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Supply Chain Management: A Recommended Performance Measurement Scorecard

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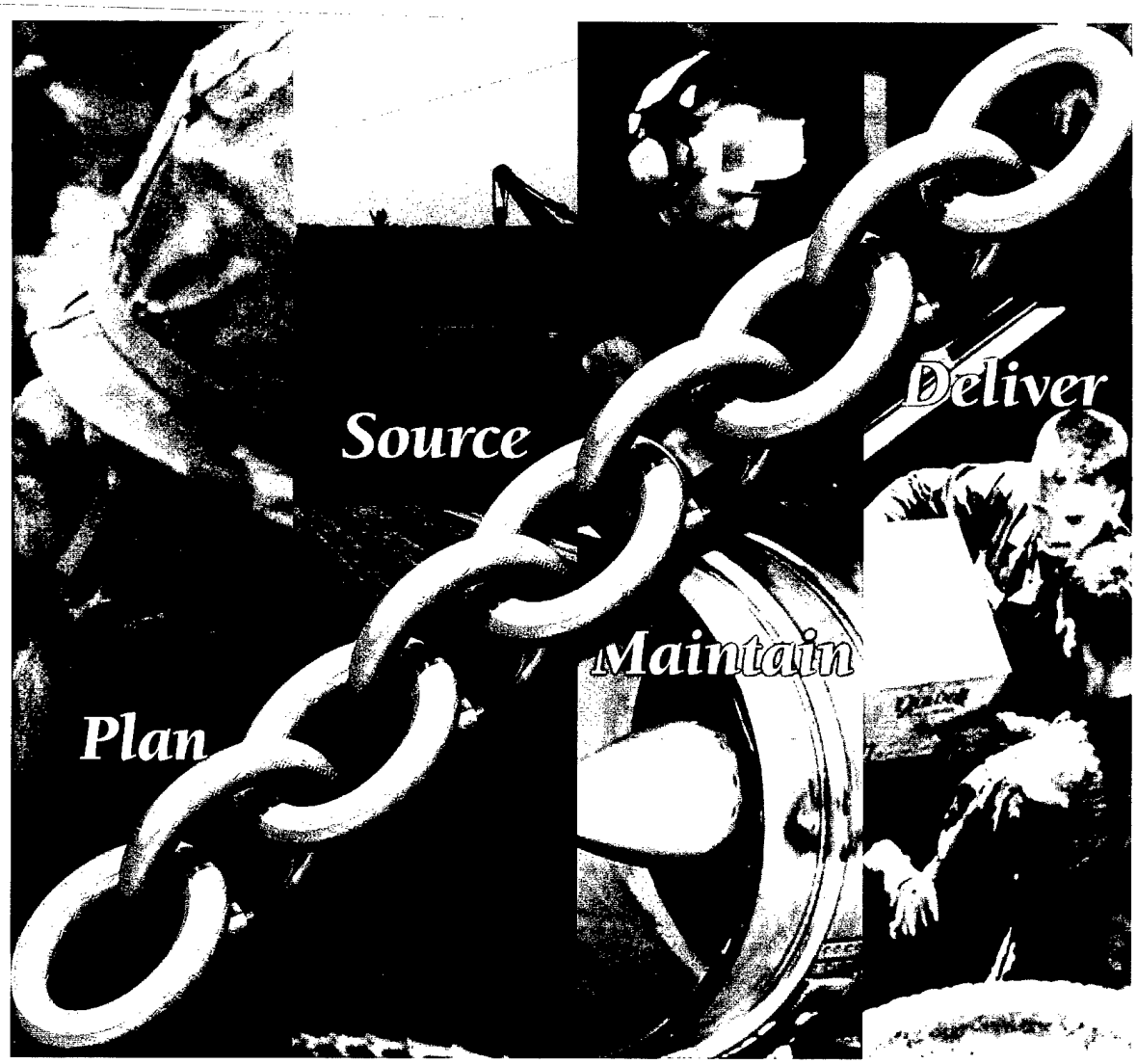

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Supply Chain Management: A Recommended Performance Measurement Scorecard

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June 1999

Larry S. Klapper
Neil Hamblin
Linda Hutchison
Linda Novak
Jonathan Vivar

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Logistics Management Institute
2000 Corporate Ridge
McLean, VA 22102-7805

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Executive Summary

Supply chain management is the management of all processes or functions to satisfy a customer's order. The Department of Defense (DoD) operates the world's supply chain, spends more than $80 billion annually on logistics, and employs more than one million logistics personnel.

DoD supply chain managers manage approximately 5 million consumable and reparable items that are procured from more than 100,000 suppliers and distributed to more than 30,000 customers. Similar to most enterprises, DoD is being challenged to reduce supply chain costs and improve customer satisfaction. As the department transitions from traditional methods of support to industry-proven best practices, senior DoD logisticians need to monitor the supply chain's overall performance continuously to ensure that policy and process changes achieve the desired results.

However, the supply chain performance measures available to senior DoD managers are not adequate to measure the overall effectiveness of the DoD supply chain. They are not balanced across customer service, cost and readiness, and sustainability performance objectives. Because of the lack of enterprise-level, balanced performance measures, the Deputy Under Secretary of Defense (Logistics), DUSD(L), tasked the Logistics Management Institute to propose a set of balanced measures that senior decision-makers can use to monitor supply chain effectiveness.

Based on our review of public-sector and existing DoD supply chain performance measures, we recommend that DUSD(L) adopt the following enterprise metrics:

- *Perfect order fulfillment.* A perfect order is an order that meets the following standards:
  - Delivered complete; all items delivered in the quantities requested
  - Delivered on time, using the customer's definition of on-time delivery

- Complete and accurate documentation (including packing slips, bills of lading, and invoices) to support the order
- Delivered in perfect condition and in the correct configuration to be used by the customer, faultlessly installed (as applicable).

- *Supply chain response time.* The total average length (measured in days) of the supply chain. This metric is derived from the average plan, source, maintain (repair), and deliver cycle times. Generally, the shortest supply chains are the most responsive chains.

- *Percent change in customer price compared to inflation.* This customer-focused cost metric measures how well procurement initiatives are keeping prices low with overall supply chain management efficiency. The metric would be computed based on a "market basket" approach similar to that used to compute the Consumer Price Index.

- *Supply chain management costs as a percent of sales (at standard price).* This metric measures all costs for operating a supply chain as a percent of the value of materiel moving through it. Supply chain management costs are the management information system, finance and planning, inventory carrying, materiel acquisition, and order management costs.

- *Weapon system logistics costs as a percent of the acquisition price (adjusted for inflation).* This metric represents the logistics costs of a weapon system as a function of its acquisition price.

- *Inventory turns.* This metric (the total sales at acquisition price divided by the value of inventory at acquisition price) measures how effectively assets are managed. This metric excludes assets held in war reserve accounts (because they are not for peacetime consumption).

- *Weapon system not mission-capable (NMC) rates.* This metric represents the percent of time a weapon system fleet is not mission-capable because of supply (lack of parts), maintenance (lack of maintenance resources), or both. NMC rates should be prepared for key weapon systems and used with other metrics (e.g., perfect order fulfillment and supply chain response time) that can be filtered by weapon system.

- *Upside production flexibility.* This metric is the number of days required to achieve an unplanned sustainable increase in production to support a two-major theater war (MTW) scenario.

- *War reserve ratio.* This metric is the ratio of on-hand war reserve assets to the war reserve requirement. This measure is an indicator of the readiness to sustain a two-MTW conflict until the industrial base is mobilized (as measured by upside production flexibility).

