Award by Public Law 100-107
June 1988	Creation of the Federal Quality Institute
1989, 1992, 1991	Adoption of TQM by many elements of government and the armed forces, including the United States Department of Defense (1989), United States Army (1992), and United States Coast Guard (1991).
2008	Department of Defense (DOD) Lean Six Sigma, Deployment, DODI 2010.43

B. PURPOSE/BENEFIT

The private sector followed suit, using TQM not only as a means to recapture market share from the Japanese, but to remain competitive when bidding on federal contracts, since "total quality" requires the involvement of suppliers, not just employees, in process-improvement efforts.

This study investigates the overall implementation and use of TQM within the sample ACAT III program, with an emphasis on performance measurement, efficiency, and effectiveness of the processes used for performance-data collection, analysis, and evaluation, which are aimed at strategic goals. LSS analysis tools are used to quantify and study the value of the reported metrics.

1. Problem Identification

The ACAT III program's contract-requirements package (CRP) development process collects, tracks, and reports metrics for identified milestones. Figure 1 depicts milestones in "re-baseline" (RB) efforts.

Figure 1 presents one aspect of the data generated by the author for this LSS project for U.S. and foreign military sales (FMS) actions. The chart shows an overall composite of project milestones reported as late. The data is based on a timeframe from October 1, 2012, to March 2014. The data provides a required date, actual date, and a re-baseline date, which is a shift in the original deadline. The data collected for the metrics is powerfully useful in the day-to-day operations of the organization and the organization's ultimate end goals seem to be consistently met. Questions arise as to why the organization consistently re-baselines and shifts the required end date. If this is true and a standard practice, why collect the metrics? Are these metrics useful and valuable for management in making program decisions? Or is leadership failing to take advantage of the metrics to make informed decisions?

The umbrella organization implements LSS as a quality tool. This study asks whether this tool is of value, and could it be implemented and used in conjunction with other quality programs to achieve performance excellence throughout the organization?

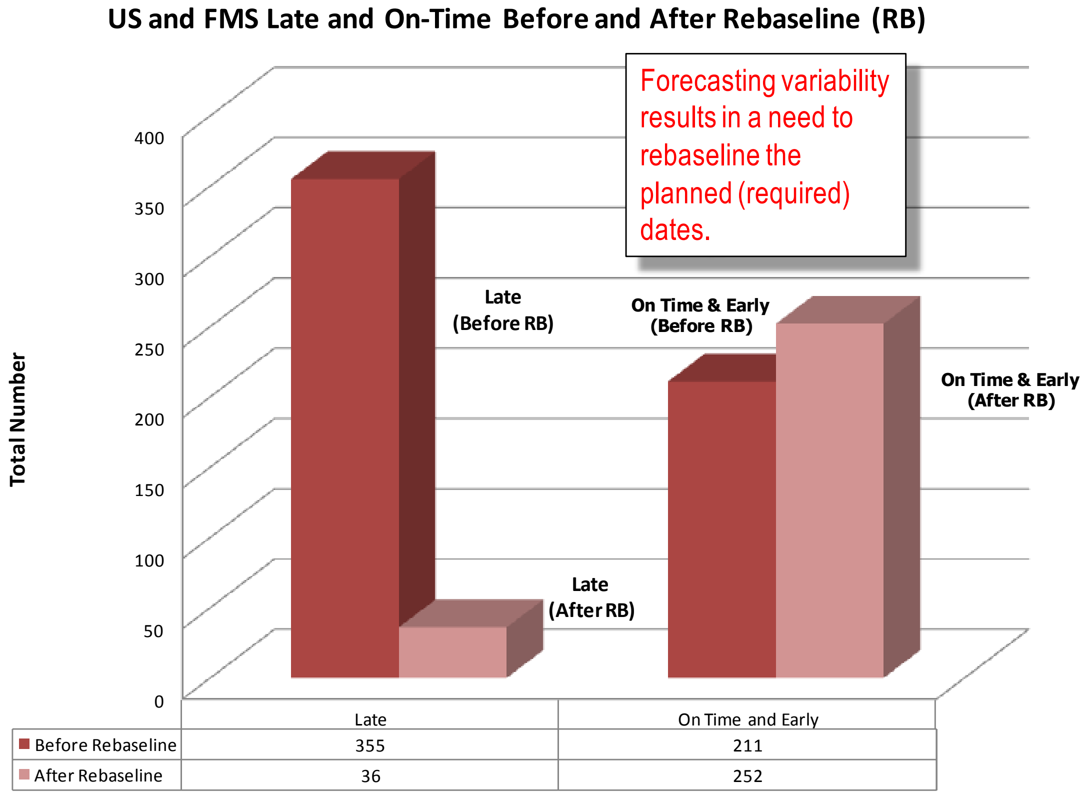

Figure 1. Milestone Re-baseline Statistics

C. THESIS STATEMENT

ACAT III program should indeed implement metrics as a means to reach performance excellence. The implementation of metrics within ACAT III programs is a powerful tool for organizations to implement in order to strive for Performance Excellence. The purpose of this project is a study of the metrics of a sample U.S. Army Aviation ACAT III program. The organization reports weekly metrics across the functional areas (logistics, business, technical (software development, risk management)) that are reviewed in functional management staff calls. This project seeks to identify if these metrics align with TQM Best Practice standards. The framework for the study is The National Institute of Standards and Technology Baldrige criteria. The proven tenets identify ways for an organization to reach performance excellence. There are seven categories of criteria that are intertwined and worth noting in order to reach this performance excellence: 1. leadership, 2. strategic planning, 3. customer focus, 4.

measurement, analysis and knowledge management, 5. workforce focus, 6. process management, 7. results. The study of metrics is an aspect of the “4. measurement, analysis, and knowledge management” criterion. However, a holistic approach is made to survey the overall organization and identify if the organization and its metrics are aligned to reach performance excellence, the basic tenet of TQM.

D. LITERATURE REVIEW AND FRAMEWORK

There are hundreds of frameworks that present positive implementations and how-tos for improving quality and performance in U.S. governmental organizations. One example is the U.S. Department of Energy Defense publication, *Programs: How to Measure Performance: A Handbook of Techniques and Tools* (DOE, 1995). This document states that performance measures tell us something quantitatively important about our products, services, and the processes that produce them. The list below identifies, from a high level, what data information metrics provides for the Department of Energy (as an example organization).

- Performance measures
- How well we are doing
- If we are meeting customer goals
- If our customers are satisfied
- If our processes are in statistical control
- If and where improvements are necessary

There are many ways to review and look at quality. The author has selected the Baldrige Performance Excellence Program and criteria to evaluate the metrics in this project, recognizing that a myriad organizations have found it an effective method that can implemented at a reasonable cost.

1. The Baldrige Performance Excellence Program

The National Institute of Standards and Technology (NIST), a division of the United States Department of Commerce, developed the Baldrige Performance Excellence Program to identify methodologies for achieving performance excellence. The strategy is to empower organizations to reach goals, improve results, and become more competitive by aligning plans, processes, decisions, people, actions and results. The method provides criteria consisting of seven sets of questions about critical aspects of organizational management and performance. Figure 2 presents the Baldrige high-level organizational profile, denoting the overall system approach.

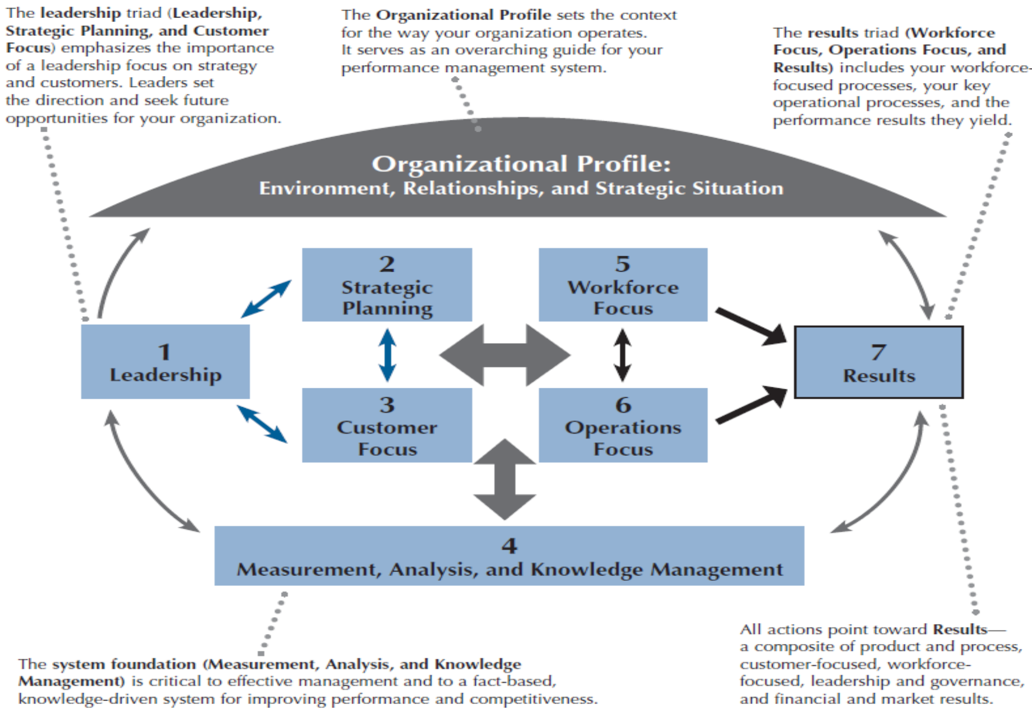

Figure 2. Baldrige Organizational Profile (from NIST, 2013, p. 1)

a. The Baldrige Criteria

Leadership The first criterion in the Baldrige program, leadership, seeks to answer the following questions:

- "How do your senior leaders lead?"
- "How do you govern and fulfill your societal responsibilities?" (NIST, 2013, pp. 4-27)

Strategic Planning The strategic planning criterion asks,

- "How do you develop your strategy?"
- "How do you implement your strategy?" (NIST, 2013, pp. 4-27)

Customer Focus The customer focus criterion explores the questions,

- “How do you obtain information from your customers?”
- “How do you serve customer needs to engage them and build relationships?” (NIST, 2013, pp. 4-27)

Measurement, Analysis, and Knowledge Management This fourth criterion inquires,

- “How do you measure, analyze, and then improve organizational performance?”
- “How do you manage your organizational knowledge assets, information, and information technology?” (NIST, 2013, pp. 4-27)

Workforce Focus Questions pertaining to the workforce are,

- “How do you build an effective and supportive workforce environment?”
- “How do you engage your workforce to achieve organizational and personal success?” (NIST, 2013, pp. 4-27)

Operations Focus The sixth criterion focuses on operations, asking,

- “How do you design, manage, and improve your key products and work processes?”
- “How do you ensure effective management of your operations on an ongoing basis and for the future?” (NIST, 2013, pp. 4-27)

Results Finally, the seventh criteria inquires,

- “What are your product performance and process effectiveness results?”
- “What are your customer-focused performance results?” (NIST, 2013, pp. 4-27)

b. Baldrige Core Values and Concepts

The Baldrige criteria are built on the set of interrelated core values and concepts provided below.

- Visionary leadership
- Customer-driven excellence
- Organizational and personal learning
- Valuing workforce members and partners
- Agility
- Focus on the future
- Managing for innovation

- Management by fact
- Societal responsibility
- Focus on results and creating value
- Systems perspective

These criteria offer a model for business excellence in any organization—manufacturing, service, or not-for-profit; large or small; public or private (Evans & Lindsay, 2011, p. 118).

c. Baldrige Criterion 4: The Focus of This Study

The Baldrige criteria offer seven areas of focus for an organization. This study analyzes and focuses on the fourth criterion—measurement, analysis, and knowledge management—and reviews the Baldrige criteria overall within the conclusion.

2. The Army's Lean Six Sigma Program

According to Lieutenant General Thomas W. Spoehr, Director, Office of Business Transformation (OBT):

> Is the Army a business? Many have persuasively argued it is not, citing the primacy of success on the battlefield far above any other metric such as profit margin or loss. But no one can argue that in many key areas the Army does not need to perform like a business; striving to obtain the most output at the least cost within our twelve Title 10 functions such as recruiting, training, and supplying. Hence, the critical mission of the Office of Business Transformation is to help the Army incorporate proven business practices in order to get the most from every dollar we are provided by the American taxpayers and Congress. (Leipold, 2014)

LSS is a vital part of today's business environment. It attacks inefficiencies and waste caused by defects and eliminates the non-value-added flow of information and materials, data storage, stacks of inventory, overproduction, and extra processing. With LSS-proven techniques, Army managers have the tools to find, fix, and finalize efficiencies to save time and money and improve our nation's ready forces at best value (DOA, 2011).

Since the start of the Army's LSS deployment in 2006, $19.1B has been saved through process improvements, such as improved materiel flow in Iraq and Afghanistan.

These financial benefits include savings to current programs, cost avoidance in future programs, and revenue generation from reimbursable activities. Today, the program continues to expand as leaders are increasingly pressed to reduce resources and eliminate waste and inefficiency. In fiscal year 2011, a total of 2,111 process-improvement projects were underway, representing $3.6B in potential savings. None of these financial benefits can be accomplished without the strong partnership of leaders, champions, and the Army's 48 LSS deployment directors (DOA, 2011).

The Army has trained 5,700 LSS "green-belts," 2,400 "black-belts," and 175 "master black-belts" to date (DOA, 2011). The goal is for organizations to become self-sustaining in LSS techniques and to leverage the gains they have earned. The LSS Program Management Office (PMO) has integrated many improvements effected in individual commands Army-wide and championed the training necessary to make LSS a routine way of doing business.

3. LSS Plans for the Future

The future of LSS is bright. Since the announcement of the efficiencies effort by the Secretary of Defense in May 2010, LSS value-stream analysis is now a fundamental step in the cost-benefit analysis for any new requirement. The LSS methodology has a proven track record, producing a return on investment of 700 to 1 since deployment. LSS is important as an analytically based methodology that enables responsible stewardship of national resources (DOA, 2011).

4. LSS Terms

"Six Sigma." The term "six sigma" (SS) is borrowed from statistics, a field that helps us measure and understand individual data points, averages, and variations in a process or service. The primary focus as applied in SS is achieving improvements in service quality and cost. Per DMAIC Tools, Six Sigma Training Resources, 2014, Six Sigma uses the normal distribution equation (the "bell curve" distribution that fits a number of real-world situations) , which predicts 3.4 defects-per-million over the long run for processes that have at least six standard deviations between the process average and the nearest specification limit (See Figure 3).

The important point is that a Six Sigma process has extra "cushion" between the outer extremes of the process results and the specification limits, so the process can drift over time without creating defects. ("What is Six Sigma," 2012)

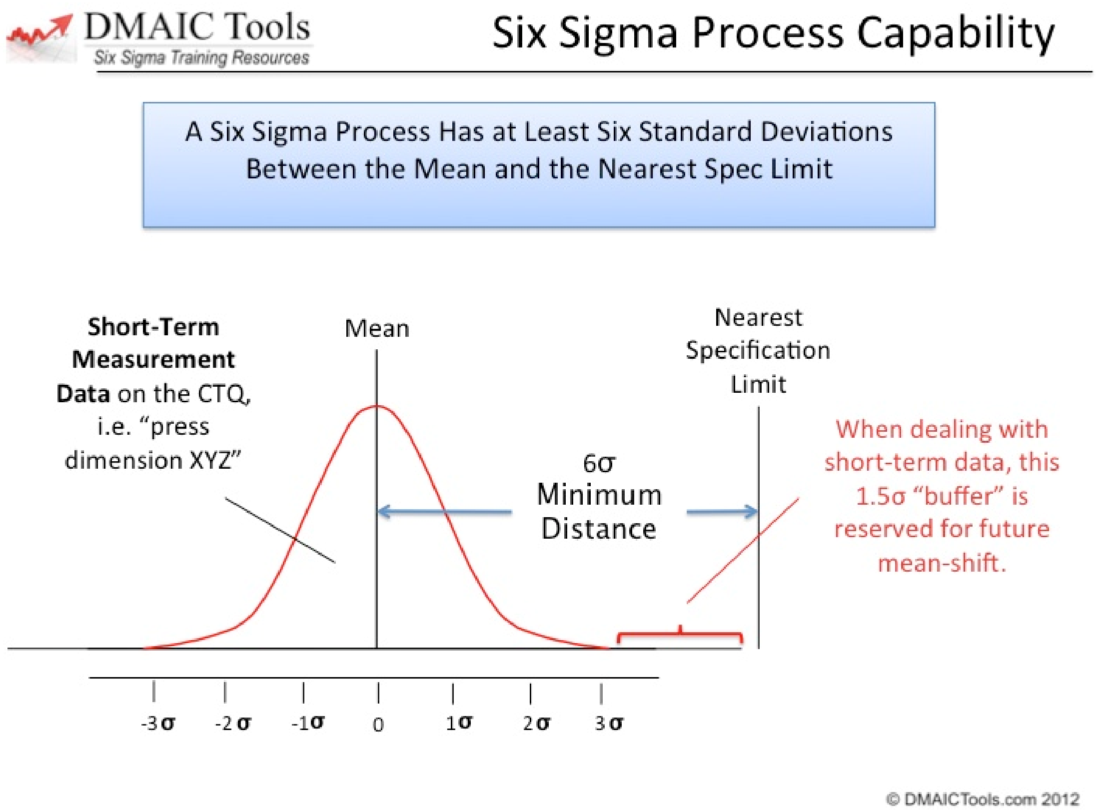

Figure 3. Six Sigma Process Capability (from "What is Six Sigma," 2012)

"Lean." The term "lean" refers to an organization removing all non-value-added waste (time and activity) in a process or service to reduce lead times, improve on-time delivery performance, and reduce cost (Breakthrough Management Group & DeCarlo, 2007).

"Lean Six Sigma." Lean Six Sigma (LSS) combines the methodologies of "Lean" and "Six Sigma" to improve an organization's process speed, quality, and reduce costs (Breakthrough Management Group & DeCarlo, 2007).

5. Define Measure Analyze Improve Control Processes

The LSS (Define Measure Analyze Improve Control) process provides a simple and logical framework for all LSS projects featuring five major steps:

1. **Define.** The first step includes defining the problem with a clear project charter based on a real problem that is relevant to the customer and will provide significant benefits to the business. This step includes identifying and understanding which underlying metric(s) will reflect project success. ("DMAIC," n.d.)
2. **Measure. The second step includes u**nderstanding and baselining the current performance of the process through a set of relevant and robust measures. This step includes documenting the current process, validating how it is measured, and assessing baseline performance. Some of the important tools in this phase include developing trend charts, process flowcharts, and process capability measurements. The sigma level is also calculated. identified. This phase includes an intense statistical analysis of the data. ("DMAIC," n.d.)
3. **Analyze.** The third step involves identifying the root causes of the problem, understanding and quantifying the effects on process performance. The analyze phase isolates the top causes behind the metric; in most cases there will be no more than three causes that must be controlled in order to achieve overall success. Affinity and fish bone diagrams, 5-whys, histograms, Pareto charts, and other analysis tools are used. ("DMAIC," n.d.)
4. **Improve.** The improve step entails developing, selecting, and implementing the best solutions, with controlled risk with a focus on fully understanding the top causes identified in the Analyze phase. Process redesign and the following tools are commonly used in this phase: regression analysis, hypothesis Testing, design of experiments, analysis of variance. A beta test or demonstration is also part of this phase, which seeks to prove out the potentially improved sigma quality level before moving to the last step, the Control phase. ("DMAIC," n.d.)
5. **Control. The control step e**nsures that solutions are embedded, the process has robust controls, and the project has a clear closure. Control is about sustaining the changes made in the Improve phase to guarantee lasting results. The outputs from this phase include a control plan that documents how the organization is to sustain the changes. ("DMAIC," n.d.)