With this balanced performance measurement scorecard, senior DoD logistics managers can monitor the effectiveness and efficiency of the supply chain as they implement logistics process improvements. In addition, the Assistant Deputy Under Secretary for Materiel and Distribution Management should use the recommended functional metrics to monitor their contribution to the enterprise.

Contents

Chapter 1 Introduction 1-1

STUDY APPROACH 1-1

RECOMMENDED ENTERPRISE PERFORMANCE MEASURES 1-2

RECOMMENDED FUNCTIONAL PERFORMANCE MEASURES 1-5

REPORT FORMAT 1-5

Chapter 2 Current DoD Supply Chain Performance Measures 2-1

BACKGROUND 2-1

MEASURES 2-1

Government Performance and Results Act 2-1

Other Sources 2-2

CONCLUSIONS 2-3

Chapter 3 Performance Measures Framework 3-1

DEFINITION OF PERFORMANCE MEASURE 3-1

SUPPLY CHAIN MANAGEMENT PERFORMANCE 3-2

PERFORMANCE MEASURES PYRAMID 3-2

SUPPLY CHAIN OPERATIONS REFERENCE MODEL 3-3

BALANCED SCORECARD METHODOLOGY 3-5

SUMMARY 3-5

Chapter 4 Enterprise Performance Measures 4-1

BACKGROUND 4-1

SCOR PERFORMANCE MEASURES 4-2

Customer Service Perspective 4-3

Cost Perspective 4-6

Readiness and Sustainability Perspectives 4-8

DOD PERFORMANCE MEASURES 4-9

Cost Perspective: Weapon System Logistics Costs as a Percent of Acquisition Price 4-9

Readiness and Sustainability Perspective 4-9

IMPLEMENTATION 4-11
SUMMARY 4-11

Chapter 5 Functional Performance Measures for Materiel and Distribution Management 5-1
INTRODUCTION 5-1
PLAN 5-1
Functional Metrics 5-1
Enterprise Relationship 5-2
SOURCE 5-3
Functional Metrics 5-4
Enterprise Relationship 5-5
MAINTAIN 5-6
Functional Metrics 5-6
Enterprise Relationship 5-7
DELIVER 5-7
Functional Metrics 5-7
Enterprise Relationship 5-8
SUMMARY 5-9

Appendix A SCOR Model

Appendix B DoD Supply Chain

Appendix C OSD, Military Service, and DLA Enterprise Performance Measures

Appendix D Process Performance Measures

Appendix E Performance Measure Definitions

Appendix F Abbreviations

FIGURES

Figure 1-1. DoD Supply Chain Performance Metrics 1-2
Figure 3-1. Performance Measurement Users 3-3
Figure 3-2. SCOR Model Supply Chain 3-4
Figure 4-1. Supply Chain Performance Measurement 4-1
Figure 4-2. Wholesale Performance Measurement 4-2
Figure 4-3. Source Cycle Time 4-5
Figure 5-1. Functional Metrics for Plan 5-2
Figure 5-2. Source Functional Metrics 5-5
Figure 5-3. Maintain Functional Metrics 5-7
Figure 5-4. Deliver Functional Metrics 5-9

TABLES

Table 3-1. Performance Measurement Definitions 3-1
Table 3-2. Definitions of Functions 3-4
Table 4-1. SCOR Enterprise Performance Measures 4-3
Table 4-2. Recommended Enterprise Performance Measures 4-11
Table 5-1. Plan Functional Metrics 5-2
Table 5-2. Functional Metrics for Source 5-4
Table 5-3. Functional Metrics for Maintain 5-6
Table 5-4. Functional Metrics for Deliver 5-8

Chapter 1
Introduction

Customers of the Department of Defense (DoD) logistics system are demanding improved performance in the areas of reliability, flexibility, and responsiveness. At the same time, the customers expect efficiencies similar to those being experienced in the private sector. The military services and the Office of the Secretary of Defense (OSD) have several initiatives to improve supply chain performance and reduce logistics costs.

Supply chain management is the management of all internal and external processes or functions to satisfy a customer's order (from raw materials through conversion and manufacture through shipment). Performance measures, or "metrics," are used to monitor the progress of supply chain initiatives. However, a consensus in DoD considers the metrics available to senior DoD managers to be inadequate or lacking the depth to measure the effectiveness of the DoD supply chain. The metrics are not "balanced" across customer service, cost, readiness, and sustainability performance objectives.

Because of the lack of adequate measures, the Deputy Under Secretary of Defense (Logistics) (DUSD[L]) tasked Logistics Management Institute (LMI) to propose a set of balanced performance measures that senior decision-makers can use to monitor supply chain effectiveness.[1] This set is a prerequisite for developing a "data strategic plan" that defines the data source, warehousing, and mining requirements for supply chain measures. This report addresses our recommended top-level, or enterprise-level, performance measures for DoD. Enterprise metrics measure the overall performance of the supply chain and are cross-functional. In addition, the report presents the functional and process performance measures for the Assistant Deputy Under Secretary for Materiel and Distribution Management, ADUSD(L)MDM, that can be used to diagnose performance at the enterprise level that might be substandard or below expectations.

STUDY APPROACH

Our approach included the following steps:

- *Research the metrics used by commercial industry and DoD.* We reviewed the *Department of Defense Logistics Strategic Plan* and relevant DoD logistics policies.[2] Next we identified and evaluated commercial

[1] The scope of this study is limited to supply chain management of secondary items.

[2] Department of Defense, Deputy Under Secretary of Defense (Logistics), *Department of Defense Logistics Strategic Plan*, 1998 edition.

measurement efforts, such as the Supply Chain Operations Reference (SCOR) model, the American Productivity and Quality Center benchmarking toolkit, and the Wharton School (University of Pennsylvania) benchmarking studies.[3] We decided to adopt the SCOR metrics because SCOR is the only model that links metrics to individual supply chain functional processes. Finally, we interviewed key supply chain management staff members in OSD, the military services, and the Defense Logistics Agency (DLA).

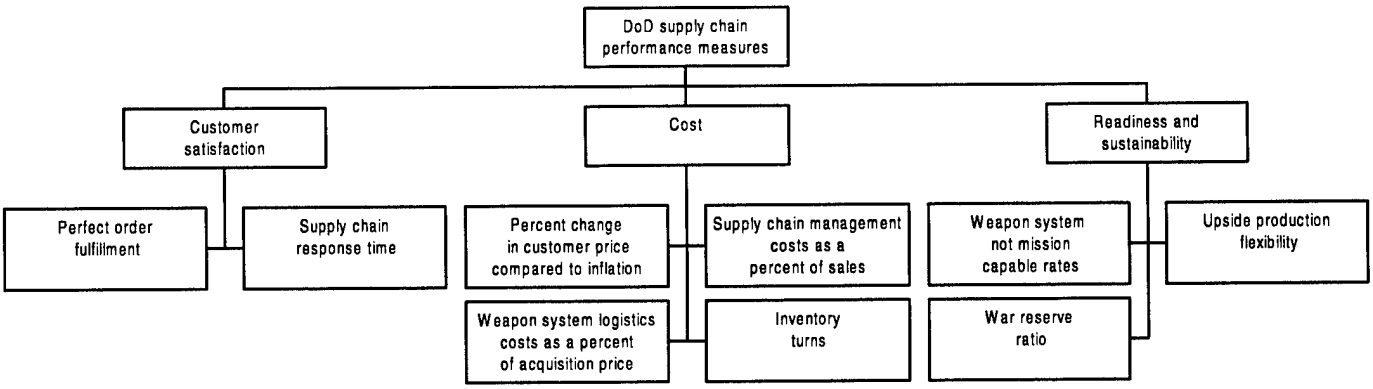
- *Select a performance measures architecture.* To be consistent with other logistics initiatives, we used the performance measures framework recommended in the DoD *Logistics Functional Requirements Guide*.[4] This framework is discussed in Chapter 3.

- *Recommend ideal performance measures for DoD.* We used the "balanced scorecard" methodology for developing our recommended set of performance measures.[5] This methodology is discussed in Chapter 3.

RECOMMENDED ENTERPRISE PERFORMANCE MEASURES

After analyzing the measures and applying them to our architecture and framework, we developed the balanced enterprise-level scorecard that uses nine metrics as depicted in Figure 1-1.

Figure 1-1. DoD Supply Chain Performance Metrics



[3] The SCOR model, developed by the Supply Chain Council, is a widely accepted commercial process and performance measures model.

[4] Department of Defense, Deputy Under Secretary of Defense (Logistics), *Logistics Functional Requirements Guide*, Logistics Management Institute, McLean, VA, August 1998, Chapter 5.

[5] Robert S. Kaplan and David P. Norton, "The Balanced Scorecard—Measures That Drive Performance," *Harvard Business Review*, Vol. 70, No. 2, January–February 1992.

Perfect order fulfillment, more than any other metric, captures most aspects (e.g., on time, right quantity, acceptable quality, adequate paperwork) that a customer considers important. It is a key metric used in the SCOR model and many other commercial supply chain metric frameworks.

Supply chain response time is also a very valuable high-level measure. It is expressed as the total length of the supply chain, measured in days (encompassing plan, source, maintain, and deliver cycle times). The SCOR model defines this time as "the time for a supply chain to respond to abnormal (significant) changes in demand." Normally a customer is buffered from the total length of the chain (because orders are filled from stock); however, for nonstocked items or when a customer's demand is exceedingly large and causes backorders, this metric approaches the order fulfillment cycle time. In general, the shortest supply chains are the most responsive to change.

Percent change in customer price compared to inflation considers a market basket of items and compares the price that customers pay to inflation. This price index can be DoD's version of the Consumer Price Index (CPI). This metric combines how well procurement initiatives are keeping prices low with overall supply chain management efficiency.

Supply chain management costs as a percent of sales (at standard price) is a key supply chain cost measure. It represents all costs associated with operating a supply chain as a percent of the value of materiel moving through it. Industry uses this metric for benchmarking.

Weapon system logistics costs as a percent of the acquisition price captures the effects of nontraditional supply chain improvements (not reflected in traditional supply chain metrics) for the enterprise level. For example, perfect order fulfillment rates and total supply chain management costs as a percent of sales are improved as the number of orders processed increases because costs and failures are spread over a larger base. In addition, a major goal of most commercial enterprises is to increase sales, thereby improving market share and profit. However, this metric is improved as the number of orders placed to repair a weapon system is reduced. This metric captures some efforts of design engineers to improve reliability and maintainability and thereby reduce a weapon system's life-cycle cost.

Inventory turns (or the inverse of days of supply) is a key commercial supply chain metric (used by the SCOR model and all other commercial frameworks). It measures the productivity of the inventory investment. In general, the higher the inventory turn, the more efficient the supply chain. This metric is more meaningful than metrics that simply express the value of inventory levels. Assets held in war reserve accounts are excluded from the computation (because they are not for peacetime consumption).

Weapon system not mission-capable (NMC) rates are key weapon system readiness metrics used by DoD. An NMC rate is the percent of time a weapon system fleet is NMC–supply (NMCS), meaning a lack of parts; NMC–maintenance (NMCM), a lack of maintenance resources; or both. The supply chain's performance can directly affect NMC rates.[6]

Upside production flexibility is a key high-level commercial supply chain metric that is also applicable to DoD operations. It is defined in SCOR as the number of days needed to achieve a 20 percent sustainable increase in production. We modified the definition to be the number of days needed to achieve a sustainable increase to support a two-major theater war (MTW) scenario. This metric is the basis for computing war reserve requirements. Ideally, the requirements are reduced by closer coordination and planning with DoD suppliers.

War reserve ratio measures the ratio of on-hand war reserve assets to the war reserve requirement. This measure is an indicator of the readiness to sustain a two-MTW conflict until the industrial base is mobilized (as measured by upside production flexibility). This ratio is an important sustainability metric that is unique to DoD supply chain management.

Ideally, the system that produces these metrics will have a "filter" or "drilldown" capability for the following elements (if applicable):

- Supply source (e.g., inventory control point [ICP], retail supply activity)
- Customer (e.g., military service, geographical area, force structure)
- Weapon system
- Type of item (e.g., stocked, prime vendor, planned direct vendor delivery [DVD], nonstocked)
- Commodity
- Issue priority (for perfect order fulfillment)
- Mission essentiality code (for perfect order fulfillment).

[6] In addition to NMC rates, DoD uses several other equipment readiness indicators, including mission-capable (MC), fully mission-capable (FMC), and partially mission-capable (PMC), that apply to all systems or equipment except ships and submarines. FMC and PMC constitute MC. PMC may consist of PMC–supply (PMCS) and PMC–maintenance (PMCM).

RECOMMENDED FUNCTIONAL PERFORMANCE MEASURES

Chapter 5 presents a series of source, maintain, deliver, and plan functional metrics of interest to ADUSD(L)MDM that can be used as diagnostic metrics for the enterprise level. Suggested diagnostic measures for the functional metrics are discussed in Appendix D.

REPORT FORMAT

The remainder of this report is organized as follows:

- *Chapter 2* describes current DoD performance measures used and explains why they are not adequate to measure total supply chain performance.
- *Chapter 3* discusses the performance measurement framework used for our analysis.
- *Chapter 4* presents information about each enterprise measure, potential data sources, and barriers to implementation.
- *Chapter 5* identifies functional performance measures for ADUSD(L)MDM.
- *Appendix A* presents an overview of the SCOR model.
- *Appendix B* describes how the SCOR model can be adapted to the DoD supply chain.
- *Appendix C* presents a summary of the enterprise measures used by OSD, the military services, and DLA.
- *Appendix D* contains a list of suggested process performance measures that are diagnostic to the functional metrics.
- *Appendix E* contains definitions of the recommended performance measures.
- *Appendix F* is a list of abbreviations used in this report.

Chapter 2
Current DoD Supply Chain Performance Measures

BACKGROUND

Two landmark reforms of the 1990s—the Chief Financial Officers Act of 1990 and the Government Performance and Results Act (GPRA) of 1993—established clear accountability of federal agencies for their performance. With these two laws, Congress imposed a new and more businesslike framework for management and accountability. In addition, GPRA created requirements for agencies to generate the information congressional and executive branch decision-makers need for improving government performance and reducing costs.[1]

Because of the legislation and other factors, government agencies are tasked to run their affairs in a more business-like manner. As a result, a balanced set of DoD supply chain management performance is critically needed.

MEASURES

Government Performance and Results Act

The DoD GPRA Performance Plan for Fiscal Year (FY) 2000 lists the following four supply chain-related performance measures and sets goals for improvement:

- *Logistics response time (LRT) (days).* This metric depicts the average time it takes to complete a customer's order—from order creation to order receipt. This metric is a valuable supply chain measure; however, it lacks a sense of "on-time" delivery. To be effective, a metric needs to represent the percent of time that customers receive their materiel by the required date.

- *Materiel asset visibility and accessibility (percent).* This metric represents the percent of items that have achieved total asset visibility (TAV). Real-time visibility of all supply chain resources is essential. *However, this metric does not measure supply chain performance.* TAV can be fully implemented and not result in supply chain improvement if the information is not properly used. Similar to electronic data interchange (EDI), real-time visibility is an enabling technology. If supply chain managers use

[1] U.S. General Accounting Office, *Executive Guide, Effectively Implementing the Government Performance and Results Act,* GAO/GGD-96-118, June 1996.

information to make better decisions, supply chain performance will improve (similar to LRT).