6. Baldrige and the LSS Program

A combined analysis of Department of Energy processes, the Baldrige criteria (found in Supplemental), and the Army's LSS program provides a framework that is process focused, data based, and management led. Each factor offers a different emphasis in helping organizations improve performance and increase customer satisfaction. Another popular framework, international organization standards (ISO) 9000, which is not explored in this research, primarily focuses on product and service conformity for guaranteeing equity in the marketplace and concentrates on resolving quality system product and service nonconformities. LSS concentrates on measuring product quality and driving process improvement and cost savings throughout the organization (Evans & Lindsay, 2011, pp. 135–137).

Several prominent businesses have successfully married the ideologies and principles of Baldrige and LSS. It is important to note, "Six Sigma can provide the impetus for change, while the Baldrige Core Values provide the keys to sustainability" (Evans & Lindsay, 2012, pp. 135–137).

E. DATA COLLECTION

Data for this project is collected from a sample ACAT III program with fictitious names and data. The data includes mission statements, standard operating procedures, and metrics in the functional areas of business, logistics, technology (software development, and risk management).

F. DATA ANALYSIS

Data for this project is first analyzed using Baldrige criterion 4: measurement, analysis and knowledge management as a framework. Next, a deep study of one aspect of the data is conducted using actual dates using LSS methodologies. Note that the LSS project remains in progress as of this writing. The in-depth study is used to identify whether the metrics employed follow TQM tenets, are useful to management, and are being exploited by management to their benefit.

G. RECOMMENDATIONS

Following the data analysis, a conclusion and recommendation are provided to identify the effectiveness of the quantitative performance metrics of the sample ACAT III program, and provides recommendations for improving the organizational performance.

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II. DATA COLLECTION

Data for this project was collected from a sample ACAT III program within Aviation Systems, with program names and numerical data changed to for program sensitivity. The data includes mission statements, standing operating procedures, and metrics in the functional areas of business, logistics, technology (software development), and risk management. A cursory review of the documentation based on the Baldrige criteria is presented in Table 2; this research focuses on criterion 4.

Table 2. Baldrige Criteria Metrics Matrix

Baldridge Criteria	Program Level	Product Directorate Level	Description	Frequency	Collected by
1. Leadership	Mission Statement	Mission Statement	Mission Statement provided on internal website	Annually	Staff
2. Strategic Planning	Unknown	Unknown			
3. Customer Focus	Mission Statement	Mission Statement	Mission Statement provided on internal website	Annually	Staff
4. Measurement, Analysis, and Knowledge Management	Program Management	Product Directorate Metric Standing Operating Procedure	Metric Standing Operating Procedure	As Required	Product Director
		Product Directorate Risk Management Standing Operating Procedure	Risk Management Standing Operating Procedure	As Required	Product Director/ Technical Chief
		Product Directorate Weekly Review Metrics	Product composite consisting of programmatic, business, logistics, and technical reports	Weekly	APM
		Product Level Management	Schedule	Weekly	APM
		Business	Contractor Cost Reports	Montly	PD Business Office
			Contract Development Actions	Daily/Weekly	PD Business Office
			Contractor Deliverables	Month	PD Business Office
		Logistics	Fielding	Weekly	PD Logistics Specialist
		Technical	Software Development Schedule	Weekly	PD Technical
			Risks	Weekly	PD Technical
5. Workforce Focus	Unknown	Unknown			
6. Operations Focus	Unknown	Unknown			
7. Results			Program Management Reviews, Acquisition Program Baseline, ACAT Reviews		

A. LEADERSHIP AND MISSION

The Product Directorate (PD) Aviation Networks and Mission Planning (ANMP) organization studied contains business, logistics, technical, and security divisions and an operations cell, which includes foreign military sales. The mission statement for the organization (which is included under criterion 1, leadership), is as follows:

> Enhances the mission planning, situational awareness, maintenance management, and command and control capabilities of the Army Aviation soldier through the development and deployment of state-of-the-art mission planning, automated logistics, and interoperability tools and products, thereby enhancing combat mission effectiveness, battlefield lethality and synchronization, aircrew situational awareness, aircraft survivability, and mission readiness. ("Aviation Networks and Mission Planning Mission," n.d.)

B. MEASUREMENT, ANALYSIS, AND KNOWLEDGE MANAGEMENT

The data collection process of Measurement, Analysis, and Knowledge Management is defined and addressed through the Product-Directorate Metrics SOP and the Product-Directorate Risk Management SOP described herein. These SOPs serve to establish policy and processes to formally establish the reporting of monthly metrics and for implementing continuous risk-management procedures for the organization.

1. Product-Directorate Metrics SOPs

The ANMP identifies a formal standard operating procedure (SOP) that identifies the reporting of monthly metrics (see Appendix A). The metrics are reviewed in the directorate's weekly staff calls.

Metrics data is collected, reported, and posted to a common area for management review. Per the SOP, product metrics serve as a fundamental system-engineering and program-management tool for leadership. Integrated product teams (IPTs) use the data to discover positive or negative trends in product or weapons-system costs, schedules, and technical performance. If negative trends are detected, immediate attention and corrective action can be applied. Since many products fall under guidelines set forth by the acquisition program's baseline thresholds and objectives, it is imperative that performance be measured accurately and often.

The objective of each assistant product manager (APM) and IPT is to develop a set of monthly metrics in a standard format that is consistent across products and IPTs. These metrics suggest an accurate picture of a product's cost, schedule, technical health, and status. Products metrics are coded as green, yellow, or red to indicate the nature and level of performance trends that have been flagged for management action. Metrics may be refined as products move through different phases of their lifecycle and new metrics can be added as required. Not all metrics definitions apply to every product, but APMs/IPTs are asked to adhere to SOPs as close as possible.

a. Metrics Defined

The status of individual metrics is defined using color identifiers, as shown in Table 3.

Table 3. Metric Status Definitions

Color	Name	Definition
	Green	Product is on or ahead of schedule, cost, or technical goals
	Yellow	Product is behind schedule, cost, or technical goals, but recoverable
	Red	Product is behind in schedule, cost, or technical goals and not recoverable

Metric performance measures, per the SOP, encompass schedule, cost, technical goals, and actual-versus-Department of the Army (DA) planned monthly obligation rates, according to the definitions and descriptions provided in Table 4.

Table 4. Performance Measures

Type	Description
Schedule	Required-need dates as compared to forecasted or actual dates
Cost	Reports cost and may denote unforeseen over-runs due to technical issues
Technical	Denotes meeting objective/threshold requirements or key performance parameters (KPPs)
Actual vs. DA Planned Monthly Obligation Rates	Identifies funding that has yet to be spent as planned

b. General Product Metrics Topics

The SOP identifies the high-level topics to be reported. The metrics reported are flexible and based on the individual program, as follows:

- Software- and hardware-development status
- Software blocking, certification status, information assurance vulnerability management (IAVM) requirements, and testing events
- Contract status
- Contract data requirements list (CDRL) status
- Risk updates per risk SOP
- Production and delivery status
- Fielding status
- Obligations funding performance curves
- APMs/IPTs top issues (risks that have already occurred)

c. APM Responsibilities

The APM is responsible for providing monthly metrics for review by the product director/deputy product director (PD/DPD) and functional manager and posting results to SharePoint. The APM also briefs the ANMP staff on product trends in cost, schedule, and technical performance.

d. Functional Manager (Business, Logistics, and Technical) Responsibilities

Functional managers are responsible for supporting APMs/IPTs in the development of monthly metrics and briefing ANMP staff on any developing trends in cost, schedule, or technical performance.

e. IPT Responsibilities

The IPT is responsible for supporting the APMs in the development and update of monthly metrics.

2. The Product Directorate Risk-Management SOP

The risk-management SOP (see Appendix B) establishes policy and processes for implementing continuous risk-management procedures for the organization. The ANMP risk SOP identifies DOD and ANMP references that are used as a basis for organizational risk metrics, as follows:

- *The Defense Acquisition Guidebook* (DAG), 2010 (DOA DAG, 2010)
- *The Risk Management Guide for DOD Acquisition*, (DOD, 2006)
- *ANMP Metric SOP* (Appendix A)
- *ANMP Risk Management SOP* (Appendix B)
- *The Continuous Risk Management Guidebook, Software Engineering Institute* (SEI, 1996)

The risk SOP describes the establishment of risk management procedures and indicates how programs will incorporate the elements of the risk-management processes into weekly activities and status meetings.

Red risks are reported immediately to the director, along with status updates as they become known. Programs and projects report the status of all yellow (amber) and red risks to the technical lead weekly. Green risks are available but may or may not be reported.

3. IPT Metrics

The individual IPTs are responsible for identifying customer and strategic requirements. Metrics are designed to drive improvement and characterize progress made under each criterion. The IPTs, under the leadership of the APM, report the health and overall status of their programs. Table 5 describes the uses and value of the overarching metrics provided by the IPT.

Table 5. Use and Value of IPT Metrics

Functional Area	Description
Logistics	Collection, management, and reporting of hardware quantity variances across their programs, and reporting the associated costs
Technical	Collection, management, and reporting of software versions across the programs, and reporting the associated costs
Metric Reporting	Sharing and discussing metric reports within the IPT
Foreign-Military Sales	Tracking and reporting details of foreign-military sales (FMS) programs
Personnel Growth	Identify growth in personnel over time commensurate with the growth of the program
Schedule	Report schedule variances

4. Business Metrics

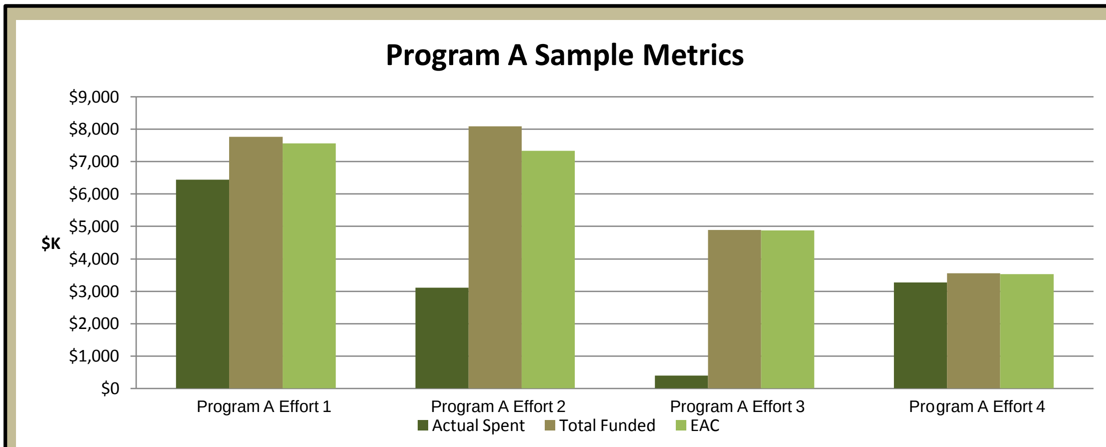
Overall, the business functional area encompasses the overall cost and financial aspects of the program, in addition to its contractual management. The key cost document is the lifecycle-cost estimate. The business functional area provides cost and contract-actions metrics on a weekly basis, to include measurements identified in three general areas: cost, contract-requirements-package development, and CDRL metrics as described.

a. Cost Metrics

In the business functional area, cost-report metrics consist of the following elements:

- Business-cost metrics
- Effort
- Period-of-performance start
- Period-of-performance end
- Actual spent
- Total funded
- Estimated funding at completion
- Variance
- Comments

Figure 4[1] represents the weekly cost report with fictional data, which is a reflection of the information provided by the primary contractor in performing program work.



	POP Start	POP End	Actual Spent	Total Funded	EAC	+/- $	+/- %	Comments
Program A Effort 1	15 Mar 13	17 Apr 14	$6,448	$7,761	$7,567	-$194	-2%	1. Phase I POP extended from 15 Sep 13 to 17 Apr 14. 2. PSMR states that a SLIN POPx was requested on 15 Jan 14.
Program A Effort 2	11 Sep 13	30 May 14	$3,104	$8,097	$7,328	-$769	-9%	1. Phase II POP extended from 14 Mar 14 to 30 May 14.
Program A Effort 3	1 Sep 2013	31 Aug 14	$394	$4,894	$4,878	-$16	0%	
Program A Effort 4	15 Feb 13	14 Feb 14	$3,270	$3,557	$3,524	-$33	-1%	1. PSMR states Gov't oversight cost less than expected. 2. PSMR states that a SLIN POPx was requested on 15 Jan 14.

Figure 4. Cost-Report Sample

b. Business-Contract-Requirement Package Development Status

Contract-requirement-package (CRP) development metrics track the progress and milestone events of each contract action. These metrics include the required and actual dates of the following milestones:

- Statement of work (SOW), CDRLS/specifications
- Technical estimate (TE)/independent government estimate (IGE)
- Functional staffing (FS)

[1] In Figure 4, POP stands for “period of performance” and EAC stands for “estimate at completion.”

- Foundation Matrix Review (FMR)
- CRP to acquisition center (AC) (or other government agency (OGA))
- Solicitation issued (SOL ISD)
- Proposal received (PRO RCD)
- Technical evaluation completed
- Contract award

Figure 5[2] shows a sample report with fictitious data and sample efforts. The LSS project intensely studies these metrics.

[2] In Figure 5, REQ stands for "required date," ACT stands for "actual date," IA stands for "information assurance," PSF for "product support facility," SSR for "system support representative," SW for "software," AFTD for "Aviation Flight Test Directorate," ATEC for "Army Test and Evaluation Command," AED for "Aviation Engineering Directorate," SED for "Software Engineering Directorate," TDP for "Technical Data Package," DIACAP for DOD information assurance certification and accreditation process," AMCOM for Aviation and Missile Command," CTSF for "Central Technical Support Facility, and V M for "virtual machine."

Item #	Contract/Effort	SOW/CDRL/Spec Complete		Tech Est/ IGE complete		Functional staffing complete		FMR Approved		CRP to AC (or OGA)		Solictitation Issued		Proposal Received		Tech Eval Complete		Contract Award	
		REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT
	FY 14 Actions (AMPS)																		
1	Program A IA Effort	9/26/13	9/26/13	11/5/13	11/5/13	11/17/13	11/18/13	N/A				11/18/13	11/18/13	12/2/13	12/3/13	12/9/13	12/13/13	1/9/14	
		$360,000					15 April 2014 - 14 April 2015											4/1/14	
2	Program A PSF Effort	9/26/13	9/26/13	11/6/13	11/18/13	11/13/13	11/26/13	N/A				11/14/13	11/26/13	11/28/13	12/20/13	12/6/13	1/9/13	1/7/14	
		$419,000					15 April 2014 - 14 April 2015											4/1/14	
3	Program A SSR	10/23/13	11/15/13	11/6/13	12/9/13	11/13/13	12/9/13	N/A				11/14/13	12/13/13	11/28/13	1/9/14	12/5/13	1/24/14	1/5/14	
														1/10/13		1/17/13		4/1/14	
		$3,346,457					15 April 2014 - 14 April 2015												
4	Program A SW Mod (FY14)	12/25/13	12/3/13	1/15/14		1/22/14		N/A				1/23/14		2/6/14		2/13/14		3/15/14	
				2/18/14		2/25/14						2/25/14		3/27/14		4/17/14		6/3/14	
		$15,602,000					15 April 2014 - 14 April 2015												
5	Program A AFTD Support	4/9/14		4/30/14		5/7/14		N/A				5/8/14		5/22/14		5/29/14		7/1/14	
		$368,000					15 July 2014 - 14 July 2015												
6	Program A ATEC Support	5/7/14		5/21/14		5/28/14		N/A				5/29/14		6/12/14		6/19/14		7/1/14	
		$22,405					1 Jul 14 - 31 Jun 2015												
7	Program A AED Support	1/9/14		1/30/14		2/6/14		N/A				2/7/14		2/21/14		2/28/14		3/30/14	
		2/18/15		2/25/15		3/4/15						3/4/15		3/25/15		4/1/15		4/30/15	
		$116,000					15 Apr 14 - 14 Apr 15.												
8	Program A SED Safety Support	4/7/14		4/28/14		5/5/14		N/A				5/5/14		5/26/14		6/2/14		7/1/14	
		$260,000					5 May 14 - 4 May 15												
9	Program A Technical TDP Review	4/9/14		4/30/14		5/7/14		N/A				5/8/14		5/22/14		5/29/14		7/1/14	
		$112,000					1 Jul 14 - 31 Jun 2015												
10	Program A DIACAP Support	1/9/14		1/30/14		2/6/14		N/A				2/7/14		2/21/14		2/28/14		3/30/14	
		2/18/15		2/25/15		3/4/15						3/4/15		3/25/15		4/1/15		4/30/15	
		$63,000					30 March 2014- 29 March 2015												
11	Program AMCOM Material Release	5/7/14		5/21/14		5/28/14		N/A				5/29/14		6/12/14		6/19/14		7/1/14	
		$16,000					1 Jul 14 - 31 Jun 2015												
12	CTSF							N/A				7/2/14		7/16/14		7/23/14		8/22/14	
		$159,000					22 Aug 2014 - 21 Aug 2015												
13	VM Solution	1/1/14	1/10/14	1/16/14	1/16/14	1/22/14	1/22/14	N/A				1/22/14		2/27/14		3/13/14		8/14/14	
		$14,000																	

Figure 5. Business Contract Requirements Package Development

5. Logistics Metrics

The logistics functional area is responsible for the fielding, hardware deliveries, and training of a program. Logistics metrics for this organization provides three primary reports: fielding and hardware-delivery status summary, individual Army-unit fielding status, and overall trending/status.

a. Fielding-Delivery Status

The data types collected for the fielding-summary metrics report are summarized as follows:

- Total acquired for specified timeframe (including spares)
- Modified table of organization and equipment (MTOE) / table of distribution and allowances (TDA)
- Total fielded
- Percent fielded of the authorizations total
- Active Army percent fielded
- National Guard percent fielded
- Army Reserves percent fielded

A graphical representation of a fielding-summary-metrics report with fictional data is given in Figure 6.

Product A Fielding Summary Sample

Product A FY12-14 Total Acquisition:
5492 (including spares)

MTOE/TDA Authorizations:
4096 for FY13
4182 for FY14

Total Fielded: 3957 towards FY13; 3983 towards FY14
% Fielded of FY13 Authorization: 93.4%
% Fielded of FY14 Authorization: 90.9%
Active Army: 3120, 93.3%
National Guard: 778, 88.4%
Army Reserves: 72, 70.6%

Figure 6. Fielding-Summary Sample

b. Individual Army-Unit Fielding Status

Individual Army-unit fielding-status metrics collect and report the data provided below.

- Unit location
- Type of unit
- Action (training or fielding)
- Required date
- Actual date
- Total number of systems

A graphical representation of an individual Army-unit fielding status report with fictional data is provided in Figure 7.

Location (Unit)	Type Unit	Action	Required Date	Actual Date	Total Systems
A	Guard	Training; Fielding	2/4/2014	2/4/2014	1
B	Active	Training; Fielding	2/5/2014	2/5/2014	1
C	Active	Training; Fielding	2/6/2014	2/6/2014	2
D	Active	Training; Fielding	2/7/2014	2/7/2014	1
E	Guard	Training; Fielding	2/7/2014	2/6/2014	1
F	Guard	Training; Fielding	2/9/2014	2/9/2014	2
G	Guard	Training; Fielding	2/9/2014	2/9/2014	2
H	Guard	Training; Fielding	2/10/2014	2/10/2014	2
I	Active	Training; Fielding	2/11/2014	2/11/2014	2
J	Active	Training; Fielding	2/11/2014	2/11/2014	1
K	Active	Training; Fielding	2/13/2014	2/13/2014	2
L	Guard	Training; Fielding	2/14/2014	2/13/2014	2
M	Guard	Training; Fielding	2/14/2014	2/12/2014	3
N	Guard	Training; Fielding	2/15/2014	Declined	2
O	Guard	Training; Fielding	2/18/2014	2/18/2014	1
P	Guard	Training; Fielding	2/18/2014	2/18/2014	2
Q	Reserve	Training; Fielding	2/19/2014		1
R	Guard	Training; Fielding	2/19/2014	2/18/2014	1
S	Guard	Training; Fielding	2/20/2014	2/20/2014	1
T	Guard	Training; Fielding	2/20/2014	No UIC	1
U	Guard	Training; Fielding	2/20/2014	2/20/2014	1
V	Guard	Training; Fielding	2/21/2014	2/21/2014	3
W	Active	Training; Fielding	2/21/2014		2
X	Active	Training; Fielding	2/21/2014		2
Y	Guard	Training; Fielding	2/21/2014	2/21/2014	2

Figure 7. Individual Army-Unit Fielding Status

c. Hardware-Procurement Delivery Report

The logistics hardware-procurement delivery schedule provides essential information for the program, including hardware procurements, shipments, and fielding information. Table 6 provides the metric data types collected, with details.