- *Reduction of supply inventory (value).* DoD has implemented several programs to reduce its inventory. This metric measures the military services' progress toward inventory reduction goals. Post-Cold War inventories were too high and needed to be reduced; however, managers cannot simply consider the value of the inventory and determine if it is good or bad. Effective supply chain metrics measure the *productivity* of inventory investment. Managers also need performance measures that can indicate if customer satisfaction or readiness has declined because of inadequate inventory.

- *Purchase card micropurchases (percent).* This metric is similar to TAV in that it measures the implementation of a program or project. However, measuring the implementation of one initiative does not place overall supply chain performance in an adequate context. Enterprise supply chain metrics should measure how well the supply chain performs. Measuring the implementation of improvement initiatives should be at low levels of a measurement framework to diagnose problems that are detected at the enterprise level.

Other Sources

OSD uses the supply chain performance measures for secondary items provided by two main sources: the Materiel and Distribution Management Annual Fact Book and DoD Supply Executive Information Management System.[2] Appendix C lists 36 executive-level metrics maintained in these two sources. The following measures are examples:

- *Wholesale supply management cost of operations.* Similar to the metric for inventory reduction, this metric depicts supply management costs as an *absolute value* rather than a ratio. Therefore, it is a measure of size and scale and not of performance. If presented as a percent of a related factor (such as total sales), it would be more meaningful. Although the measure's title includes "cost" and implies actual expenditures, the basis of the metric is budgeted cost. In general, DoD should use execution financial data to measure performance (unless it is measuring adherence to plans).

- *Wholesale inventory turnover.* A measurement of inventory turns is a key supply chain performance metric because it measures inventory productivity.

[2] Both sources are available on the Internet at http://www.acq.osd.mil/log/mdm/exinfo.htm.

- *Wholesale inventory requirements levels.* This metric indicates the DoD average (in days) of safety level, administrative lead-times, production lead-times, and repair cycle times. They are useful measures because they express the level of inventory in days. A goal of supply chain management is to reduce cycle times by "replacing inventory with information" that can be used to make better decisions.

- *Stock availability for wholesale stocked items.* Stock availability, or fill rate, is also a key performance measure. It represents the percent of stocked item requisitions that are filled immediately and is an important indicator of customer satisfaction. When this metric is used with a cost metric (e.g., inventory turns), managers can quickly evaluate the productivity of their investments in inventory. However, because this metric measures only *wholesale* availability, it does not provide an integrated supply chain perspective. Many customer orders are satisfied from DoD inventory levels *below* wholesale.

CONCLUSIONS

Although many current metrics provide useful information, they do not provide senior managers with a sense of how well the supply chain is performing.

- They do not measure *total supply chain performance*. Many metrics measure only wholesale performance. Others simply measure the implementation of an initiative without any link to the performance metrics that should indicate the resulting supply chain improvement.

- They are *not linked or correlated* to one another so managers can consider important supply chain relationships. For example, reduced inventory may not be beneficial if readiness rates are declining.

In the next chapters we discuss a measurement framework that can provide DoD supply chain managers with a balanced, linked set of performance measures.

Chapter 3
Performance Measures Framework

In this chapter we discuss

- the definition of performance measures,
- the importance of supply chain performance measurement,
- a performance measures pyramid framework,
- the SCOR model, and
- the balanced scorecard methodology.

DEFINITION OF PERFORMANCE MEASURE

Simply stated, a *performance measure* is a value or characteristic to measure output or outcome.[1] Table 3-1 presents terms defined by OMB Circular No. A-11 that relate performance measures to strategic goals and objectives.

Table 3-1. Performance Measurement Definitions

Term	Definition
General objective	Objectives are paired in a strategic plan with a general goal and are used to help assess if a general goal was or is being achieved; an objective usually describes a level of achievement more specific than a general goal
Outcome goal	A description of the intended result, effect, or consequence that will occur from carrying out a program or activity
Output goal	A description of the level of activity or effort that will be produced or provided during a period or by a date, including a description of the characteristics and attributes (e.g., timeliness) established as standards for conducting the activity or effort
Performance goal	A target level of performance expressed as a tangible, measurable objective to compare to actual achievement, including a goal expressed as a quantitative standard, value, or rate; this goal is included in the annual performance plan and can be an outcome or output goal
Performance indicator	A value or characteristic that measures output or outcome; performance indicators are associated with performance goals in the annual performance plan
Performance measure	A performance goal or indicator

[1] Office of Management and Budget, *Preparation and Submission of Budget Estimates*, OMB Circular No. A-11, July 1, 1998, p. 290.

The overriding objective of the DoD logistics system is to provide responsive and cost-effective support to ensure readiness and sustainability for the total force in peacetime and war. An effective and efficient supply chain is an important ingredient to overall success.

SUPPLY CHAIN MANAGEMENT PERFORMANCE

Chapter 1 presents the definition of *supply chain management.*[2] In addition, the Council of Logistics Management defines *logistics* as the "part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements."[3]

Recent studies indicate that supply chain performance affects more than 85 percent of a manufacturer's costs and a large percent of its revenues.[4] Monitoring this performance through measurements is, therefore, practical and can help to identify optimization opportunities. Superior performers are reengineering their supply chains to decrease costs, improve customer satisfaction, and increase profits. Effective reengineering requires an understanding of the supply chain processes and their relationships. This understanding permits the development of a performance scorecard and the setting of improvement goals.

PERFORMANCE MEASURES PYRAMID

Figure 3-1 shows three levels of DoD performance measure users. The top level of the pyramid is the enterprise level (i.e., the primary focus of this report). In our framework the DUSD(L) is this level. The next level of the pyramid is the functional level (e.g., supply, maintenance, and transportation). The last level of the pyramid is the process level.

The enterprise metrics measure the overall effectiveness of the supply chain. In this architecture, the metrics are linked. The metrics selected for the enterprise level typically are cross-functional and measure overall performance. The functional metrics are linked to at least one enterprise metric and measure a major function's performance. The process (e.g., warehousing, requirements planning) metrics are related to one or more functional metrics and are diagnostic in nature.

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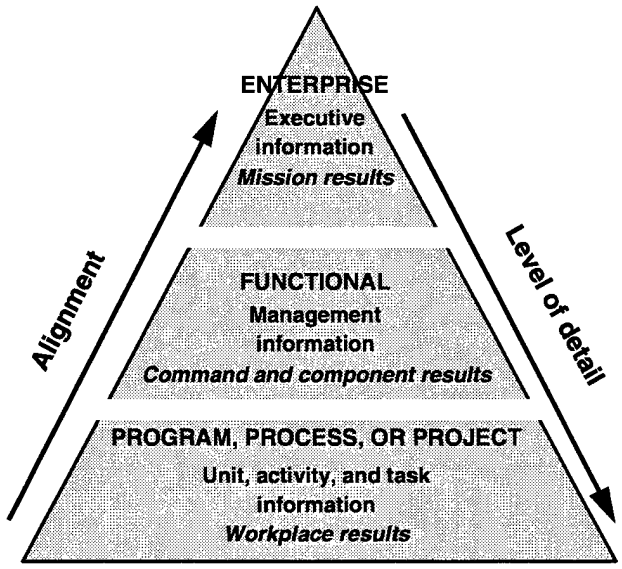
[2] Supply Chain Council, *Supply Chain Operations Reference Model Concept Development Workshop*, 1998.

[3] Council of Logistics Management, http://www.clm1.org, accessed 22 March 1999.

[4] Supply Chain Council, *Supply Chain Operations Reference Model Concept Development Workshop*, 1998.

Figure 3-1. Performance Measurement Users



SUPPLY CHAIN OPERATIONS REFERENCE MODEL

One way to understand a supply chain is to use a process model. The Supply Chain Council created the SCOR model as a way for companies to communicate. It is a framework for examining a supply chain in detail, defining and categorizing the processes that make up the supply chain, assigning metrics to the processes, and reviewing comparable benchmarks. More than 400 companies use the SCOR model to understand and improve their supply chains. The companies include aerospace and defense manufacturers, large consumer product manufacturers, and third-party logistics providers. The SCOR model is the only supply chain framework that we found that links performance measures, best practices, and software requirements to a detailed business process model.

Figure 3-2 shows that the SCOR model's supply chain is composed of four management processes—plan, source, make, and deliver—known as level 1 processes. (Table 3-2 defines the processes.) Each link in the supply chain consists of a level 1 process.

Figure 3-2. SCOR Model Supply Chain

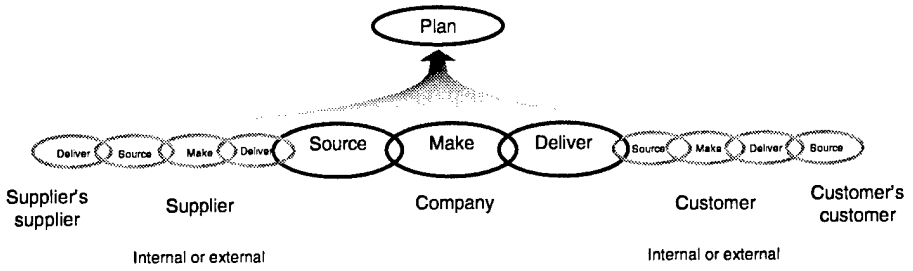


Table 3-2. Definitions of Functions

Function	Definition
Plan	Processes that balance aggregate demand and supply for developing the best course of action that meets established business rules
Source	Processes that procure goods and services for meeting planned or actual demand
Make	Processes that transform goods to a finished state for meeting planned or actual demand
Deliver	Processes that provide finished goods and services, including order management, transportation management, and warehouse management, for meeting planned or actual demand

The SCOR model continues to two more levels of processes and subprocesses. The model recommends performance measures for each SCOR process (see Appendix A). By implementing the SCOR model, DoD would be able to

- communicate with current and potential vendors using common terminology and standard descriptions;
- use the model as a planning and forecasting tool;
- leverage metrics and benchmarking to determine performance goals, set priorities, and quantify the benefits of a process change;
- link functional and process metrics to enterprise performance in a structured way;
- understand the best practices to obtain the best performance;

- understand supply chain management and evaluate performance; and
- identify the software tools best suited for DoD processes.

The SCOR model is widely accepted and applied in industry and may be adopted by the American National Standards Institute as a standard supply chain process model. As a result, we conclude that DoD should use the SCOR model's performance measures when practical and supplemented with additional metrics as needed.

BALANCED SCORECARD METHODOLOGY

To be consistent with the *Logistics Functional Requirements Guide*[5] and the SCOR model, we selected the "balanced scorecard" methodology for developing our recommended set of performance measures.[6] This methodology is widely accepted for developing performance measures because it balances past performance with the "drivers of future financial and competitive performance."[7] The balanced scorecard approach requires that the scorecard results be balanced for external and internal, financial and nonfinancial, and short-term and long-term perspectives. We balanced the metrics for the three levels of the pyramid using the following perspectives:

- Customer satisfaction (external)
- Supply chain costs (internal)
- Readiness and sustainability (external).[8]

Process metrics diagnose process results (internal and short-term). Functional metrics measure the ability of the process results to satisfy customer satisfaction, cost, and readiness requirements (external and long-term). We maintain this balance at the enterprise level through the parent and child relationship between enterprise and functional metrics.

SUMMARY

By combining the best elements of several structures, we developed a hybrid performance measurement framework ideally suited for the DoD supply chain. We

[5] Department of Defense, Deputy Under Secretary of Defense (Logistics), *Logistics Functional Requirements Guide*, Logistics Management Institute, McLean, VA, August 1998, p. 5-16.

[6] Robert S. Kaplan and David P. Norton, "The Balanced Scorecard—Measures That Drive Performance," *Harvard Business Review*, Vol. 70, No. 2, January–February 1992.

[7] Robert S. Kaplan and David P. Norton, *The Balanced Scorecard—Translating Strategy into Action,* Boston: Harvard Business School Press, 1996, p. 8.

[8] We excluded human relations and training perspectives in our modified adaptation of the balanced scorecard for DoD logistics.

used the three levels of linked metrics (enterprise, functional, and process) recommended by the *Logistics Functional Requirements Guide*. We chose the SCOR processes of plan, source, make (maintain), and deliver for the supply chain functions and processes to monitor. Finally, we selected three perspectives (customer satisfaction, cost, and readiness and sustainability) to build the balanced scorecard. The remainder of this report presents the recommended DoD supply chain scorecard.

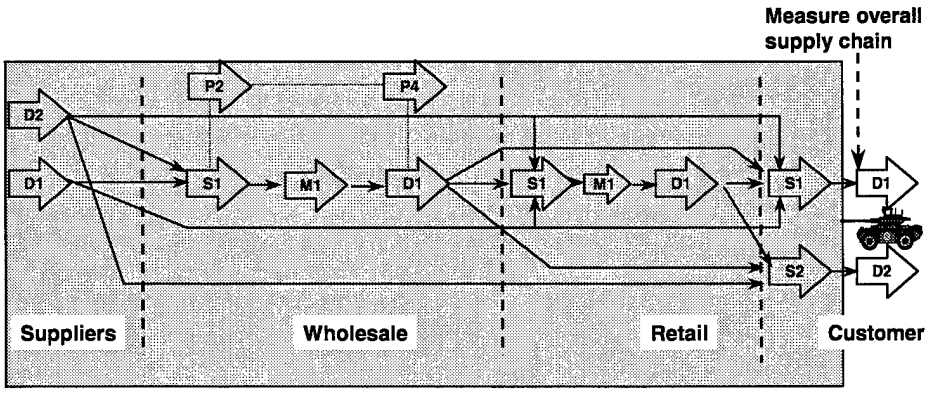
Chapter 4
Enterprise Performance Measures

BACKGROUND

The enterprise performance measures discussed in this chapter are designed to measure the efficiency and effectiveness of the DoD supply chain. To identify the relevant performance measures for DoD, we use the SCOR model methodology for graphically depicting a supply chain. Figure 4-1 presents a SCOR process diagram for DoD. Customers order materiel from the supply chain (the gray box in Figure 4-1), and orders are delivered. Customer orders can be grouped in the following two categories:

- *Single line item.* "Single line item" requisitions or issue requests prepared by a customer (e.g., mechanic for a weapon system) that are
  - Military Standard Requisition and Issue Procedures documents or
  - documents and transactions (e.g., manually prepared issue request documents, transactions generated by a maintenance application for submission to a supply system) unique to a military service.
- *Job order.* A list of materiel (several line items) to complete a job (e.g., a bill of materiel [BOM] for repairing a damaged or failed weapon system).