Table 6. Hardware Procurement Delivery Report

Metric	Details
Contract identification	Contract number
Hardware description	Specification
Dates and number delivered on a particular date	Dates and numbers
Actual deliveries roll up	Actual deliveries each month to date Cumulative deliveries to PM to date
Delivery quantities to units roll up	Required for fielding's each month for FY13 total Actual fielded each month Cumulative fielded to units Projected on-hand inventory Actual on-hand inventory

A representation of the report with fictional data is provided in Figure 8.

Product A Hardware Delivery Schedule

Planned Contractual Deliveries										
Contract	**Hardware Description**	**Sep-13**	**Oct-13**	**Nov-13**	**Dec-13**	**Jan-14**	**Feb-14**	**Mar-14**	**Apr-14**	**Total**
Contract A Sample	Standard CPU	0	0	0	0	0	0	0	0	**1180**
Contract B Sample	Standard CPU	0	0	0	0	0	0	0	0	**875**
Contract C Sample	Standard CPU	200	200	37	0	0	0	0	0	**437**
Total contracted deliveries		200	200	37	0	0	0	0	0	**2492**

Actual Deliveries	**Sep-13**	**Oct-13**	**Nov-13**	**Dec-13**	**Jan-14**	**Feb-14**	**Mar-14**	**Apr-14**	**Total**
Actual deliveries each month to date	82	0	0	0	0	0	0	0	**NA**
Cumulative Deliveries to PM to date	2492	2492	2492	2492	2492	2492	2492	2492	**2492**

Delivery Quantities to Units	**Sep-13**	**Oct-13**	**Nov-13**	**Dec-13**	**Jan-14**	**Feb-14**	**Mar-14**	**Apr-14**	**Total**
Required for fieldings each month for FY13 total	60	50	50	50	50	40	40	41	**2096**
Actual fielded each month	30	29	36	45	20	33	0	0	**NA**
Cumulative fielded to units	1820	1849	1885	1930	1950	1983	0	0	**1983**
Projected On-hand Inventory	322	472	459	409	359	319	279	238	**NA**
Actual On-Hand Inventory	672	643	607	562	542	509	0	0	**NA**

Green	Amber	Red	Complete	Date Entry
On/Ahead of Schedule	Behind Recoverable	> Not Recoverable	Action Completed	(Numerical) MMDD/YY

10

Figure 8. Hardware-Delivery Schedule Sample

d. Fielding Report Summary Report

The logistics fielding-report summary metrics chart provides, over time, the total number of authorizations, the required-for-fielding cumulative, the actual fielded cumulative, and the current hardware inventory. A representation with fictitious data is provided in Figure 9.

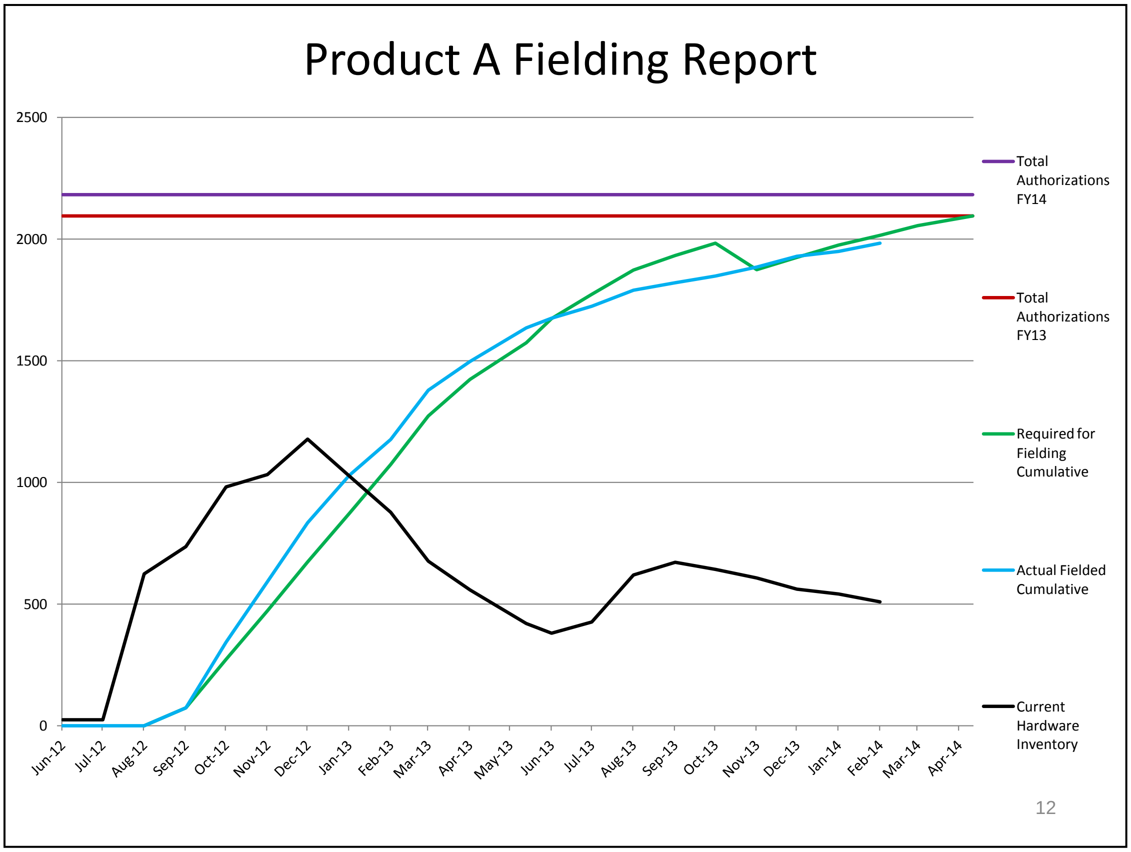


Figure 9. Fielding Report

6. Technical Metrics

The technical functional area is responsible for the technical development of a program. Within the organization, the technical metrics are software-development-schedule metrics used to ensure milestones are met. The list below identifies the metrics collected for the sample program. Note that the metrics defined will depend on the individual program.

- Software release version
- Software release to organization
- Testing
- Aviation Flight Test Directorate (AFTD) testing
- Certificate of Networthiness
- Safety confirmation
- Army Interoperability Certification (AIC)/G6 letter

- Software release
- Material release
- Availability for fielding

The software-development metrics define required need dates and then the actual date the event occurred, as shown with fictional data in Figure 10.[3]

SW Release Version	SED SW Release to Project		Testing			ATO		CON		Safety Confirmation		AIC / G6 Letter		Software Release (SR)		Available for Fielding	
	REQ	ACT	Type	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT
SAMPLE V1	3/7/14		Interop #1	1/7/2013	22/2/13	2/1/14		2/1/14		2/1/14		9/1/13	10/1/13	4/1/14		5/1/14	
			UTE #1	4/29/2013	5/2/13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			Interop #2	5/17/2013	5/17/13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			UTE #2	8/5/2013	8/8/13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			OT&E	9/16/2013	9/18/13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 10. Software-Development Metrics

7. Risk-Program Metrics

Per the ANMP risk SOP, each IPT is to meet on a regular basis to discuss risk and document concerns in the ANMP risk database. The risk metrics include program information pertaining to cost, schedule, performance, and programs. The information items reported are the following:

- Risk identification
- Mitigation
- Issues
- Top risks
- Risk matrix: probability and impact

Figure 11 depicts a fictitious risk report that can be automatically created through the organization’s risk database. This database is used for all IPTs within the organization.

[3] In Figure 10, ATO stands for “authority to operate,” CON stands for “certificate of networthiness,” and N/A stands for “not applicable.”

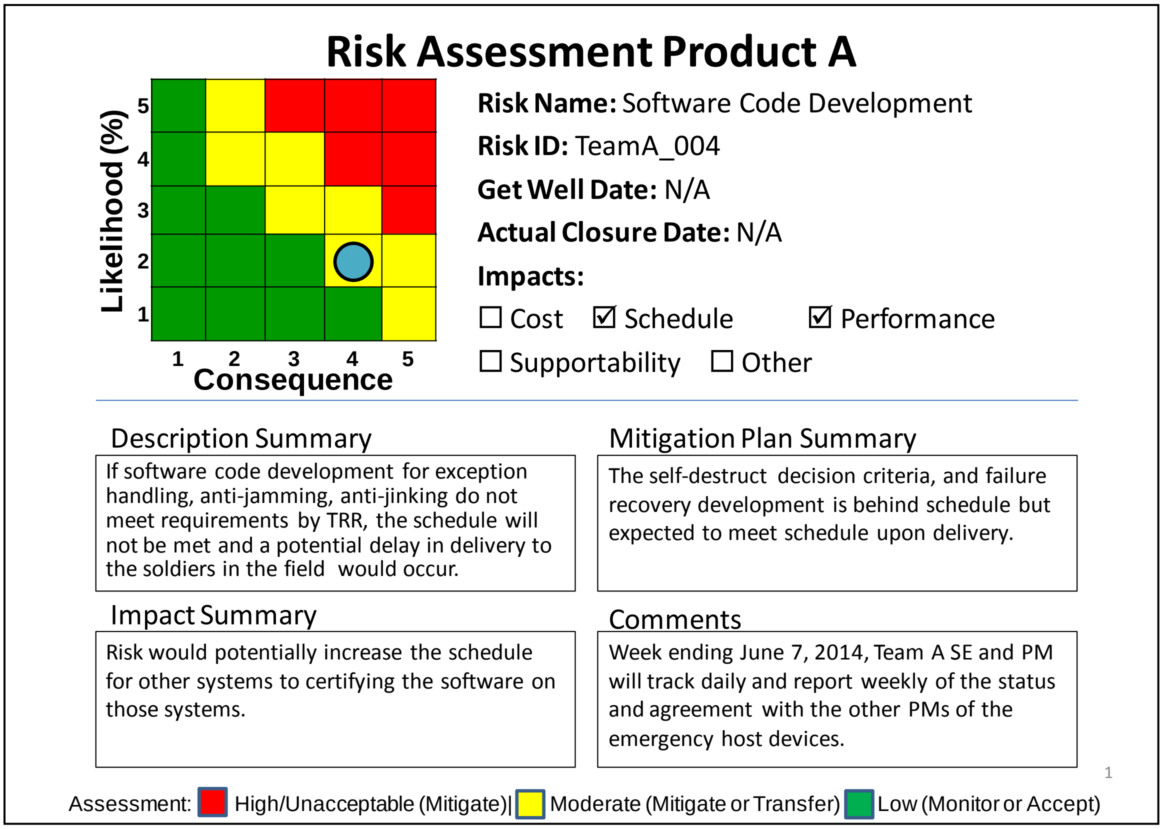


Figure 11. Risk-Assessment Sample Report

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III. DATA ANALYSIS

The collected metrics data is analyzed using the framework of the Baldrige criterion, measurement, analysis, and knowledge management along with LSS of a select data set. The LSS study includes overarching processes, baseline statistics, data stratification, and cause and effect analysis.

A. METHODOLOGY

The fourth Baldrige criterion, measurement, analysis, and knowledge management, asks two questions: “How do you measure, analyze, and then improve organizational performance?” and “How do you manage your organizational knowledge assets, information, and information technology?”

This section focuses on the first question. The second cannot be addressed here because there are no currently known metrics that track and manage an organization’s knowledge assets, information, skill sets, and information technology.

The analysis presented is twofold. In the first section, the metric in Table 7 is explored through the question, “How do you measure, analyze, and then improve organizational performance?” The second section uses LSS to analyze the data from a selected data set.

Table 7. Measurement, Analysis, and Knowledge Management

Baldridge Criteria	Program Level	Product Directorate Level	Metric/Description	Frequency	Collected by
4. Measurement, Analysis, and Knowledge Management	Program Management	Product Directorate Metric Standing Operating Procedure	Metric Standing Operating Procedure	As Required	Product Director
		Product Directorate Risk Management Standing Operating Procedure	Risk Management Standing Operating Procedure	As Required	Product Director/ Technical Chief
		Product Directorate Weekly Review Metrics	Product composite consisting of programmatic, business, logistics, and technical reports	Weekly	APM
		Product Level Management	Schedule	Weekly	APM
		Business	Contractor Cost Reports	Montly	PD Business Office
			Contract Development Actions	Daily/Weekly	PD Business Office
			Contractor Deliverables	Month	PD Business Office
		Logistics	Fielding Delivery Status Summary	Weekly	PD Logistics Specialist
			Individual Army Unit Fielding Status		
			Hardware Procurement Delivery Report		
		Technical	Software Development Schedule	Weekly	PD Technical
			Risks	Weekly	PD Technical

B. BALDRIGE CRITERION 4: MEASUREMENT, ANALYSIS, AND KNOWLEDGE MANAGEMENT

How to measure, analyze, and then improve organizational performance is the question. The SOPs identify the means to measure and analyze, but do not specify how an organization can improve through the use of metrics. The SOPs assert that negative trends must be reported, but do not identify how to improve processes and procedures so negative trends do not occur. There appears to be no defined method for process improvement. An organization may be extremely efficient, perform a great deal of work, and do a great job at reporting metrics. However, its potential will never be reached if there are no "process-improvement processes" in place to optimize the system and boost quality to new levels. Organizations that have attained performance excellence are always seeking ways to improve and have measures and guidelines in place to achieve this goal. This is the essence of total-quality management.

The data collected since the inception of the SOP has never been fully analyzed. This study delves into one aspect of the metrics using the Contract-Requirements Package Development metrics. The contract-requirements package development metrics are the focus and topic of the LSS Study provided herein. Note that it is not essential to conduct LSS on every aspect of a program. Generally, simple analysis methods can be implemented that will provide a means to improve the organization as a whole.

C. CONTRACT-REQUIREMENTS PACKAGE DEVELOPMENT, LSS STUDY

The data analysis in this study includes the LSS "measure and analyze" phase from the author's Contract-Requirements Package Development metrics LSS project. The data analyzed is from the metrics collected for the contract-requirements package. The LSS project includes an intense statistical analysis of the data. The author of this research does not claim profound statistical knowledge and provides analytical outcomes in layman's terms. For clarity, a high-level set of LSS terminology is provided in Table 8.

Table 8. LSS Project Definitions

LSS Term	Definition
Cycle time	Actual start—actual end
Defect time	Time required to resolve an error or rework
Takt time	Rate or duration required for each milestone to achieve on-time contract award
Defect	Project milestones that are identified as late and/or re-baselined.
Opportunities	Calculated as the number of total milestones.
Weekly metric reviews	The weekly product organization review where milestone efforts are reviewed.
Re-baseline (RB)	A new date defined when the original required date cannot be met
Sigma quality level	Calculation derived from the number of program issues (defects) per million opportunities.
Variation (variance)	The difference between planned milestone (time and cost) versus actual.

Contract-requirements-package metrics were selected for the LSS project to evaluate the practical utilization of metrics used within the ANMP organization, as several data points are available and the team is professional in collecting and tracking the information. The development metrics for contract-requirement packages track the progress and milestone events for each contract action. Table 9 shows the metrical items reported, with fictitious forecasted dates (required dates) defined by the organization and fictitious actual dates achieved.

Table 9. Contract Requirements Package Milestones with Fictitious Dates

Contract Development Package Milestones	Forecasted Date	Actual Date
Statement of Work, CDRL/Specifications	11/27/2013	11/27/2013
Technical Estimate/Independent Government Estimate	12/11/2013	01/31/2014
Functional Staffing	12/18/2013	2/6/2014
Solicitation Issued	12/19/2013	2/07/2014
Proposal Received	1/9/2014	2/18/2014
Technical Evaluation Completed	1/16/2014	3/17/2014
Contract Award	2/27/2014	5/27/2014

Figure 12 provides a graphical representation of the weekly cost report with fictional data. The LSS project is an intense study of these metrics.

Item #	Contract/Effort	SOW/CDRL/Spec Complete		Tech Est/ IGE complete		Functional staffing complete		FMR Approved		CRP to AC (or OGA)		Solictitation Issued		Proposal Received		Tech Eval Complete		Contract Award	
		REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT	REQ	ACT
	FY 14 Actions (AMPS)																		
1	Program A IA Effort	9/26/13	9/26/13	11/5/13	11/5/13	11/17/13	11/18/13	N/A				11/18/13	11/18/13	12/2/13	12/3/13	12/9/13	12/13/13	1/9/14	
		$360,000					15 April 2014 - 14 April 2015											4/1/14	
2	Program A PSF Effort	9/26/13	9/26/13	11/6/13	11/18/13	11/13/13	11/26/13	N/A				11/14/13	11/26/13	11/28/13	12/20/13	12/6/13	1/9/13	1/7/14	
		$419,000					15 April 2014 - 14 April 2015											4/1/14	
3	Program A SSR	10/23/13	11/15/13	11/6/13	12/9/13	11/13/13	12/9/13	N/A				11/14/13	12/13/13	11/28/13	1/9/14	12/5/13	1/24/14	1/5/14	
														1/10/13		1/17/13		4/1/14	
		$3,346,457					15 April 2014 - 14 April 2015												
4	Program A SW Mod (FY14)	12/25/13	12/3/13	1/15/14		1/22/14		N/A				1/23/14		2/6/14		2/13/14		3/15/14	
				2/18/14		2/25/14						2/25/14		3/27/14		4/17/14		6/3/14	
		$15,602,000					15 April 2014 - 14 April 2015												
5	Program A AFTD Support	4/9/14		4/30/14		5/7/14		N/A				5/8/14		5/22/14		5/29/14		7/1/14	
		$368,000					15 July 2014 - 14 July 2015												
6	Program A ATEC Support	5/7/14		5/21/14		5/28/14		N/A				5/29/14		6/12/14		6/19/14		7/1/14	
		$22,405					1 Jul 14 - 31 Jun 2015												
7	Program A AED Support	1/9/14		1/30/14		2/6/14		N/A				2/7/14		2/21/14		2/28/14		3/30/14	
		2/18/15		2/25/15		3/4/15						3/4/15		3/25/15		4/1/15		4/30/15	
		$116,000					15 Apr 14 - 14 Apr 15.												
8	Program A SED Safety Support	4/7/14		4/28/14		5/5/14		N/A				5/5/14		5/26/14		6/2/14		7/1/14	
		$260,000					5 May 14 - 4 May 15												
9	Program A Technical TDP Review	4/9/14		4/30/14		5/7/14		N/A				5/8/14		5/22/14		5/29/14		7/1/14	
		$112,000					1 Jul 14 - 31 Jun 2015												
10	Program A DIACAP Support	1/9/14		1/30/14		2/6/14		N/A				2/7/14		2/21/14		2/28/14		3/30/14	
		2/18/15		2/25/15		3/4/15						3/4/15		3/25/15		4/1/15		4/30/15	
		$63,000					30 March 2014- 29 March 2015												
11	Program AMCOM Material Release	5/7/14		5/21/14		5/28/14		N/A				5/29/14		6/12/14		6/19/14		7/1/14	
		$16,000					1 Jul 14 - 31 Jun 2015												
12	CTSF							N/A				7/2/14		7/16/14		7/23/14		8/22/14	
		$159,000					22 Aug 2014 - 21 Aug 2015												
13	VM Solution	1/1/14	1/10/14	1/16/14	1/16/14	1/22/14	1/22/14	N/A				1/22/14		2/27/14		3/13/14		8/14/14	
		$14,000																	

Figure 12. Business Contract Requirements Package Development

This particular program has been reporting and tracking the contract-requirements-package project's milestone metrics since September 1, 2012. Initial data analysis revealed that U.S. contract milestones were missed 57 percent of the time, with a sigma-quality level (SQL) of 1.33, and FMS contract milestones were missed 71 percent of the time (SQL = 0.95). An update to the data in August 2014 identified U.S. contract milestones were missed 63 percent of the time (SQL = 1.14) and FMS contract milestones were missed 79 percent of the time (SQL = 0.67).