Figure 4-1. Supply Chain Performance Measurement

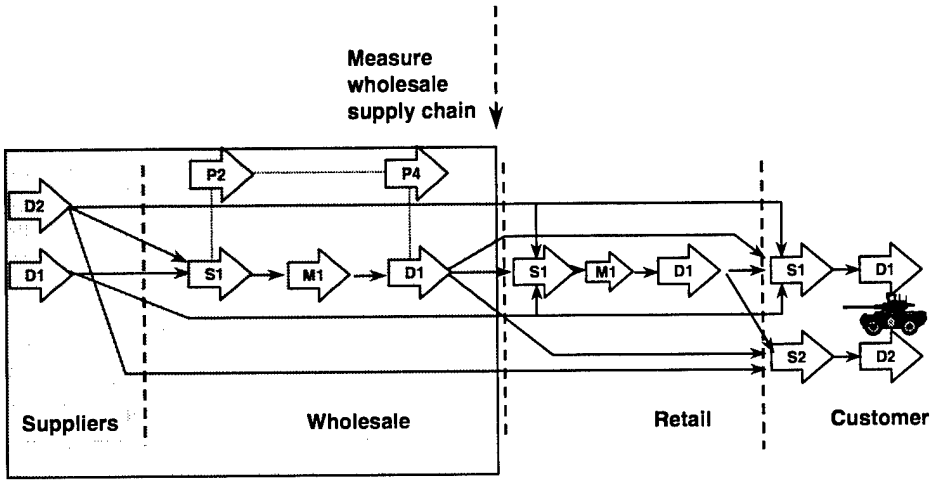


The first category is consistent with traditional DoD supply chain performance measures (e.g., fill rate, LRT). The supply system of the customer receiving the orders can prepare the measures. The second category produces measures that are meaningful to maintenance personnel (they cannot complete a job until all

required materiel is received) and are prepared by maintenance systems that open and close jobs.

Figure 4-2 shows the traditional DoD enterprise measurement nodes (for only wholesale performance) for several measures, including LRT. Measuring the responsiveness of only the wholesale system can be misleading because most orders are requisitions from a retail level for replenishing stock (i.e., repositioning inventory in the supply chain) and do not delay a repair or maintenance action.

Figure 4-2. Wholesale Performance Measurement



SCOR PERFORMANCE MEASURES

Table 4-1 shows the SCOR level 1, or enterprise-level, performance measures. The SCOR model includes a standard set of performance measures. We consider some metrics on the SCOR level 1 scorecard to be more applicable for the functional level. For example, delivery performance (to request date), fill rate, and order fulfillment lead-time focus on aspects of the deliver function. In addition, delivery performance is a component of the perfect order fulfillment rate. Order fulfillment lead-time (deliver) is a segment of supply chain response time.

Some metrics do not apply to the defense environment very well. We do not consider warranty costs, value-added productivity, and cash-to-cash cycle time as useful measures of the DoD supply chain. Warranty costs are useful for manufacturers as measures of quality and customer satisfaction; they are not applicable to DoD unless depot maintenance activities offer warranties on secondary item repairs. Cash-to-cash cycle time measures cash flow and is very sensitive to accounts receivable (and the quickness that customers pay their bills). Because DoD customers do not pay directly for an invoice (i.e., internal fund transfers), this metric is not useful. We exclude inventory days of supply because it is the inverse of inventory turns (included in our recommended scorecard).

Table 4-1. SCOR Enterprise Performance Measures

SCOR level 1 supply chain management metrics	Customer-facing		Internal-facing	
	Delivery performance quality	Flexibility and responsiveness	Cost	Assets
Delivery performance	X			
Fill rate (make-to-stock)	X			
Order fulfillment lead-time	X			
Perfect order fulfillment	X			
Supply chain response time		X		
Production flexibility		X		
Total supply chain management cost			X	
Value-added productivity			X	
Warranty cost or returns processing cost			X	
Cash-to-cash cycle time				X
Inventory days of supply				X
Asset turns				X

However, most SCOR measures are very applicable. We recommend that DoD adopt the following measures to provide customer service, cost, and readiness and sustainability perspectives.

Customer Service Perspective

We recommend DoD adopt the following SCOR customer service performance measures.

PERFECT ORDER FULFILLMENT

Perfect order fulfillment is the ratio of perfectly satisfied orders to total orders. A perfect order is an order that meets the following standards:

- Delivered complete; all items delivered in the quantities requested
- Delivered on time, using the customer's definition of on-time delivery
- Complete and accurate documentation (including packing slips, bills of lading, and invoices) to support the order
- Delivered in perfect condition and in the correct configuration to be used by the customer, faultlessly installed (as applicable).

Perfect order fulfillment rate should be measured from the customer's perspective (Figure 4-1) using both categories (single line items and job orders). The customer's required delivery date or Uniform Materiel Movement and Issue Priority System time standards should be used.[1] The same drilldown capability as order fulfillment lead-time should exist.

Implementation of this measurement may be difficult if accurate documentation and condition of the materiel are needed before customers' systems can accurately record the conditions. However, time and quantity standards should always be included.

SUPPLY CHAIN RESPONSE TIME

Supply chain response is expressed as the total length of the supply chain, measured in days (encompassing plan, source, maintain, and deliver cycle times). For DoD it is the sum of the average *source* and *order* cycle times.[2]

Source Cycle Time

Source cycle time is the cumulative lead-time (including administrative lead-time [ALT], supplier lead-time, receiving time, and handling time) from demand identification until the materiel is available. In the DoD supply chain, source cycle time for reparables is the average dollar-weighted time to obtain assets from new procurement (ALT and production lead-time [PLT]) and repair (retrograde time and repair cycle time, or RCT). Consumable items use only ALT and PLT (see Figure 4-3).

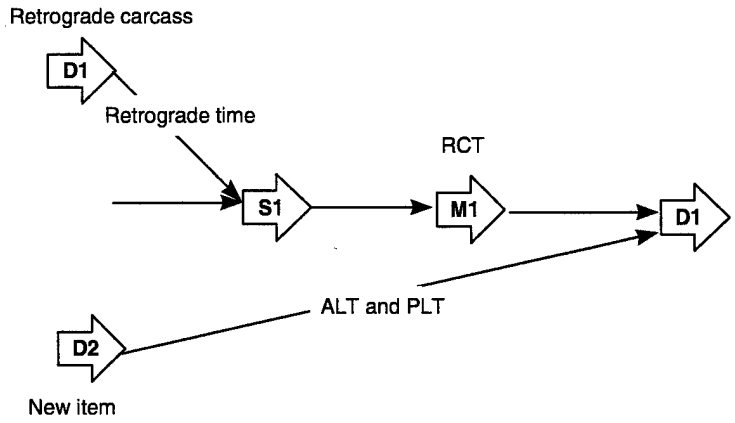
Source cycle-time metrics should have a drilldown, or filtering, capability for the following elements:

- Military service
- ICP
- Reparable and consumable items
- Weapon system (for unique items)
- Commodity
- Essentiality.

[1] Department of Defense, *DoD Materiel Management Regulation*, DoD 4140.1-R, May 1998, Appendix 8.

[2] Planning time is not considered relevant as an additive factor. Elements of planning time are already included in administrative lead-time. Maintain is also included in our definition of source cycle time because repair is a primary source of supply for serviceable reparables.

Figure 4-3. Source Cycle Time



Note: This figure uses SCOR level 2 processes and supply chain threads to illustrate source cycle time. Appendix A explains the processes and threads. D1 = deliver stocked product; D2 = deliver make-to-order product; M1 = make to stock; S1 = source stocked materiel.

Order Fulfillment Lead-Time

Order fulfillment lead-time is the average lead-time from customer signature and authorization to order receipt, order receipt to order entry complete, order entry complete to order ready for shipment, and order ready for shipment to customer receipt of order. In DoD this time is referred to as LRT and includes several segments measured separately. The Logistics Metrics Analysis Reporting System (LMARS) produces LRT metrics (for wholesale only).