The primary goal of the LSS project was to ensure that organizational project metrics are aligned with total-quality principles and industry best practices. Missed milestones force project schedules to move to the right, while potentially increasing operational costs and lowering customer satisfaction. Besides seeking to ensure alignments, the other goals of this project are to improve project-schedule performance, as outlined previously, improve project-schedule forecasting accuracy, and improve the SQL for U.S.- and FMS-contract milestones to 2.28 and 1.34, respectfully—a 50 percent improvement over the August 2014 update.

1. The Data Collection Plan

The data-collection plan is a LSS/TQM tool used at the onset of LSS projects to identify and define the plan for collecting and analyzing the data. This particular project identifies the following performance measures, with details provided in Figure 13:

- **Defects** Project milestones that are identified as late
- **Process variability** The difference between the current measurement system process, total-quality principles, and industry best practices
- **Sigma level** A calculation derived from the number of late start times (defects) per million opportunities
- **Cost** Actual funding sent to contractor, versus actual spent by contractor Note that cost is not addressed in this report.

Performance Measure	Operational Definition	Data Source and Location	How Will Data Be Collected	Who Will Collect Data	When Will Data Be Collected	Sample Size	Stratification Factors	How will data be used?
Defects	Project milestones that are identified as late.	Product Office	Pulled from weekly metrics	Analyst	Sept. 2012 – March 2014	134 efforts/~954 individual actions	Individual Efforts	To measure Sigma level; to determine improvement targets
Process Variability	The difference between the current measurement system process and Total Quality principles and industry best practices.	Product Office	Pulled from weekly metrics	Analyst	Sept. 2012 – March 2014	134 efforts/~954 individual actions	Individual Efforts	To check for differences in Product Offices process
Sigma Level	Calculation derived from the number of late start times (defects) per million opportunities	Product Office	Calculated from data analysis.	Analyst	Sept. 2012 – March 2014	134 efforts/~954 individual actions	Individual Efforts	To assess process quality and capability
Cost	Actual funding sent to contractor versus actual spent by contractor	Product Office	Pulled from monthly cost metrics	Analyst	Sept. 2012 – March 2014	134 individual efforts	Individual Efforts	To assess financial performance

Figure 13. Data Collection Plan

2. Current-State Process Map

The LSS/TQM tool for current-state process mapping serves to identify each process step associated with completion of a contract action. Observe that the map ties to the metrics collected for the contract-requirements package development flow.

The current-state process map for this project provides a flow from inception to completion (see Figure 14). The map identifies customer-value added in green, non-value added–required) in amber, and non-value added in red.

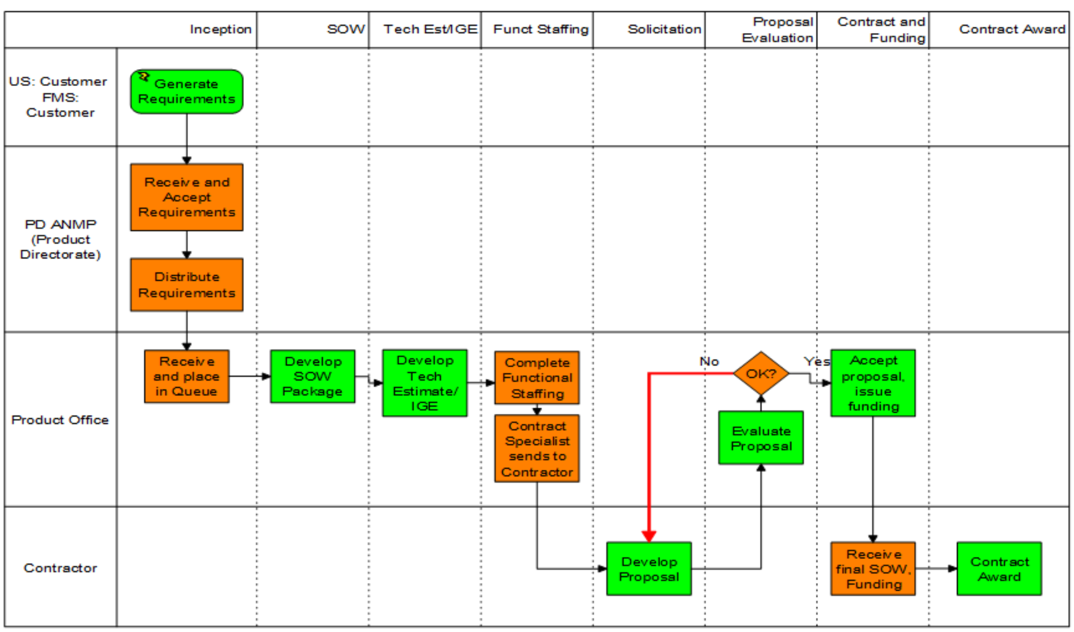


Figure 14. Current-State Process Map

3. Value Stream Map

The value-stream map (VSM) is a common TQM technique used in LSS projects to provide a better understanding of process and problems and show where in the process the root causes might reside. Initially the project included two VSMs: one for the U.S. and the other for FMSs. Note that their processes are similar; the main difference is the source of the initial requirement. The VSM's define the steps required and timeframe for each action. VSM terminology is defined in Table 10.

Table 10. Value-Stream Map Definitions

VSM Definition	Description
Total C/T: total cycle time	Based on our data, the average time that it took to complete the task. This is based on the actual time minus the actual time of the previous milestone.
NVA: non-value-added time	Any work an organization performs that adds no value to itself or the customer (waiting time). For example, for functional staffing, the unit may have five working days planned, when in actuality, it may take only one day for the functional staff to review. The non-value-added time in this example is four days.
Defect	A percentage of the number of late items, based on the total for that milestone.
Planned	Based on planned (required) dates data, the average time planned to complete a task. This is based on the required date minus the required date of the previous milestone.
Lead Time	The sum of all the cycle and wait times for a particular process, or the length of time it takes for the entire process. In the information displayed, this is the total cycle time for all milestones.
VA/T Value Added Time	Cycle time (C/T) less non-value-added (NVA) time

a. Current State Value Stream Map (U.S.)

The U.S. VSM (see Figure 15) identifies each step within the process and average cycle times based on the actual data and defects (the percentage of late items). U.S. efforts have covered various effort types from simple to complex. The overall cycle time is 133 days and the planned time is 106 days.

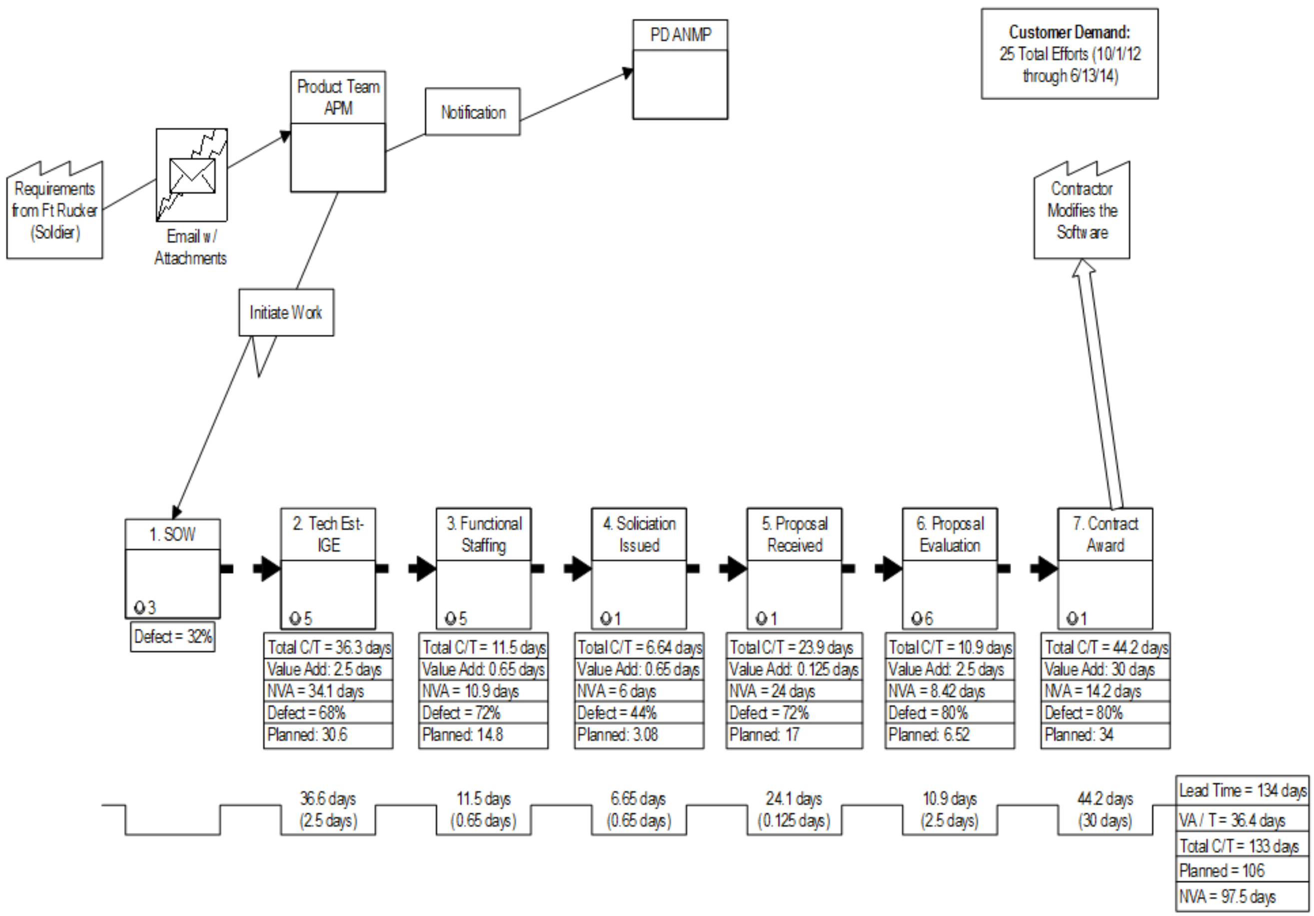


Figure 15. Current Value Stream Map (U.S.)

b. Current-State Value Stream Map (FMS)

The FMS VSM (see Figure 16), like the U.S. VSM, identifies each step within the process and average cycle times based on actual data and defects (percentage of late items). The FMS process is more consistent, meaning that the efforts are more similar to one another than the U.S. efforts. The overall cycle time is 157 days and the planned time is 98 days.

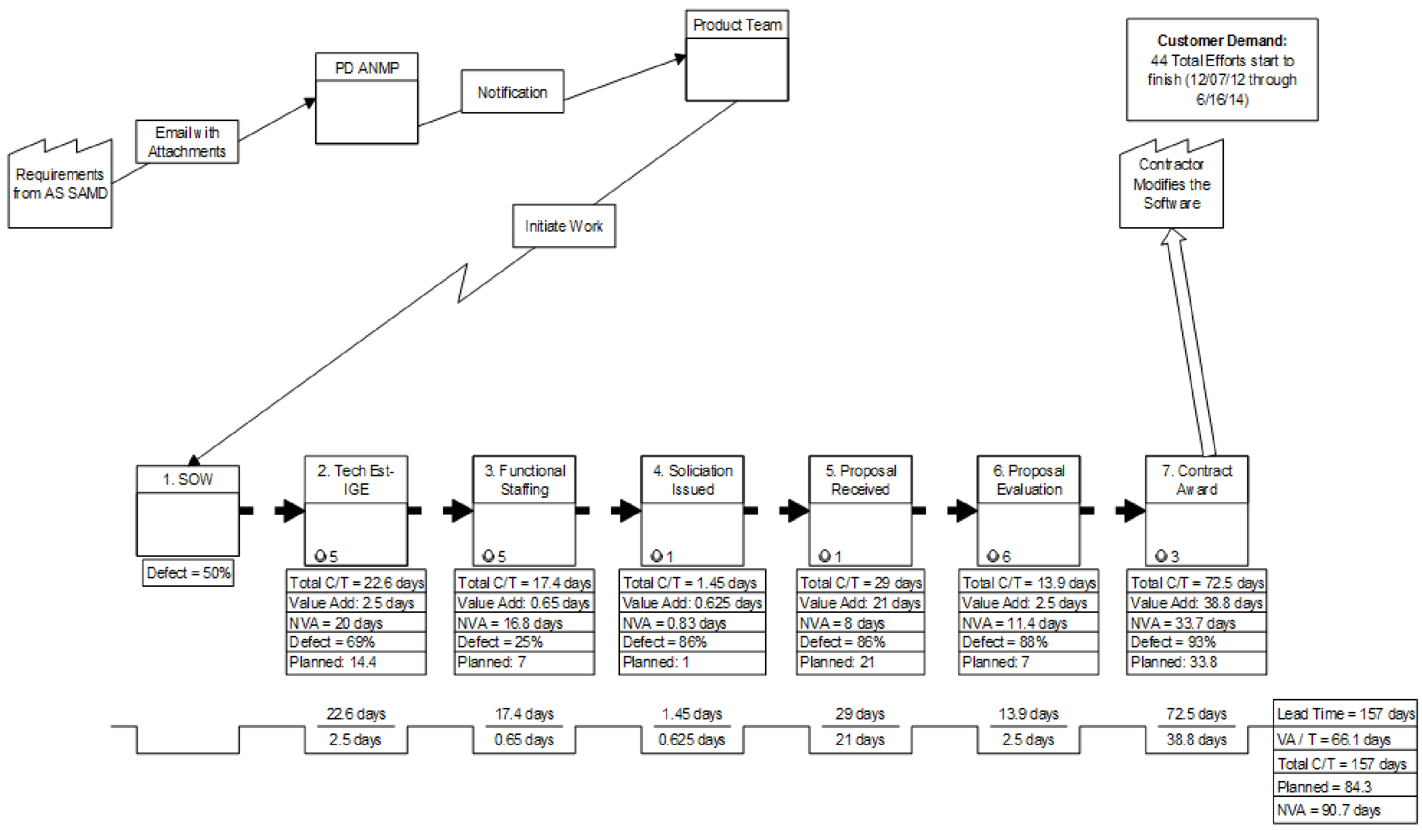
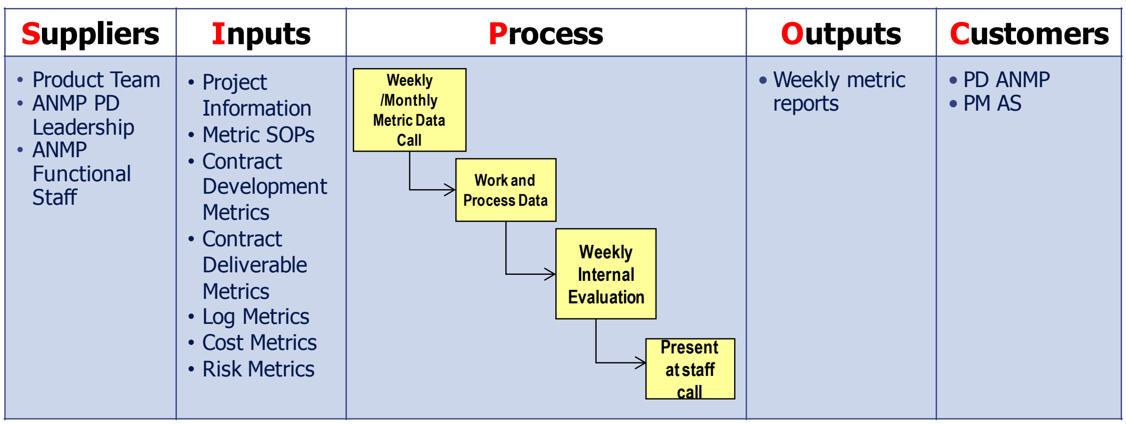


Figure 16. Current Value Stream Map (FMS)

4. Suppliers, Inputs, Process, Outputs, and Customers

The LSS/TQM tool for suppliers, inputs, processes, outputs, and customers (SIPOC) is used in the project to identify the boundaries of the process and help ensure that all required inputs (resources needed) and their sources are identified. Figure 16 identifies the outlay of the project to include the voices of the customer and the business. The metrics identify the inputs, processes, and output details.

The SIPOC map also confirms that the right process metrics have been chosen and logical trade-offs have been made in determining what to measure. The SIPOC was defined early in the process to provide an overall map with which to scope the project and identify major players.



VOC/VOB	Input Metrics	Process Metrics	Output Metrics	
Ensure process on track	Requirements	Weekly Review	Proposal Evaluation	**Quality**
Ensure financials are within budget	Budget and Tech Est	Independent Government Estimate	Proposal Evaluation	**Cost**
Ensure schedule is met	Required Date	Actual Date	Actual	**Time**

Figure 17. SIPOC

5. Measurement System Analysis

The measurement system of this project was analyzed to ensure the methods of recording and calculating task durations do not contribute additional error in reported performance results. Although the personnel who collect and track the data are customarily efficient and careful, analysis identified potential bias in the measurement system.

In the current measurement system, task durations could be either under-estimated or over-estimated, on a consistent basis. Review of historical performance also revealed that task completion dates were consistently "re-baselined" to a future date. There also is a possible lag-time reaction in bias, and an initial late submission creates a downstream chain reaction. This is because tasks are completed in a sequential manner. One task does not begin until its predecessor is complete. The system identifies possible variability in required (planned) versus actual dates. The LSS project defines and reports the tenets for the measurement system, as identified in Figure 18.

Type of Measurement Error	Description	Considerations to this Project
Discrimination (resolution)	The ability of the measurement system to divide measurements into "data categories"	Time can be measured to hours. Cost can be measured to single dollars. Quality can be measured to specific component errors.
Bias	The difference between an observed average measurement result and a reference value	Possible bias, adjustments or corrections are always moved toward the future. Items are re-baselined to a future date.
Stability	The change in bias over time	There is a possible lag time reaction in bias. At initial late submission creates a downstream chain reaction.
Repeatability	The extent variability is consistent	There is possible variability in required (planned) versus actual dates.
Reproducibility	Different appraisers produce consistent results	Technical Team, Cost Analysts, Contract Specialists, Functional Staff produce consistent results.
Variation (Variance)	The difference between planned versus actual.	High degree of variance between milestone planned versus actual (Time and Cost)

Figure 18. Measurement System

The *Minitab 16 Software Glossary* help article defines accuracy and precision as follows and is illustrated in Figure 19. Measurement system (task duration estimating) errors can be classified into two categories: accuracy and precision. Accuracy describes the difference between the measurement (planned duration) and the part's actual value (actual duration). Precision describes the variation (variance) you see when you measure (record actual data) the same part repeatedly with the same device (same person performing the documentation). Per *Minitab 16 Software Glossary* help article:

> Within any measurement system, you can have one or both of these problems. For example, you can have a device (estimating process) that measures parts precisely but not accurately (smaller actual date variances but not to plan). You can also have a device that is accurate (the average or median of the measurements (actual dates) is very close to the accurate value), but not precise, that is, the measurements have large variance. You can also have a device that is neither accurate nor precise.