Ideally, order fulfillment lead-time is measured from the final customer's perspective (Figure 4-1). Metrics should be produced for both categories of orders (single line item and job order).

- The order fulfillment lead-time for a single line item is a measurement taken from the supply or procurement system that is the point of entry for the order or issue request. (Examples of systems are the Navy's Shipboard Nontactical Automated Data Processing [ADP] Program, Shipboard Uniform ADP System, and Uniform ADP System; Army's Unit Level Logistics System; Air Force's Standard Base Supply System; and Marine Corps' Supported Activities Supply System.) This measurement also includes purchase card transactions.

- The order fulfillment lead-time for job orders is a measurement taken from the maintenance system that is the point of entry for scheduling and recording the maintenance action. An order fulfillment lead-time is computed for the bill and is the time to fill the item that takes the longest time to fill (because the job cannot be completed until all items are received).

Order fulfillment lead-time metrics should have a drilldown, or filtering, capability for the following elements:

- Ordering military service
- Ordering theater
- Ordering unit
- Issue priority group
- Source of supply (e.g., ICP, retail supply)
- Reparable and consumable items
- Type of item (e.g., stocked, planned DVD, unplanned DVD, local purchase, outsource product support)
- Weapon system (for unique items)
- Commodity
- Essentiality.

The existing LRT metrics for wholesale should continue as a measure of wholesale support; however, they are not measures of the responsiveness of the entire DoD supply chain.

Cost Perspective

We recommend DoD adopt the following SCOR cost performance measures.

Percent Change in Customer Price Compared to Inflation

Customer price (standard price) is represented by a market basket of secondary items similar to the basket of goods in the CPI. The market basket should be updated periodically to reflect changes in weapon system design because DoD replaces many secondary items with new technological versions rather than continuing to use the original versions. This metric should be produced every year (after new standard prices are set), and the price of the market basket should be compared to inflation.

SUPPLY CHAIN MANAGEMENT COSTS AS A PERCENT OF SALES AT STANDARD PRICE

Supply chain management costs are supply chain-related management information system (MIS), supply chain planning, inventory carrying, materiel acquisition, and order management costs.

- MIS costs are the costs of developing and operating logistics information systems.
- Supply chain planning costs are the costs associated with forecasting, developing finished goods or end item inventory plans, and coordinating the demand and supply process throughout the supply chain, including all channels.
- Inventory carrying costs are the costs of shrinkage, insurance, and taxes; obsolescence for raw materiel, work in progress, and finished goods inventory; channel obsolescence; and field sample obsolescence.
- Materiel acquisition costs are the costs of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and storage, inspection, materiel process engineering, and tooling.
- Order management costs are the costs of creating customer orders; order entry and maintenance costs; contract, program, and channel management costs; installation planning costs; order fulfillment costs; distribution costs; outbound transportation costs; and customer invoicing and accounting costs.

Ideally, this metric is measured from the customer's perspective (Figure 4-1); revenue is the value of materiel moving from the gray box to a customer, and supply chain costs are the costs of operating the gray box. Because costs and sales are difficult to capture at this level, wholesale supply chain costs as a percent of wholesale revenue should be used as a measure of wholesale support; however, this measure does not reflect the cost of the entire DoD supply chain.

Until the DoD logistics community implements activity-based costing (ABC), allocating supply chain management costs to the cost categories discussed is not likely. However, total costs and revenues can be collected (because they are elements for setting cost recovery rates) at wholesale and retail levels.

INVENTORY TURNS

Inventory turns are computed by dividing the total sales (at last acquisition price) by the value of inventory (at last acquisition price), excluding war reserves. One major goal of supply chain improvement projects is to optimize inventory levels and thereby increase inventory turns. Inventory turns should be measured from the

customer's perspective (Figure 4-1) using the standard price of materiel moving from the gray box to the customer and the value of inventory in the box. Wholesale inventory turns can be used as a measure of wholesale efficiency; however, this metric does not measure the efficiency of the DoD supply chain.

Readiness and Sustainability Perspectives

We recommend DoD adopt the following SCOR performance measures to provide readiness and sustainability perspectives.

UPSIDE PRODUCTION FLEXIBILITY

The SCOR model defines upside production flexibility as the number of days to achieve an unplanned, sustainable 20 percent increase in production. We define upside production flexibility to be the number of days to achieve a sustainable posture for executing the national military strategy of fighting two MTWs. Ideally, the metric is computed for each item managed and used for computing war reserve requirements.[3]

We believe that the most promising source for this metric is the DLA Integrated Consumable Item Support (ICIS) model. ICIS receives peacetime and wartime demand rates, peacetime ALTs and PLTs, peacetime asset balances, and industrial preparedness planning factors. One metric that ICIS measures is the projected response time by item. The difference between the peacetime response time and the wartime response time can be used to approximate upside production flexibility. However, response time estimates are more relevant if industrial preparedness planning has been performed and contract surge capabilities are used as inputs to the model. If ICIS were expanded to include service-managed reparables as requested by the Joint Chiefs of Staff, ICIS would be able to provide this metric for all items.

Upside production flexibility metrics should have a drilldown, or filtering, capability for the following elements:

- Military service
- ICP
- Reparable and consumable items
- Weapon system

[3] For example, if 60 days are needed to increase production to the two-MTW demand rate, 60 days of war reserves are needed to ensure an uninterrupted supply.

- Commodity
- Essentiality.

DoD Performance Measures

We recommend that DoD use three additional measures not included in the SCOR model. DoD needs a cost perspective to support a weapon system (rather than the order focus of the SCOR model). As a result, we recommend that DoD measure weapon system logistics costs as a percent of the acquisition price. DoD also needs additional metrics to measure its supply chain's ability to support a two-MTW scenario. Therefore, DoD needs performance metrics in peacetime that measure wartime readiness and sustainability because the wartime demand is much higher than the demand of peacetime operations.

Cost Perspective: Weapon System Logistics Costs as a Percent of Acquisition Price

This metric is computed annually for selected weapon systems. It is useful to determine the benefits of logistics engineering changes and compare changes over time. The total logistics costs by weapon system consist of the following:

- Total sales of secondary items (at standard price) for the weapon system
- Total depot overhaul and intermediate-level end item repair costs (both materiel and labor)
- Total organizational-level maintenance labor.

The acquisition price of the weapon system would be adjusted for inflation as well as modifications and upgrades.

Readiness and Sustainability Perspective

We recommend that DoD use the following two additional readiness and sustainability performance measures.

Weapon System NMC Rates

FMC rates are equipment readiness metrics that the military services use for weapon systems. The inverse of an FMC rate is the NMC rate. An item of equipment can be NMC for two reasons: maintenance or supply.

NMC rates should be produced for key weapon systems and used with the other enterprise performance measures that can be filtered by weapon system (e.g., perfect order fulfillment rate and supply chain response time). The Army Readiness

Integrated Data Base, a classified system, contains NMC rates. The other military services have similar reporting systems that can be used to obtain these rates.

WAR RESERVE RATIO

The *DoD Materiel Management Regulation* states that "the DoD components shall acquire and maintain, in peacetime, war materiel inventories sufficient to sustain operations, as prescribed in Defense Planning Guidance scenarios, for committed forces."[4] The *DoD Secondary Item Stratification Manual* requires that the military services and DLA stratify war reserve requirements and assets into retail and wholesale protectable and unprotectable categories.[5] The war reserve ratio is the ratio of war reserve on-hand assets to the war reserve requirements. A drilldown capability should include the following elements:

- Protectable and unprotectable war reserves
- Military service
- ICP
- Reparable and consumable items
- Weapon system
- Commodity.

[4] Department of Defense, *DoD Materiel Management Regulation*, DoD 4140.1-R, May 1998, p. 52. Only the Army currently computes a war reserve requirement.