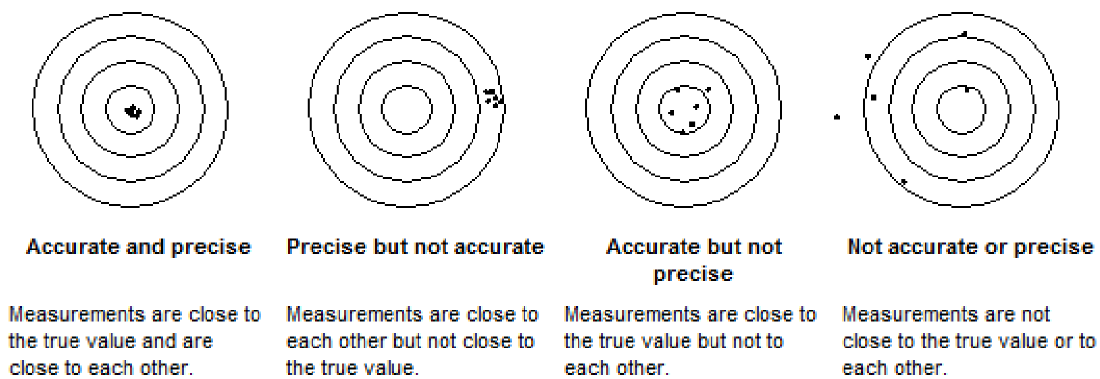


Figure 19. Precision and Accuracy

D. DATA STRATIFICATION—BASELINE STATISTICS

Figure 20 presents data collected from October 1, 2012, to March 2014. Overall, a significant number of project milestones were reported as late. The data collected provides a required date, actual date, and re-baseline date. The re-baseline date is a shift in the original required date.

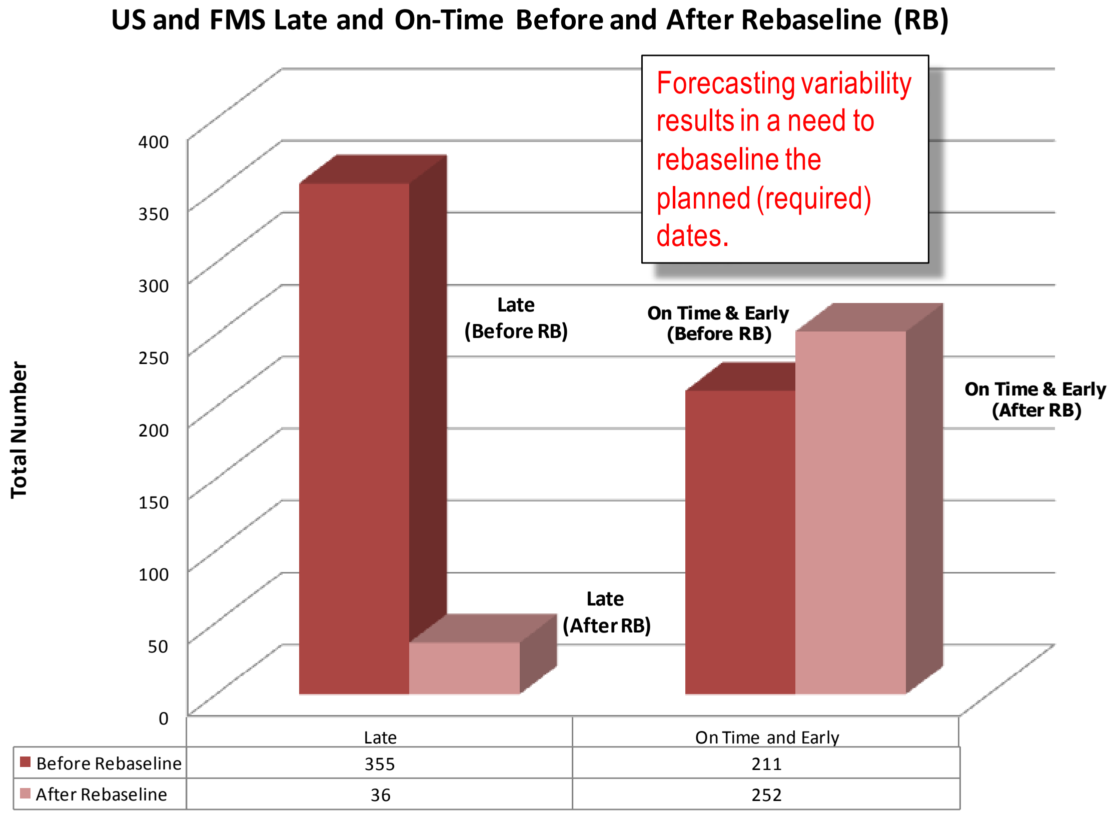


Figure 20. Milestone Re-baseline Statistics

1. Process Capability for Milestones: the U.S. and FMS

Figure 21, showing data through March 2014, is a statistical analysis of the overall process capability for the on-time achievement of CRP milestones. The capability tool assesses whether a process is capable of consistently meeting its target (or staying within its specification limits). The chart shows an upper specification limit—the maximum desired time past the planned due date—of zero days. Anything above zero is a nonconformance. The chart reveals an expected PPM (parts per million) of 773,733.27 (out of a million opportunities), meaning that performance will result in a nonconformance 77.37 percent of the time, based on past performance. From a capability standpoint, the chart shows that the current process is incapable of meeting the target (or staying under the upper spec limit (USL)) consistently.

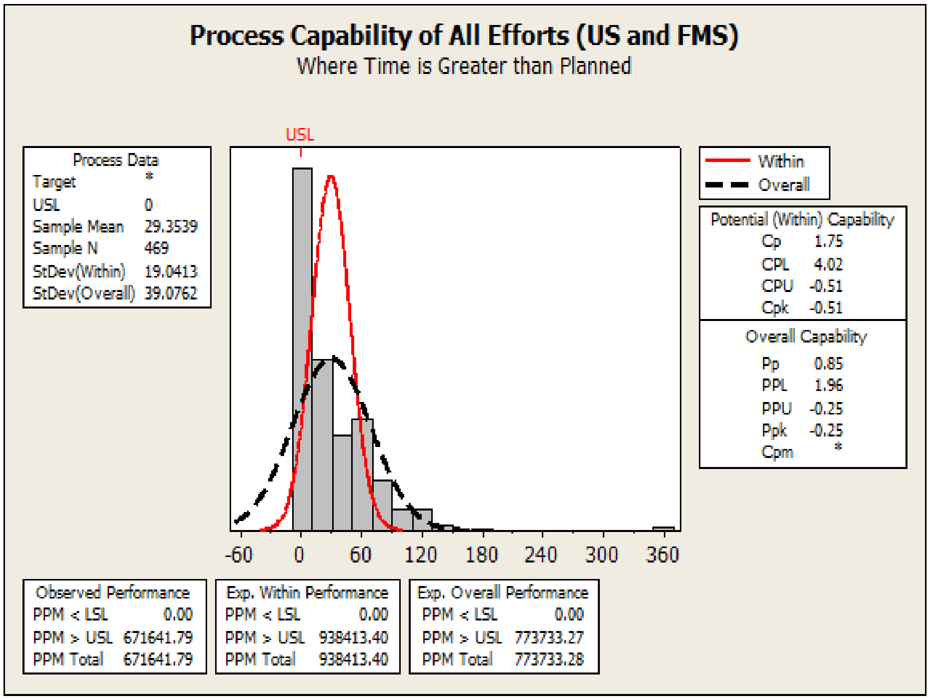


Figure 21. All-Efforts Process Capability

2. Process Capability of U.S. Actions

Data elements were stratified into two groups of similar task complexity. The groups were U.S. actions and FMS actions. The statistical analysis in Figure 22 (data through March 2014) centers only on U.S. action statistics. The expected overall performance for PPM above USL is 688185.98, meaning U.S. actions result in a nonconformance 68.82 percent of the time.

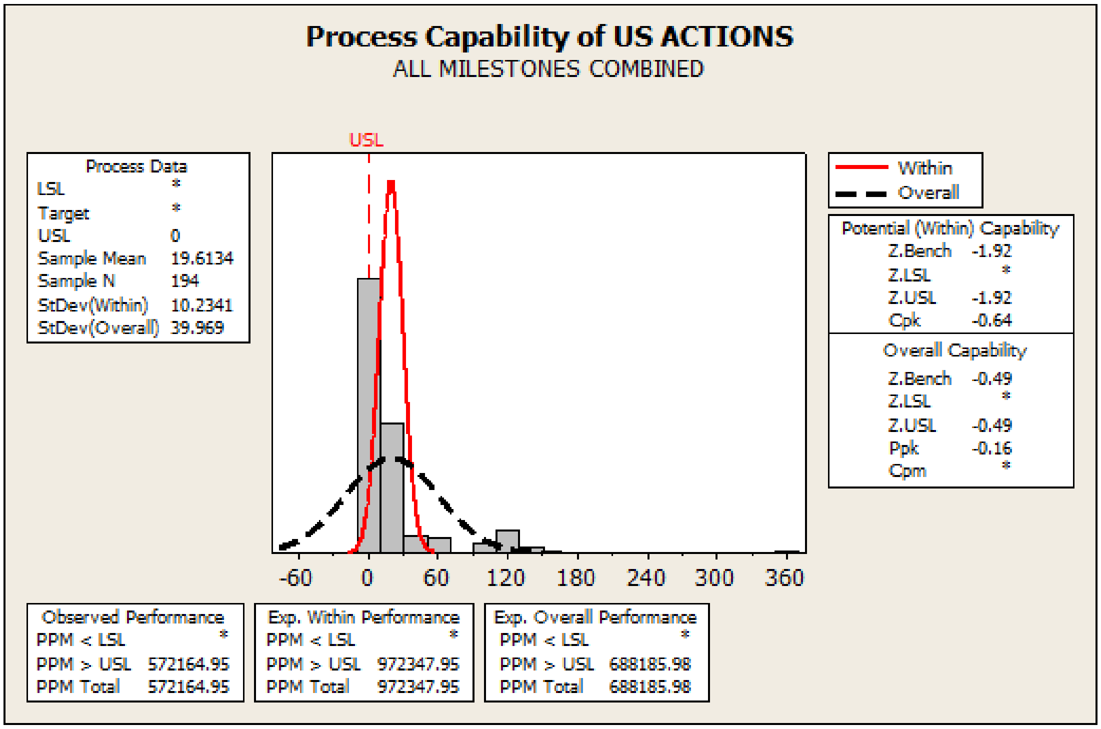


Figure 22. Process Capability of U.S. Actions

3. Capability Analysis of U.S. Actions

Figure 23 (data through March 2014) shows a stratification breakdown of the U.S. data by contract effort. The chart identifies Item 3 (functional reviews, represented as a green curve) as a problematic area with regard to result variability. This is revealed by the distribution spread's being broader than the other curves, which are more consistent. Higher variability reveals instability issues within the process, which triggers concerns from a consistency and process-control standpoint. However, all curves show high standard deviations (indicators of variability) and averages well beyond the desired planned completion target of zero days, so all areas should be investigated further. Curves should optimally shift to the left after process improvement has been implemented and controlled.

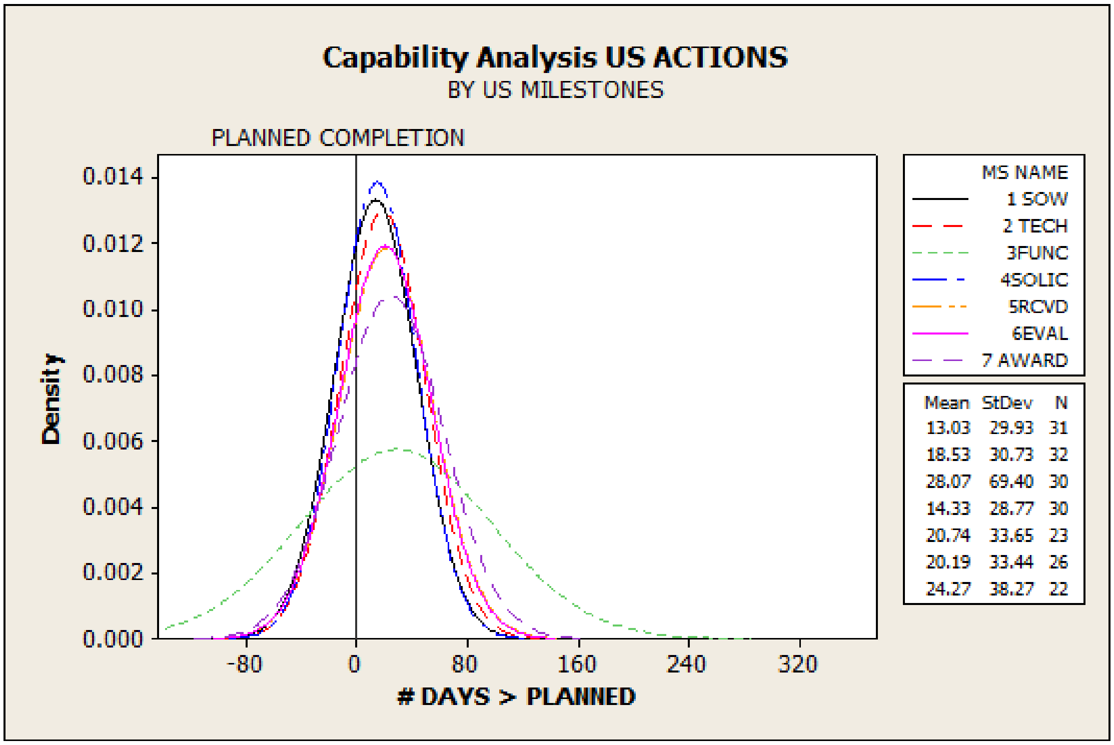


Figure 23. Capability Analysis of U.S. Actions by Milestone

4. Capability Analysis of FMS Actions

The statistical analysis in Figure 24 (data through March 2014) identifies FMS-action statistics with all milestones combined. Once again, the expected PPM is high, resulting in a nonconformance 79.33 percent of the time.

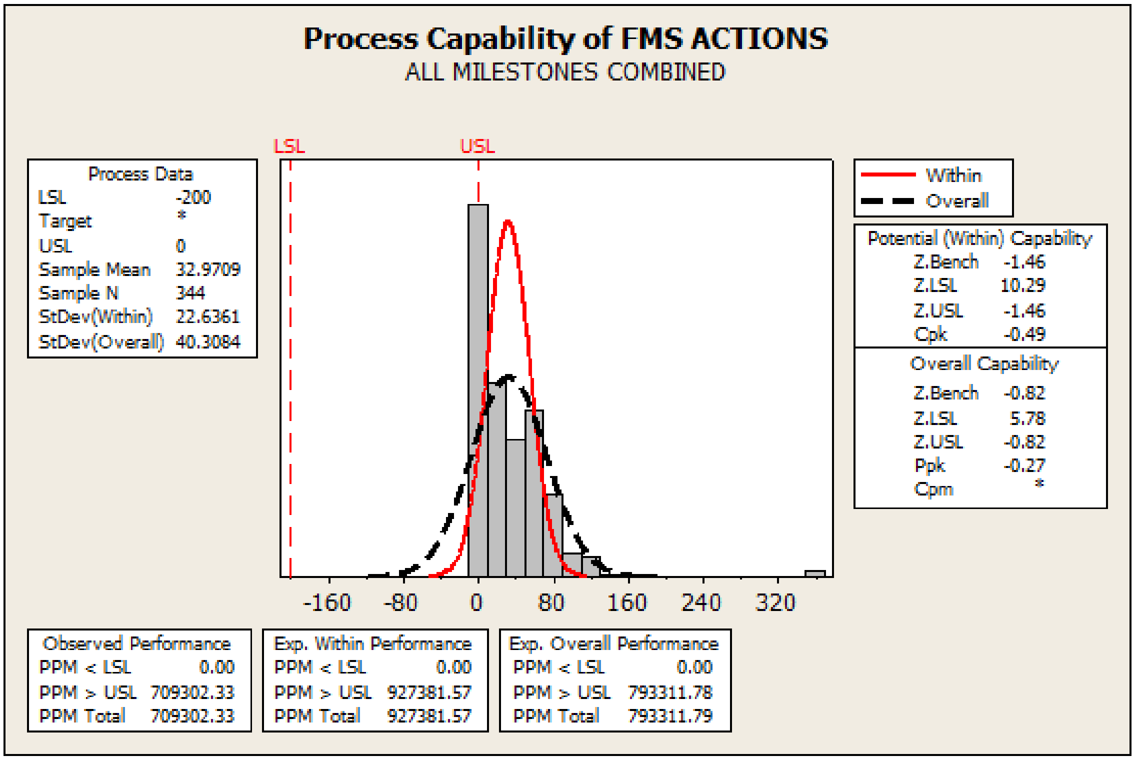


Figure 24. Process Capability of FMS Actions

5. Histogram of FMS Actions

The statistical analysis in Figure 25 (data through March 2014) identifies functional reviews, solicitation, and award as having high variability with broader distribution curves than the other four action categories. However, all seven areas reveal high standard deviations, indicating high variability across all categories. In addition, all averages are significantly above the planned completion target of zero days, indicating the need to further investigate performance in all areas.

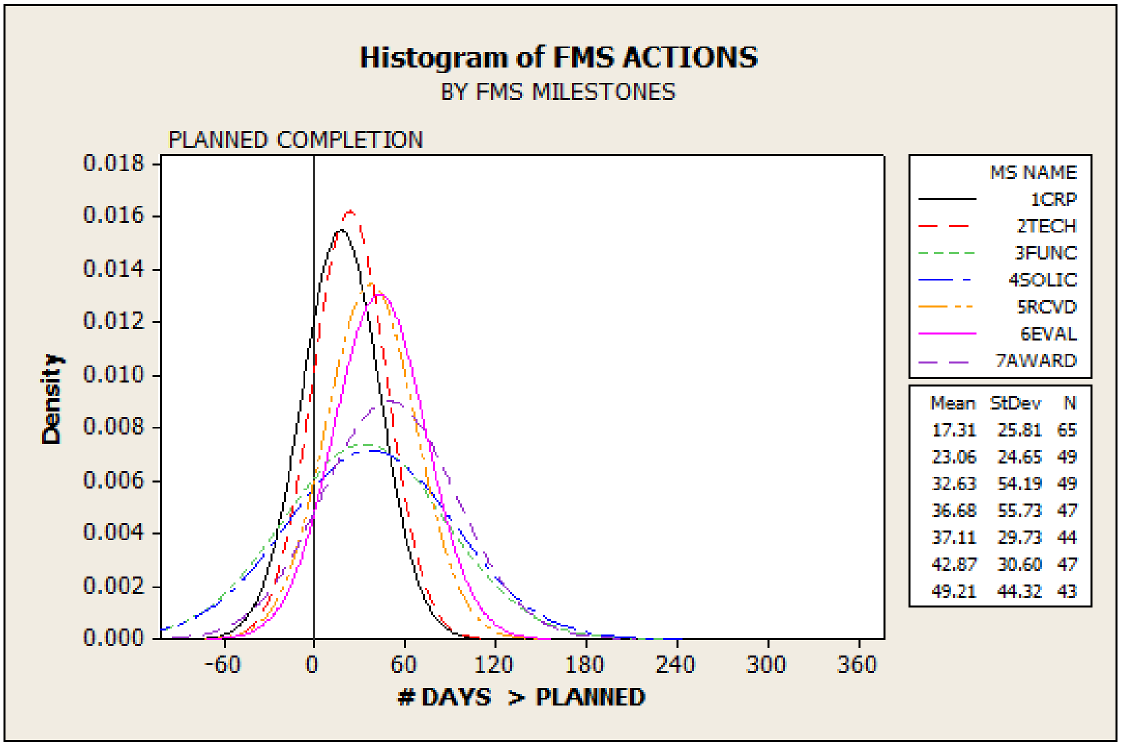


Figure 25. Histogram of FMS Actions by Milestone

E. DATA STRATIFICATION–DATA OBSERVATIONS BY TIME

Figures 26 and 27 identify results following a deeper analysis in August 2014 of data through July 2014. The new data identified that U.S. milestones are late 63 percent of the time and FMS milestones are late 79 percent of the time, as seen figures 25 and 26.

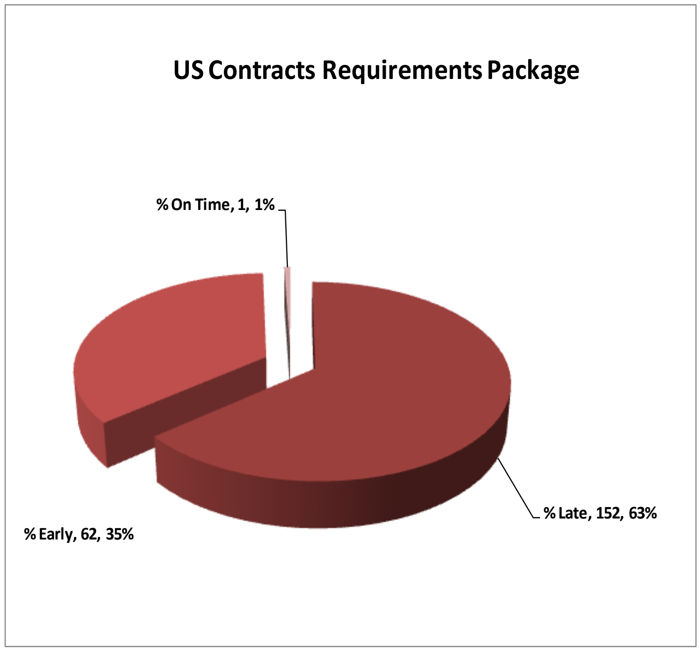


Figure 26. U.S. Contract-Requirement Packages Late/Early Chart, Updated

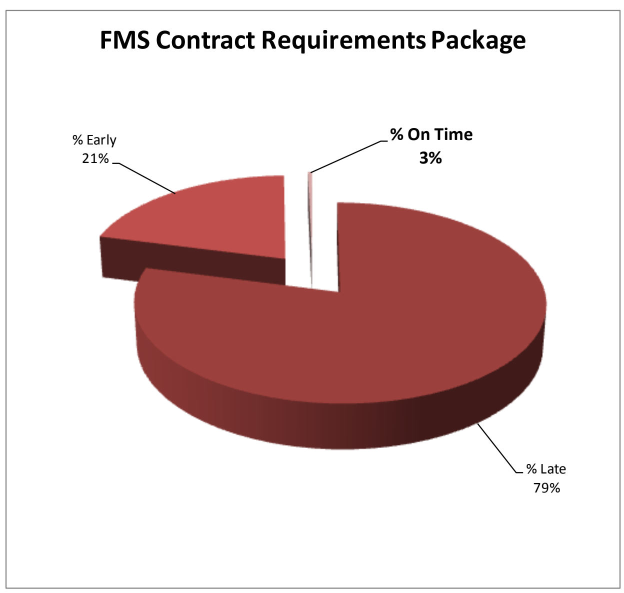


Figure 27. FMS Contract-Requirement Packages Late/Early Chart, Updated

1. Task Dependencies

Evaluation of the data reveals the relationships between various tasks. Because contract milestones are performed in sequence, there is a strong relationship between two linked tasks; they are linked by a dependency between their finish and start dates. This means that for the process studied, there is a finish-to-start (FS) relationship. Figure 28 demonstrates that dependent task (B) cannot begin until the task it depends on, (A), is complete. This is the current state of the process (Orfano, 2011).

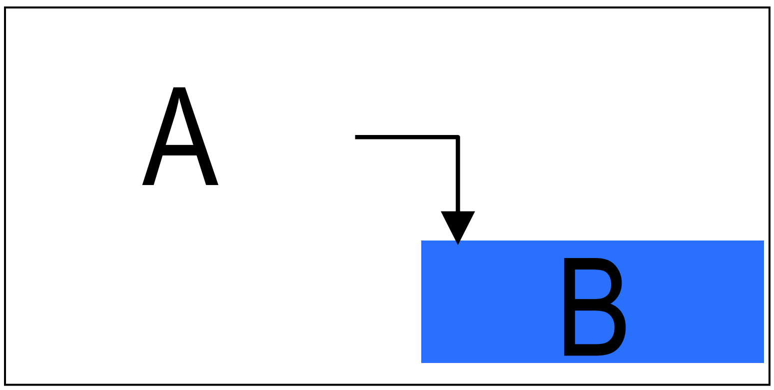


Figure 28. Finish to Start Relationship

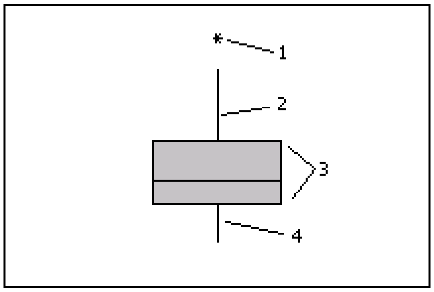
2. Box Plot Definitions

Another TQM tool, box plots (also called box-and-whisker plots) are used to analyze and compare sample distributions. Figure 29 illustrates and defines the meaning of the box plots for the novice statistical interpreter.

Boxplot

A graphical summary of the distribution of a sample that shows its shape, central tendency, and variability.

The default boxplot display consists of the following:



1 **Outlier (*)** – Observation that is beyond the upper or lower whisker

2 **Upper whisker** – Extends to the maximum data point within 1.5 box heights from the top of the box

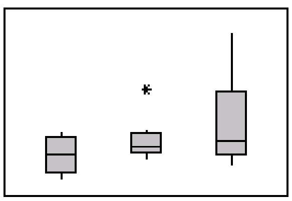
3 **Interquartile range box** – Middle 50% of the data

- Top line – Q3 (third quartile). 75% of the data are less than or equal to this value.
- Middle line – Q2 (median). 50% of the data are less than or equal to this value.
- Bottom line – Q1 (first quartile). 25% of the data are less than or equal to this value.

4 **Lower whisker** – Extends to the minimum data point within 1.5 box heights from the bottom of the box

Boxplots can help you understand your distribution. For example, the boxplot above represents hold times for customer support calls. The outlier at the upper end and longer upper whisker and upper part of the box indicate positive skewness, which makes sense because at the lower end of the distribution, no hold times can be less than zero.

Boxplots are also useful for comparing several distributions. For example, a quality engineer compares the diameter of plastic pipes produced weekly over three weeks. The boxplot below represents the results.



The medians for the three weeks are similar. However, the boxplots show a tendency for some higher pipe diameters over time.

Figure 29. Boxplot (Box and Whisker Plot) Definition (from *Minitab 16 Statistical Glossary*, 2010)

Figure 30 provides a box plot of U.S. contract actions. An observation suggests that the current measurement system exhibits symptoms of bias that might be attributed to underestimating the planned dates for the milestones. This is suggested by significantly different box plots for planned versus actual statistics, which is termed "bias."

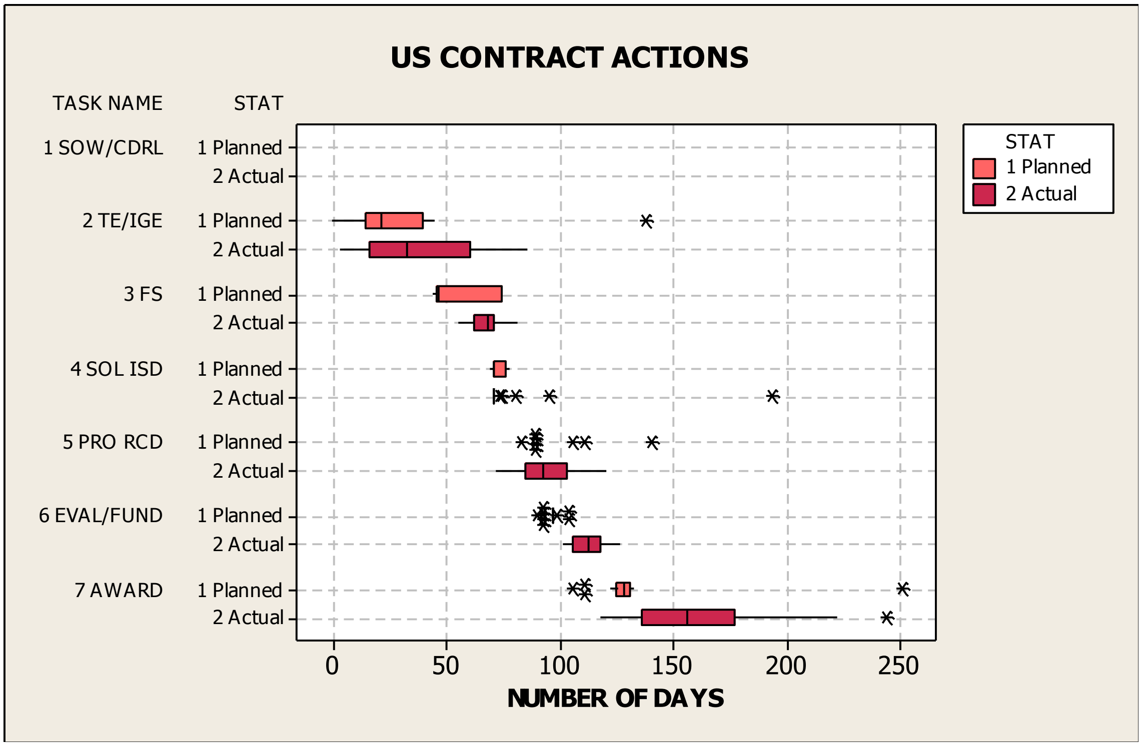


Figure 30. U.S. Contract Actions Box Plot

Like U.S. contract actions, the box plot of FMS contract actions in Figure 31 indicates that the current measurement system exhibits symptoms of bias that could be attributed to underestimating the planned dates for milestones. This is suggested by significantly different box plots for planned versus actual statistics.

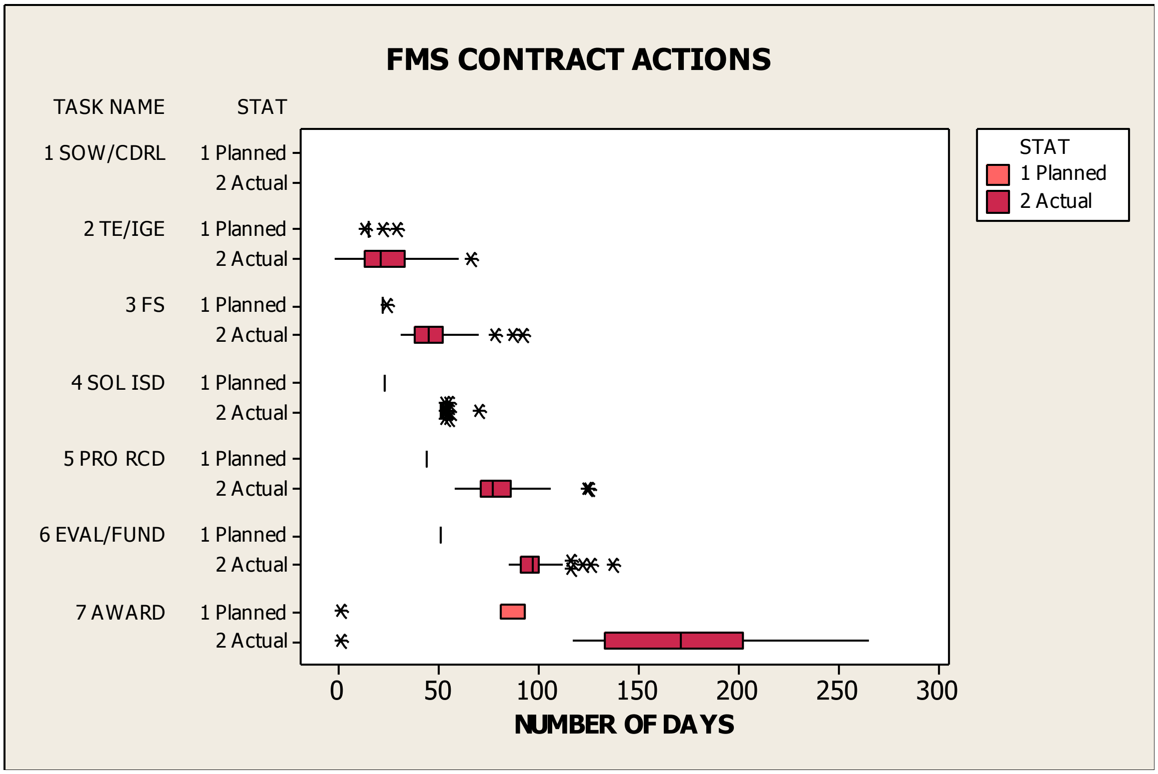


Figure 31. FMS Contract Actions Box Plot

Figure 32 contains a statistical median analysis of the data. In layman's terms, the median is the midpoint of the sample data set, that is, the middlemost value of a data set after the numbers have been arranged in ascending order. The statistical median analysis identifies variance between planned- and actual-day values for each milestone.

US ACTIONS

Results for TASK NAME = 1 SOW/CDRL

```
Variable  STAT       Median
DAYS      1 Planned       *
          2 Actual        *
```

Results for TASK NAME = 2 Tech Est

```
Variable  STAT       Median
DAYS      1 Planned   21.00
          2 Actual    32.00
```

Results for TASK NAME = 3 CRP Acc

```
Variable  STAT       Median
DAYS      1 Planned   46.00
          2 Actual    68.00
```

Results for TASK NAME = 4 RFP Acc

```
Variable  STAT       Median
DAYS      1 Planned  70.000
          2 Actual    70.00
```

Results for TASK NAME = 5 Pro Rcv'd

```
Variable  STAT       Median
DAYS      1 Planned   90.00
          2 Actual    92.00
```

Results for TASK NAME = 6 Pro Eval

```
Variable  STAT       Median
DAYS      1 Planned  97.000
          2 Actual   112.00
```

Results for TASK NAME = 7 Award

```
Variable  STAT       Median
DAYS      1 Planned  128.00
          2 Actual   156.00
```

FMS ACTIONS

Results for TASK NAME = 1 SOW/CDRL

```
Variable  STAT       Median
DAYS      1 Planned       *
          2 Actual        *
```

Results for TASK NAME = 2 Tech Est

```
Variable  STAT       Median
DAYS      1 Planned  14.000
          2 Actual    20.00
```

Results for TASK NAME = 3 Func Staff

```
Variable  STAT       Median
DAYS      1 Planned  21.000
          2 Actual    43.75
```

Results for TASK NAME = 4 CRP 2 AC/SED

```
Variable  STAT       Median
DAYS      1 Planned  22.000
          2 Actual   49.750
```

Results for TASK NAME = 5 Pro Rcv'd

```
Variable  STAT       Median
DAYS      1 Planned  43.000
          2 Actual    76.25
```

Results for TASK NAME = 6 Pro Eval

```
Variable  STAT       Median
DAYS      1 Planned  50.000
          2 Actual    96.75
```

Results for TASK NAME = 7 Award

```
Variable  STAT       Median
DAYS      1 Planned   92.00
          2 Actual   170.75
```

Figure 32. Media Analysis of U.S. and FMS Actions

3. Test for Equal Variance

According to Minitab's software program help function, the test for equal variance is as follows:

> Minitab calculates and displays a test statistic and p-value for both Bartlett's test and Levene's test where the null hypothesis is of equal variances versus the alternative of not all variances being equal. If there are only two levels, an F-test is performed in place of Bartlett's test.

- Use Bartlett's test when the data come from normal distributions; Bartlett's test is not robust to departures from normality.

- Use Levene's test when the data come from continuous, but not necessarily normal, distributions. This method considers the distances of the observations from their sample median rather than their sample mean, makes the test more robust for smaller samples. (*Minitab 16 Statistical Glossary*, 2010)

The test-for-equal-variance report of the U.S. contract-actions data identified in Figure 33 provides a visual cue that suggests a difference in variance at the 4 SOL ISD task. The sample data suggest the current system estimates very consistent dates, versus a much larger actual variance. This graph observes the number of standard deviations or margin of error. The statistics identify imprecision in the current measurement system.

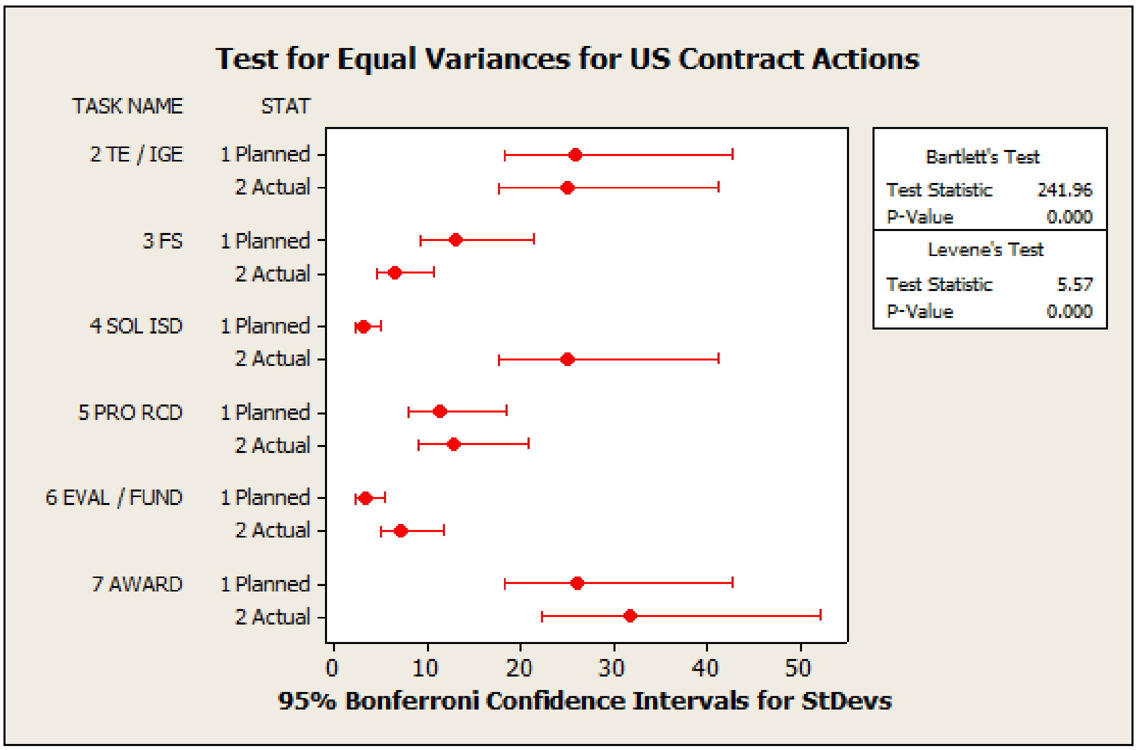


Figure 33. Test for Equal Variance in U.S. Contract Actions

The test for equal variance of FMS contract actions, provided in Figure 34, identifies an even greater variance than that of U.S. actions.

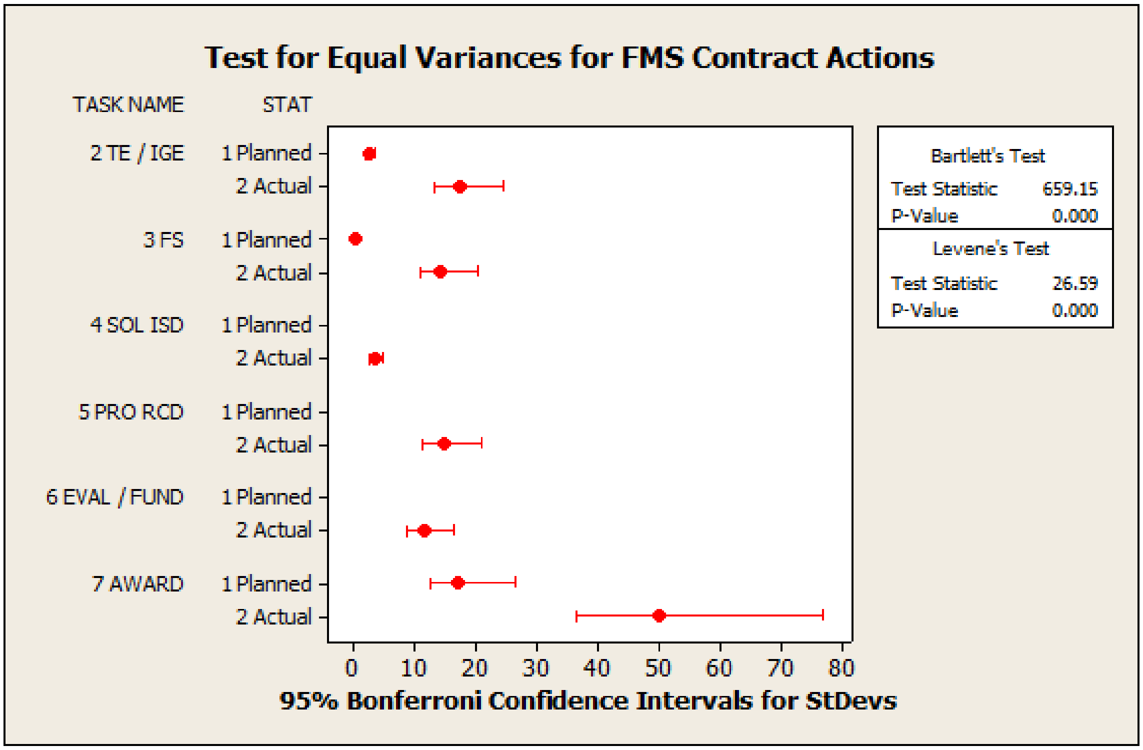


Figure 34. Test for Equal Variance FMS Contract Actions

The standard-deviation statistical analysis measures the average distance of the data values from their means. Figure 35 displays that, for most tasks, the sample data suggests discrepancies in the current system estimation of consistent dates, versus much larger actual dispersions.

US ACTIONS

Results for TASK NAME = 1 SOW/CDRL

```
Variable  STAT       StDev
DAYS      1 Planned      *
          2 Actual       *
```

Results for TASK NAME = 2 TE/IGE

```
Variable  STAT       StDev
DAYS      1 Planned  25.91
          2 Actual   25.03
```

Results for TASK NAME = 3 FUNC SF

```
Variable  STAT       StDev
DAYS      1 Planned  13.02
          2 Actual    6.39
```

Results for TASK NAME = 4 SOL ISD

```
Variable  STAT       StDev
DAYS      1 Planned  2.957
          2 Actual   25.02
```

Results for TASK NAME = 5 PRO RCD

```
Variable  STAT       StDev
DAYS      1 Planned  11.17
          2 Actual   12.65
```

Results for TASK NAME = 6 EVAL/FUND

```
Variable  STAT       StDev
DAYS      1 Planned  3.177
          2 Actual    7.12
```

Results for TASK NAME = 7 AWARD

```
Variable  STAT       StDev
DAYS      1 Planned  25.96
          2 Actual   31.66
```

FMS ACTIONS

Results for TASK NAME = 1 SOW/CDRL

```
Variable  STAT       StDev
DAYS      1 Planned      *
          2 Actual       *
```

Results for TASK NAME = 2 TE/IGE

```
Variable  STAT       StDev
DAYS      1 Planned  2.421
          2 Actual   17.22
```

Results for TASK NAME = 3 FUNC SF

```
Variable  STAT       StDev
DAYS      1 Planned  0.312
          2 Actual   14.09
```

Results for TASK NAME = 4 SOL ISD

```
Variable  STAT          StDev
DAYS      1 Planned  0.000000
          2 Actual      3.253
```

Results for TASK NAME = 5 PRO RCD

```
Variable  STAT          StDev
DAYS      1 Planned  0.000000
          2 Actual      14.73
```

Results for TASK NAME = 6 EVAL/FUND

```
Variable  STAT          StDev
DAYS      1 Planned  0.000000
          2 Actual      11.43
```

Results for TASK NAME = 7 AWARD

```
Variable  STAT       StDev
DAYS      1 Planned  17.06
          2 Actual   49.88
```

Figure 35. Standard-Deviation Analysis of U.S. and FMS Actions

F. AFFINITY DIAGRAMS: CAUSE-AND-EFFECT ANALYSIS

An analysis of why contract metrics reported as late was performed. The professional analysts working the individual actions provided input as to why there were defects. The inputs were consolidated into similar groupings, resulting in an affinity diagram. The affinity diagram was applied to synthesize the individual reasons at a higher level and translate them into LSS terminology. Table 11 provides the seven forms of waste as applied to services that served as a template for generating the project's affinity diagram.

Table 11. Lean Seven Wastes (from George, 2003)

Seven Wastes	Examples
1. Overprocessing	Adding more value to a service/product than what your customers want or are willing to pay for.
2. Transportation	Unnecessary movement of materials, products or information.
3. Motion	Needless movement of people.
4. Inventory	Any work-in-process that is in excess of what is required to produce for the customer.
5. Waiting	Any delay between when one process step or activity ends and the next step/activity begins.
6. Defect	Any aspect of the service that does not conform to customer needs.
7. Overproduction	Production of service outputs or products beyond what is needed for immediate use.

The project's root-cause analysis/affinity diagram, provided in Table 12, summarizes the observations of the data. The data shows imprecision and inaccuracy as it pertains to the measurement system.

Table 12. Affinity Diagram

Sample Data Observations	Possible Contributors	AFFINITY	MEASUREMENT SYSTEM	Accuracy	Precision	Linearity	Bias	PROCESS	Over-Production of Information	Over-Processing of Information	Inventory of Information	Waiting	Unnecessary Information Movement	Unnecessary People Movement	Rework, Defects
US ACTIONS - Difference in medians at Proposal Evaluation and Contract Award tasks. It appears that current forecasting methods (measurement system) underestimate Actual median durations	Waiting for questions to be answered			●								●			
	External process cycle times longer than estimated			●	●							●			
FMS ACTIONS - Appears that current forecasting methods consistently under estimate **median** task durations across all tasks.	Underestimation of actual task durations						●								
	Waiting for approvals						●					●			
US & FMS HARDWARE & LICENSE ACTIONS - Median duration for Actual Function Staffing is better than Planned.	Actual task duration is better than planned			●											
	External process cycle times longer than estimated			●	●							●			
US ACTIONS - Data suggest that the variance (margin of error) between Planned versus Actual vary significantly.	Expected variance (Planned) is much smaller than Actual			●	●										
FMS ACTIONS - Appears that the **variance** (margin of error) for Planned dates are less that Actuals, for most of the task completion dates.	Process changes not disseminated, resulting in delay			●	●							●			●
FMS ACTIONS - Appears that the variance (margin of error) for Planned dates are less that Actuals, for most of the task completion dates.	Delay in correct distribution statement, resulting in Contract Award delay											●			●
	Cycle times not based upon document dates			●	●							●			
	Actions occurring over caledar holidays			●	●							●			

The Pareto chart of lean error types, shown in Figure 36 identify that “waiting” is the largest percentage of error, meaning that the project should focus on areas where waiting could be reduced and eliminated.

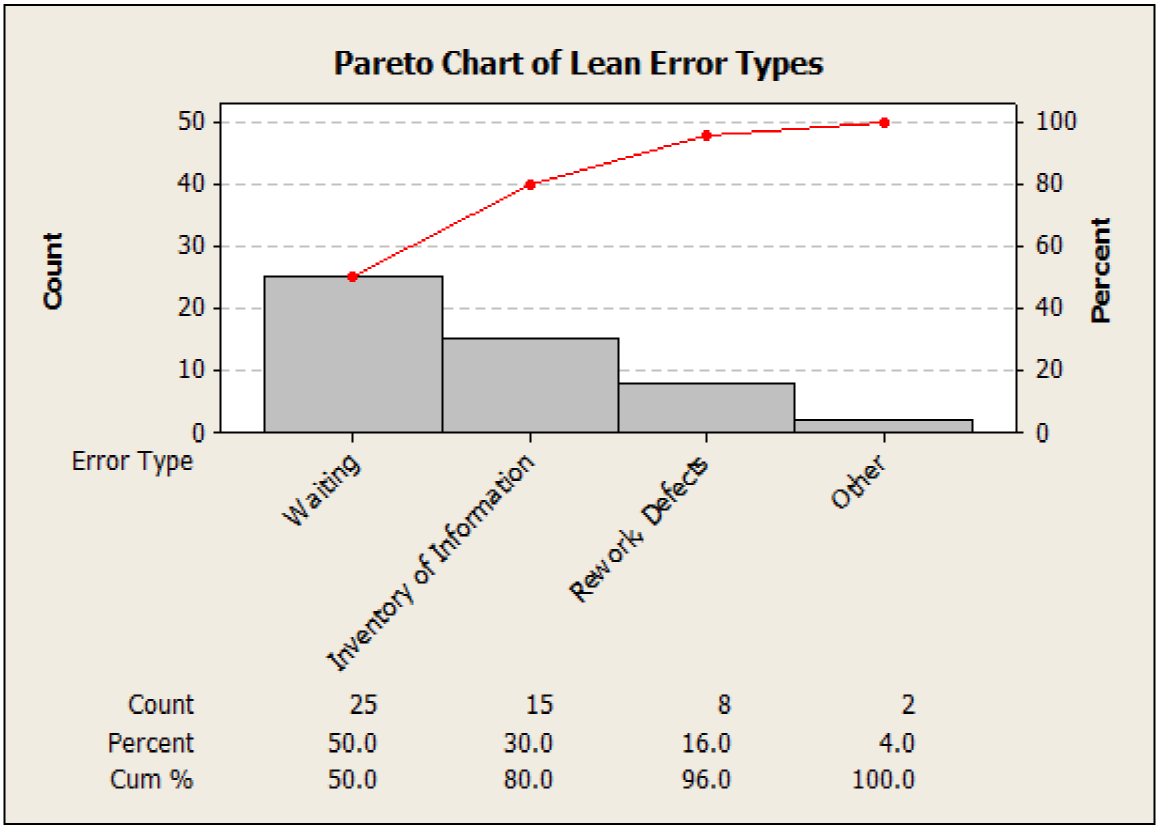


Figure 36. Pareto Chart of Lean Error Types

The key take-aways for the LSS analyze phase are as follows:

- U.S. and FMS contract actions exhibit consistent bias meaning there is consistent underestimating of the start dates and durations.
- The key lean error is waiting (sign offs).
- Contract award durations for U.S. and FMS are underestimated.
- Hardware and license procurement is precise and accurate, which is a best practice to be captured and replicated.

G. LSS IMPROVE AND CONTROL PHASES

The improve and control phases of the LSS project are beyond the scope of this paper, which focuses primarily on improvements in identification and accuracy of forecast dates.

IV. CONCLUSION AND RECOMMENDATIONS

The use of metrics within ACAT III programs is a powerful tool in the pursuit of performance excellence. This project studies the metrics of a sample United States Army Aviation ACAT III program. The organization reported weekly metrics across functional areas (logistics, business, technical [software development and risk management]) that were reviewed in functional-management staff calls.

The organization follows metrics and risk SOPs and uses the metrics weekly to identify areas of focus. The metrics collected are aligned with the organizational goals of the organization. This research finds that data collected since the SOP inception has never been fully analyzed, and provides full analysis of one aspect of the metrics using LSS. It is determined that items shown as “late” are not truly late, because the end state is met and the ultimate product, software, seems to be consistently delivered on time. In several FMS cases, processes are actually three or four weeks ahead of schedule. Thus it may be inferred that timeframes for completion may need adjusting. The organization studied is observed as efficient and produces exemplary work products. An extraordinary workload is performed, tracked, and documented by the organization. Metrics are used to provide the pulse for the organization on a daily and weekly basis. With some enhancements to the measurement system, the organization can serve as a model for organizations to follow.

As with any entity, improvement is possible. Like other DOD organizations, the studied organization handles a great deal of work, and like all those that aspire to performance excellence, it is open to improvement and to measures and guidelines that promote total-quality management.

While the author used LSS to study an aspect of the program, simple analysis methods could be implemented that could provide means to improve the organization and provide better feedback. The SOPs might address analysis, checking items, and implementing improvement measures. The LSS analysis clearly identifies areas of concern. While the studied program and team implement and track weekly metrics per the SOP, there is no direct focus on creating an organization with performance excellence. The organization collects and spends a great deal of time tracking the data, but no analysis is performed to demonstrate areas that can be improved.

Organizations that truly implement TQM best-practice standards use measurement as a means to achieve performance excellence. These organizations ensure that their metrics align with organizational objectives and goals. The metrics currently collected are based on moving targets (as planned dates are constantly updated) and metrics are not consistently "doable" within a given time frame, which the SMART test suggests for quality of performance metrics:

- S = Specific: clear and focused to avoid misinterpretation. Should include measure assumptions and definitions and be easily interpreted.
- M = Measurable: can be quantified and compared to other data. It should allow for meaningful statistical analysis. Avoid "yes/no" measures except in limited cases, such as start-up or systems-in-place situations.
- A = Attainable: achievable, reasonable, and credible under conditions expected.
- R = Realistic: fits into the organization's constraints and is cost-effective.
- T = Timely: doable within the time frame given.

In conclusion, how to measure, analyze, and then improve organizational performance is the question. The SOPs identify the means to measure and analyze, but do not specify how an organization can improve through the use of metrics. The SOPs assert that negative trends must be reported, but do not identify how to improve processes and procedures so negative trends do not occur. There appears to be no defined method for process improvement. An organization may be extremely efficient, perform a great deal of work, and do a great job at reporting metrics. However, its potential will never be reached if there are no "process-improvement processes" in place to optimize the system and boost quality to new levels. Organizations that have attained performance excellence are always seeking ways to improve and have measures and guidelines in place to achieve this goal. This is the essence of total-quality management.

Organizational leaders of ACAT III programs should include metrics as part of their overall strategy. The use of metrics within ACAT III programs are highly useful as a means to strive for performance excellence.

A. THE PROVEN VALUE OF METRICS WITHIN OTHER STUDIES

Other studies have cited the value of the implementation of metrics within organizations. For example, in the 2005 Naval Postgraduate School MBA Project *DoN Procurement Metrics Evaluation*, Christopher G. Brianas states,

> However, this tool is only effective when those using it have confidence that the metrics in place are the correct ones linking to each Focus Area, have been collected and reported on accurately, are responsive to manager actions and decisions, provide the necessary information for managers to make those decisions, and have appropriate targets set for each metric. (Brianas, 2005)

In a 2002 thesis, T*he Evolution and Application of Technical Risk Management within the United States Navy*, Michael A. Wheeler studies risk management and concludes,

> Although there is still work to do, the Navy has made strides over the past two decades, moving from a risk avoidance culture to a risk awareness culture. Risk management is a growing discipline and the need is understood by most all acquisition professionals. Risk management is engrained within DoD and DoN policy the acquisition of defense systems within budget, on schedule (or reduced cycle times), and improved readiness is the Navy's objective. This is achieved through the proactive identification and mitigation of technical risks. The only weaknesses lie in the implementation of risk management and assessment methods and the communication of risk. This author expects aspects to improve in the future, however slowly. (Wheeler, 2009)

In a third NPS thesis, A Case Analysis of the U.S. Army Bradley Fighting Vehicle A3 Program, June 1998, James S. Romero recommends,

- Focus Metrics on Managing the Program—Having metrics that focus on the purpose of managing the software development effort is critical to metrics effectiveness.
- Implement Only the Most Useful Metrics—The program manager should only implement the most useful metrics that are absolutely required to manage the program.

- Make the Software Developer Responsible for Metrics—To ensure that metrics are effective, they must be fully-integrated with the software development effort. One way that the program manager and contractor can promote this integration is by ensuring that the software developer is also responsible for metrics.
- Tailor Your Metrics (Management Level, Stage, and Presentation)—Metrics will be most effective if they are tailored to the specific application, such as management level, stage of development, and presentation.
- Get Educated on Software Development and Metrics—When managing any software-intensive system it is vital that the program managers have at least a general understanding of software-related issues. (Romero, 1998)

B. RECOMMENDATIONS OF THIS STUDY

Two recommendations are derived from this study, one for the organizational level and one for senior managers. The recommendations are framed with reference to the National Institute of Standards and Technology's Baldrige criteria. While this study focuses on the measurement, analysis, and knowledge-management criterion, a holistic approach is made to survey the overall organization and identify if the organization and its metrics are aligned to reach performance excellence, the brass ring of TQM.

1. Organizational-Level Recommendation

The author recommends that organizational leaders improve metrics to align with Baldrige criterion 4: measurement, analysis, and knowledge management, including analysis of data on a consistent basis. This could be done by means of a simple trending chart, automated so that trends are easily identified and corrective actions can be quickly taken. In addition, the timeframes for required dates need to be investigated to ensure they are appropriate in relation to actions. In some cases, two actions are combined into one, though two different entities are responsible for the actions (technical estimates and independent government estimates). This could be improved. Weekly reviews need to discuss all red items so corrective actions can be made. Because red may be a result of limited resources, the organization should annually review overall metrics, personnel, and ways to improve performance.

2. Senior Level Organizational Level Recommendations

Suggestions to senior level managers include the implementation of risk and metrics SOPs for all sub organizations at the product directorate level, reviewing LSS implementation, insert technology automation, implement suggestions provided in "Power of Alignment" and implement Baldrige criterion.

a. Implement Risk-and-Metrics SOP

Initially, the risk-and-metrics SOP should be implemented across the board at the program level. The methodology is excellent and very useful.

b. Review LSS Implementation

Senior management should review the efficiency and effectiveness of implementation of the DOD's LSS program across the organization. There are pros and cons to all systems, including LSS. At times, as in this project, there may appear to be subjectivity in the implementation. While subjectivity can be helpful at times, it can also have a negative impact on timelines for project completion.

c. Insertion of Technology Automation

The organization should consider inserting more automation into their processes. This way, the organization could more readily pull metric reports. Currently, for example, the individual teams perform their work details using email and track the metrics with MS Excel. If a database were used to track and route the data, the process may be streamlined improving productivity and quality. This approach would have another benefit with prospective automated reports detailing trends and enable the organization to quickly identify critical areas of concern. .

d. Study "Power of Alignment" by George Labovitz and Victor Rosansky of Organization Dynamics, Inc.

The organization's leaders should read and study the "Power of Alignment," a goldmine for organizational management. Per Labovitz and Rosansky,

> Managers must now keep their people centered in the midst of change, deemphasize hierarchy, and distribute leadership by distributing authority, information, knowledge and customer data throughout their organizations. Alignment is a response to the new business reality where customer requirements are in flux, where competitive forces are turbulent, and where the bond of loyalty between an organization and its people has been weakened." The old linear approach to management has given way to one of simultaneity—to alignment. (1997)

Alignment suggests that organizational leaders engage "The Main Thing"—Keeping people and organizations centered in the midst of change. This is two-fold: 1) getting everyone headed in the same direction with a shared purpose and 2) integrating the resource and systems of the organization to achieve that purpose. The practical methods suggest leaders do the following:

- Connect their employees behavior to the mission, turning intentions into actions
- Link teams and processes to the changing needs of customers
- Shape business strategy with real-time information from customers
- Create a culture in which all these elements work together seamlessly

Power of alignment suggests the use of measurement and metrics as key for the self-aligning company. The authors identify through their experience with literally dozens of successful organizations that measurement is an incredibly powerful tool for getting and saying aligned. Characteristics of key measures should include the following key 1. Broad enough so everyone in the organization can understand their individual contribution; 2. Unify the organization, its culture, systems, processes and output; and 3. Must be future oriented so that they will still be effective as the company grows (Labovitz & Rosansky, 1997).

DOD leadership can lead successfully through the following suggestions:

- Keep people continually connected to the environment in which they operation. They must understand what is at stake. (With funding shortfalls in DOD, leaders should communicate how things could go wrong, and how programs could be financially jeopardized.)
- Help people to think holistically
- Always keep people connected to the main thing.
- Reward and recognize people for working toward the main thing.

- Use the review process to carry the message to employees.
- Create opportunities for people to interact.

e. Implementation of Baldrige Criteria

The organization should investigate and consider implementing the Baldrige criteria for overall performance excellence. This customizable method is cost effective as compared with programs such as ISO, which entail the hiring of auditors to certify the organization. With the Baldrige criteria, an organization can self-nominate for the Baldrige Award at no cost. The U.S. government implemented the Baldrige Award in 1987 to encourage organizations to examine their practices, benchmark against other organizations, and make whatever changes were necessary to become leaner, faster, and more customer-oriented, with fact-based decisions and responsiveness to multiple stakeholders, in pursuit of zero defects and high performance.

Continuous improvement is not merely a good thing for a handful of ambitious companies, but a survival strategy for every organization, as the optimal way to create capabilities for rapid adjustment to rising standards and changing conditions.

> The Baldridge criteria for performance excellence are a set of questions in seven interrelated areas (known as categories) that guide you in assessing your organization's performance. For over 20 years, leaders of role-model U.S. organizations in all sectors—manufacturing, service, small business, education, health care, and non-profit—have used this framework to consider all aspects of running their organizations and to drive improvement. The criteria help these leaders align processes and resources; improve communications, productivity, and effectiveness; and achieve strategic goals. Without being prescriptive, the criteria focus on critical aspects of management that contribute to success.
>
> Responding to the criteria questions is the beginning of a Baldrige journey toward performance excellence. While answering them fully is not necessarily easy, it will help you see your organization's strengths, opportunities for improvement, and gaps more clearly—so you can move forward with well-informed actions. (NIST, 2011, Executive Guide, p. xii).

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APPENDIX A. PD ANMP MONTHLY PRODUCT METRICS SOP

This appendix provides the ANMP monthly product metrics standing operating procedures that are used as guidance for the ACAT III program of study (Chandler, 2010).

DEPARTMENT OF THE ARMY
PROJECT MANAGER, AVIATION SYSTEMS
OFFICE OF THE PRODUCT DIRECTOR
AVIATION NETWORKS AND MISSION PLANNING
REDSTONE ARSENAL, ALABAMA 35898

SFAE-AV-AS-ANMP September 24, 2010

SUBJECT: Aviation Networks & Mission Planning (ANMP) Monthly Product Metrics SOP

1. Product metrics is a fundamental system engineering and program management tool that provides leadership and Integrated Product Teams (IPTs) insight into potential negative trends in the products or weapon systems cost, schedule, or technical performance. If negative trends are detected then immediate attention and corrective action can be applied. Since many of our products are under the guidelines set forth by the Acquisition Program Baseline's thresholds and objectives, it is imperative that performance is measured accurately and often.

2. The objective is for each Assistant Product Manager (APM) /IPT to develop a set of monthly metrics in a standard format that is consistent across each product and IPT. The metrics will indicate an accurate depiction of the products cost, schedule, and technical health and status and will adhere to the code of green, yellow, or red that defines the goodness or the severity level of the performance trends being flagged for management action. Metrics can be refined as products move into different phases of their life cycle and can be retired, and new metrics can be added as needed. Not all metrics defined below will apply to each product; however, APMs/IPTs are requested to adhere to this Standard Operating Procedure (SOP) as closely as possible.

3. Metrics defined:

a. A green metric indicates that the product is on or ahead of schedule, cost, or technical.
b. A yellow metric indicates that the product is behind schedule, cost, or technical but recoverable.
c. A red metric indicates that the product is behind in schedule, cost, or technical and not recoverable.
d. Schedule metrics will focus on required need dates compared to the forecasted or actual date.
e. Cost metrics will focus on unforeseen over runs due to technical issues (may refer to EVM data).
f. Technical metrics will focus on meeting objective/threshold requirements or KPPs
g. Actual vs. DA Planned monthly obligation rates cost curves will focus on funding that has yet to be spent as planned.

4. Product metrics will address:

a. Software and hardware development status
b. Software blocking, certification status, IAVM requirements, and testing events
c. Contract status
d. CDRL status
e. Risk updates per risk SOP
f. Production and delivery status
g. fielding status
h. obligations funding performance curves
i. APMs/IPTs top issues (risks that have already occurred)

5. APM Responsibilities:

a. Provide monthly metrics for Product Director/Deputy Product Director (PD/DPD) and Functional Managers review and post to SharePoint.
b. Brief the ANMP staff on product trends in cost, schedule, or technical performance.

6. Functional Managers Responsibilities:

a. Support the APMs/IPTs in the development of the monthly metrics.
b. Brief the ANMP staff on any developing trends in cost, schedule, or technical performance.

7. IPT Responsibilities:

a. Support the APMs in the development and update of the monthly metrics.

7. If you have any questions, the POC of this effort is Scott Caruso, 256-313-1172. Suggested changes, additions and/or deletions to this SOP should be coordinated with the Functional Manager's and DPD.

MIKE CHANDLER
Product Director
Aviation Networks and Mission Planning

APPENDIX B. PD ANMP RISK-MANAGEMENT SOP

This appendix provides the ANMP risk management standing operating procedure that is used as guidance for the ACAT III program of study (Chandler, 2011).

Product Director Aviation Network and Mission Planning

Risk Management Standard Operating Procedure

DATED:
30 June 2011

Version 5

PREPARED BY:

Product Office, Aviation Networks and Mission Planning
ATTN: SFAE-AV-AV-ANMP
Building 5309

Redstone Arsenal, AL 35898-1295

DEPARTMENT OF THE ARMY
PROJECT MANAGER, AVIATION SYSTEMS
OFFICE OF THE PRODUCT DIRECTOR
AVIATION NETWORKS AND MISSION PLANNING
REDSTONE ARSENAL, ALABAMA 35898

SFAE-A V -AS-ANMP 30 June 2011

SUBJECT: Aviation Networks & Mission Planning (ANMP) Risk Management SOP

1. PURPOSE: To establish policy and process for implementing Continuous Risk Management procedures in PD ANMP programs and projects.

2. REFERENCES:
a. Defense Acquisition Guidebook (DAG), 19 February 2010
b. Risk Management Guide for DoD Acquisition Version 6, August 2006
b. ANMP System Engineering SOP, 30 June 2011
c. ANMP Monthly Metrics SOP, 24 September 2010
d. Continuous Risk Management Guidebook, SEI

3. POLICY:
a. All PD ANMP programs and projects will establish risk management procedures as outlined in this SOP.

b. PD ANMP programs and projects will incorporate the elements of the risk management process into weekly activities and status meetings.

c. RED risks will be reported immediately to the Director, PD ANMP, along with updates in the status as soon as they become known. Programs and projects will report status on all AMBER and RED risks to the PD ANMP Technical Lead weekly.

d. The overall program/project risk shall be reported as RED if any individual area (cost, schedule, performance, and supportability) is reported as RED.

4. DEFINITIONS:
a. Risk - A measure of future uncertainties in achieving program performance goals within defined cost and schedule constraints. It has three components: a future root cause, a likelihood assessed at the present time of that future root cause occurring, and the consequence of that future occurrence.

b. Risk Event – an item or element that could deviate from the program plan or system cost, schedule or technical objectives. These items should be assessed to determine the level of risk.

c. Risk Management - the practice of continually assessing program cost, schedule, and technical uncertainties and consequences. It includes planning for risk, assessing (identifying and analyzing) risk areas, developing risk-handling options, monitoring risks to determine how risks have changed, and documenting the overall risk management program.

d. Risk Assessment - the process of identifying and analyzing program areas and critical technical process risks to increase the probability/ likelihood of meeting cost, schedule, and performance objectives.

e. Risk Planning - the process of developing and documenting an organized, comprehensive, and interactive strategy and methods for identifying and tracking risk areas, developing risk handling plans, performing continuous risk assessments to determine how risks have changed, and assigning adequate resources.

f. Risk Handling - the process that identifies, evaluates, selects, and implements options in order to set risk at acceptable levels given program constraints and objectives. This includes the specifics on what should be done, when it should be accomplished, who is responsible, and associated cost and schedule.

g. Risk Monitoring - the process that systematically tracks and evaluates the performance of risk-handling actions against established metrics throughout the acquisition process and develops further risk-handling options, as appropriate.

h. Risk Documentation – the recording, maintaining, and reporting assessments, handling analysis and plans, and monitoring results. It includes all plans, reports for the PM and decision authorities, and the tools required to generate the documentation.

i. Probability - an estimate of the likelihood of a risk happening once identified.

j. Consequence – the impact on program objectives should the risk event happen as described in the Risk SOP.

k. Risk rating - the process by which the impact and probability of a risk are combined to give an overall risk rating.

5. RESPONSIBILITIES

a. The Product Director (PD ANMP) has authority for SOP approval, resourcing risk mitigation plans, reporting risks external to PD ANMP, and championing continuous risk management within PD ANMP.

b. The Deputy Product Manager (DPdM) is responsible for implementing the procedures of this SOP.

c. The Functional Managers and Staff are responsible for approving the IPT cost, schedule, technical and supportablity risk assessments, risk mitigation strategies and mitigation plans.

d. The PD ANMP Technical Lead is responsible for SOP and risk management process development, changes and training.

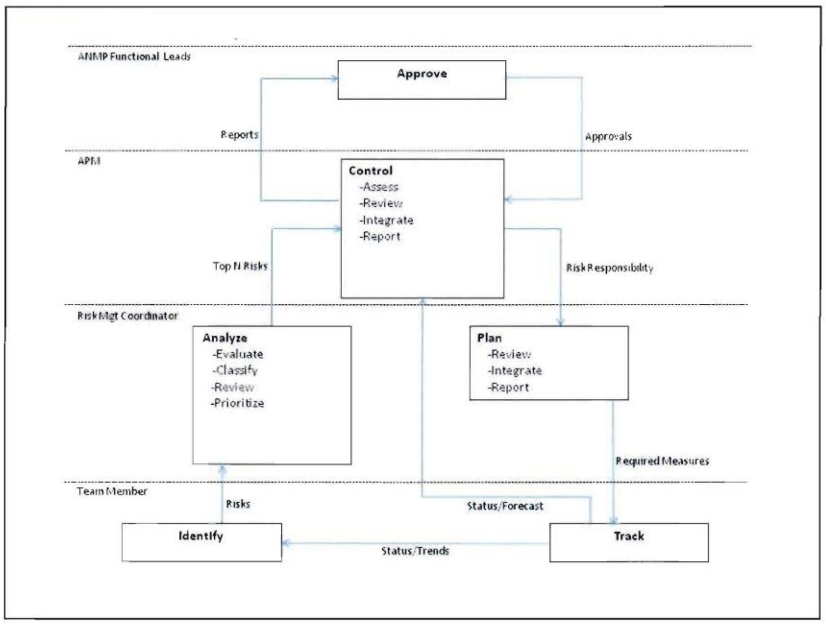
e. The Assistant Product Managers are responsible for continuous product risk assessments, control, review, monthly metrics reporting and integration of the risk management process into their respective IPTs.

f. The program/project Risk Management Coordinator, with support from the Business, Technical and Logistics Leads, is responsible for analysis, planning, and reporting risks to APM.

g. The program/project IPT members are responsible for risk identification and tracking.

6. RISK MANAGEMENT PROCESS

a. Establish the program/project risk management process using the following steps and process flow diagram.



Step 1 - Risk Identification. A risk is any event or circumstance that threatens to disrupt the planned execution of a material acquisition program. There are 4 types of risks each PD ANMP APM must address :

- Cost – the ability to execute the planned scope of the acquisition program with available funding and manpower.

- Schedule – the ability to execute the scope to the acquisition program to its planned or directed schedule.

- Technical – the quantifiable aspects of the managed system as defined by requirements documents and specifications.

- Supportability – the elements of logistics appropriate to the system, e.g. Mean Time to Repair (MTTR), Mean Time Between Failures (MTBF), spares availability, training development and similar fielding and sustainment considerations as applicable.

During risk identification, the question to be answered is, "What can go wrong?" Risks will be described in the form of "If-Then" statements. For instance, "If the system requirements continue to creep, then the project cost and schedule will be adversely affected."

Step 2 - Risk Analysis. At this stage, the program Risk Coordinator, with appropriate support, will determine the likelihood and consequence to the risk identified in Step One as per the Likelihood and Consequence Tables located in the Appendix.

Step 3 - Risk Mitigation Planning and Implementation. At this step, alternatives to managing the risk must be evaluated and a mitigation plan developed for each identified risk. The four typical approaches to handling risk are:

1. Avoid, by eliminating the cause of the risk or by changing the circumstances that induce the risk. A change in a technical approach is an example of a way to avoid risk.
2. Control, by monitoring and managing the risk, acknowledging that this risk is a part of the program that cannot be avoided, but can be influenced. For example, the risk in developing a software architecture may be controlled through a management approach that emphasizes spiral development.
3. Transfer, by reallocating the timing, ownership, or distribution of the risk. A shift in a funding year may be an approach to transferring risk.
4. Assumption, by acknowledging that this risk is a part of the program that cannot be avoided, or influenced. The risk of sufficient funding at the DA level is a risk that must be assumed although the ability to influence funding decisions above a certain level may be minimal.

The objectives of the risk mitigation plan are as follows:

1. Ensuring consequences and sources of the risks are known.

2. Developing effective and efficient plans (only as much mitigation as needed).
3. Production over time of the corrective set of actions that minimize risks and impacts.
4. Prioritizing risks for mitigation.

Risk mitigation implementation is managing the risk mitigation efforts according to the planned mitigation efforts.

Step 4 – Risk Management Reporting. Risk reporting will consist of a Power Point presentation of program risks using the example Power Point slide found in the Appendix. The slides are intended as a stand-alone presentation or as an insert into another presentation. The composite risk shown on the risk analysis matrix for a particular risk should correspond to the highest level risk calculated in the 4 types of risk reporting required.

Step 5 – Update Risks. The program/project risks should be updated as follows:

- Quarterly – program level update, all identified risks reviewed, all new risk baselined in the plan.
- Monthly – all risks briefed to the PD ANMP.
- Weekly – all AMBER/RED risks to the Technical Lead for ANMP.
- Immediately – all high level (RED) risks to the PD ANMP.

b. Establish a baseline set of risks for the program/project. PD ANMP categories for risk management include: Cost, Schedule, Technical, and Supportability (logistics).

c. Set up a risk management database, organize the project team and develop the documentation required for assessing and reporting risks.

7. Questions on this SOP should be directed to Mr. Scott Caruso, 256-313-1172.

MIKE CHANDLER
Product Director Aviation Networks
and Mission Planning

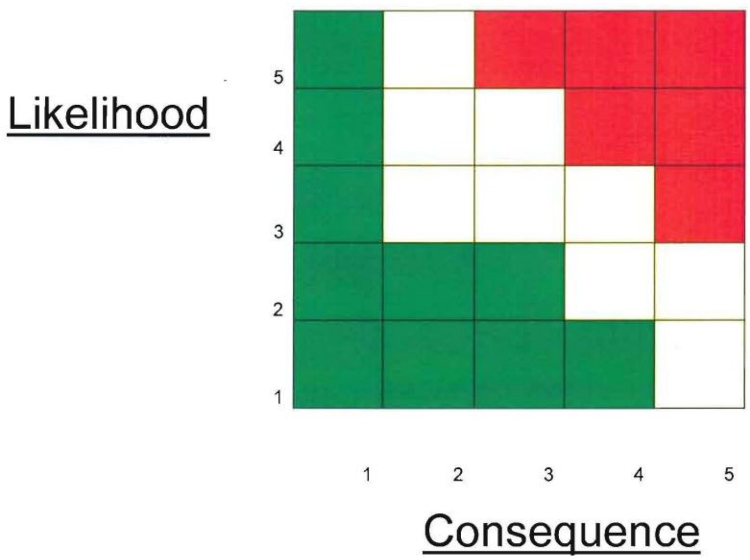
APPENDIX

1. Consequence Analysis Table
2. Likelihood Analysis Table
3. Risk Analysis Matrix
4. Sample Risk Management Presentation Slide

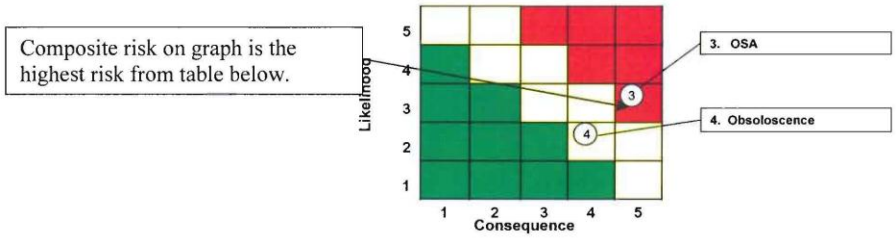
Likelihood Analysis Table:
What is the likelihood the risk will happen?

Level		Planned Approach and Processes:
1	Highly Unlikely	Will effectively avoid or mitigate this risk based on standard practices.
2	Unlikely but possible	Have usually mitigated this type of risk with minimal oversight in similar cases.
3	Likely	May mitigate this risk but workarounds will be required.
4	Highly Likely	Cannot mitigate this risk, but a different approach might lessen impact.
5	Near Certainty	Cannot mitigate this risk and no know processes or workarounds are available.

Table 2



Risk Analysis Matrix
Table 3



	Description	Cost	Sched	Perf	Supt	Mitigation Strategy	Status of Mitigation Strategy Action
3	If requirements cannot be defined completely prior to development start, then cost, schedule and performance will be adversely affected.	●	○	○	●	– Complete cost estimate and schedule – Prove feasibility of model driven development approach – Modify tech approach – remove MDD	– Schedule complete 10/16/09 – Prelim cost estimate 12/16/09 – Feasiblity of MDD 3QFY10
4	If replacement flash drives cannot be procured then support for the IDM will be adversely affected.	●	●	●	○	– Funding obligated for use of these drives on the IDM Bridge Buy II contract – Coordinate with CECOM to complete a lifetime buy for supportability (sustainment)	– CECOM currently working the action to order 100 spare BitMicro flash drives

Risk Presentation Slide Example

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SUPPLEMENTAL BALDRIGE PERFORMANCE EXCELLENCE PROGRAM

National Institute of Standards and Technology (NIST)
United States Department of Commerce
January 2013

This supplemental text, Baldrige Performance Excellence Program by the National Institute of Standards and Technology (NIST), United States Department of Commerce, January 2013, is provided as a recommendation for management to implement within the subject organization. The document provides a practical approach to help organizations improve performance practices, capabilities and results. It provides a way to facilitate communication and sharing of best practices, and serves as a working tool for understanding and managing organizational performance, for guiding strategic plans, and for providing opportunities to learn. Per the supplemental, the *Baldrige Criteria for Performance Excellence* empowers organizations explained within the text below:

> The Baldrige Criteria for Performance Excellence empower your organization—no matter the size or industry—to reach your goals, improve results, and become more competitive by aligning your plans, processes, decisions, people, actions, and results. Using the Criteria gives you a holistic assessment of where your organization is and where it needs to be. The Criteria give you the tools you need to examine all parts of your management system and improve processes and results while keeping the whole organization in mind.
>
> The Criteria are a set of questions about seven critical aspects of managing and performing as an organization: 1. Leadership; 2. Strategic planning; 3. Customer focus; 4. Measurement, analysis, and knowledge management; 5. Workforce focus; 6. Operations focus; and 7. Results
>
> These questions work together as a unique, integrated performance management framework. Answering the questions helps you align your resources; identify strengths and opportunities for improvement; improve communication, productivity, and effectiveness; and achieve your strategic goals. As a result, you progress toward performance excellence:
>
> - You deliver ever-improving value to your customers and stakeholders, which contributes to organizational sustainability.

- You improve your organization’s overall effectiveness and capability.
- Your organization improves and learns.
- Your workforce members learn and grow. (NIST, 2013, p. ii)

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