[5] Department of Defense, *DoD Secondary Item Stratification Manual*, DoD 4140.1-M, June 1995.

IMPLEMENTATION

Table 4-2 lists the recommended performance measures and our assessment of their degree of implementation difficulty.

Table 4-2. Recommended Enterprise Performance Measures

Recommended key supply chain management metrics	Perspective			Implementation degree of difficulty
	Customer satisfaction	Cost	Readiness and sustainability	
Perfect order fulfillment	X			For wholesale, low for date and quantity, and moderate for quality and documentation High for retail
Supply chain response time	X			Low for wholesale for source and order fulfillment lead-times High for retail
Percent change in customer price compared to inflation	X	X		Moderate (military services and DLA need to select items for the market basket and conduct a review each year; Defense Logistics Information Service [DLIS] should to be able to produce the index easily)
Supply chain management costs as a percent of sales (at standard price)		X		Low for wholesale High for retail
Weapon system logistics costs as a percent of the acquisition price		X		Moderate (cost data for all levels except the organizational level should be available from the Visibility and Management of Operating and Support Costs System of each military service)
Inventory turns		X		Low for wholesale High for retail
Upside production flexibility			X	High
Weapon system NMC rates			X	Low
War reserve ratio			X	Low

SUMMARY

Based on our review of commercial and DoD supply chain performance measures, we recommend that the measures presented in this chapter be adopted at the enterprise level.

Chapter 5
Functional Performance Measures for Materiel and Distribution Management

INTRODUCTION

This chapter presents the supply chain functional performance measures that we recommend as diagnostic to the enterprise metrics. We define the supply chain functions to be synonymous with the SCOR model level 1 processes of plan, source, make (changed to maintain for our application), and deliver. Appendix E contains a definition of each performance measure.

PLAN

Plan, one of the four critical functions for managing the supply chain, is the act of balancing supply and demand (i.e., setting the budget and obligation authority to procure assets to meet anticipated requirements). Processes of the plan function include demand forecasting, aggregating and prioritizing requirements, and preparing budgets. In DoD, the processes generally are under the auspices of item managers (the act of procuring items is part of the source function). The plan function is the beginning of the logistics chain and affects all subsequent activities; therefore, monitoring this function closely is critical for the logistics chain's proper performance.

Functional Metrics

Table 5-1 contains a comprehensive list of plan functional metrics that can measure the effect of planning on the DoD logistics chain.

The deficit ratio measures the degree of imbalance between assets and requirements. The supply chain planning cost aggregates labor, overhead, systems, and other costs associated with assets and requirements. The inventory holding cost measures the cost of holding inventory. The Defense Working Capital Fund (DWCF) net operating result measures the difference between the fund's income and expenses and is the complement to the deficit ratio. When assets exceed requirements, the overage measures the excess. The percent of national stock numbers (NSNs) with two-MTW planning factors measures the thoroughness of DoD's planning for a worst-case contingency. The percent of NSNs with war reserve requirements defined is similar to the previous metric, but examines the war reserve aspect of readiness. The ratio of on-hand to funded war reserves and the

ratio of funded war reserves to war reserve requirements measure DoD's war reserve readiness.

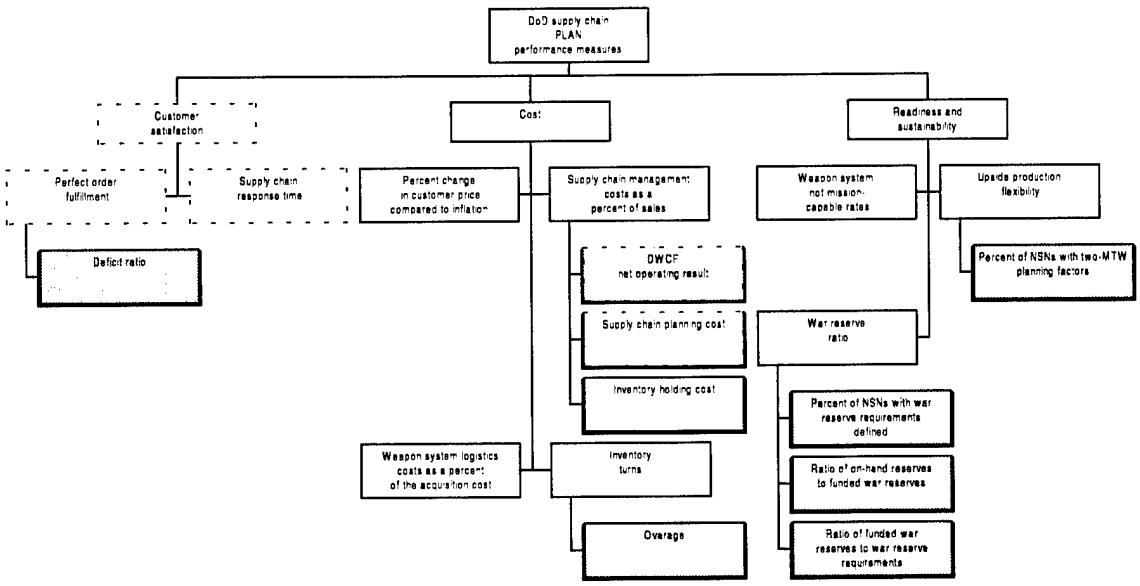
Table 5-1. Plan Functional Metrics

Metric	Customer satisfaction	Cost	Readiness and sustainability
Deficit ratio	X		X
Supply chain planning cost		X	
Inventory holding cost		X	
Defense Working Capital Fund net operating result		X	
Overage		X	
Percent of national stock numbers with two-MTW planning factors			X
Percent of national stock numbers with war reserve requirements defined			X
Ratio of on-hand to funded war reserves			X
Ratio of funded war reserves to war reserve requirements			X

Enterprise Relationship

Each enterprise metric requires a set of functional metrics to provide an adequate diagnostic drilldown capability (i.e., when a problem surfaces at the enterprise level, the functional metric isolates the source of the problem). Figure 5-1 depicts the relationship between plan enterprise and functional metrics.

Figure 5-1. Functional Metrics for Plan



The plan function plays a role in most enterprise metrics. For each enterprise metric, the contribution of the plan function is described, and a metric for measuring the contribution is presented.

- *Perfect order fulfillment.* When items are not available because of poor planning, the perfect order fulfillment percent declines. The deficit ratio is used to assess if the supply pipeline has enough assets. This metric describes the shortfall in assets.

- *Supply chain management costs as a percent of sales.* The plan metrics that relate to this enterprise metric are the supply chain planning cost, which captures the resources (e.g., labor) associated with planning; inventory holding cost, which captures the cost of holding materiel on-hand; and DWCF net operating result, which captures the financial impact of forecasting or asset matching and also measures the fund's ability to control expenses and establish prices.

- *Weapon system logistics costs as a percent of the acquisition cost.* The costs use the same diagnostic metrics as the supply chain management costs; however, they are divided among weapon systems.

- *Inventory turns.* The overage provides diagnostics into this enterprise metric. The functional metric examines the assets in the supply chain pipeline that do not support requirements in the budget cycle.

- *Weapon system NMC rates.* Mission-capable rates are influenced by the same conditions as perfect order fulfillment (i.e., when the supply pipeline does not have enough assets, this metric shows a decline). The plan contribution is as previously described.

- *War reserve ratio.* The percent of NSNs with war reserve requirements identified is a measurement of the thoroughness of war reserve planning. The ratios of on-hand to funded war reserve and funded to war reserve requirement delineate the impact of funding limitations on the war reserve position.

- *Upside production flexibility.* The plan function has the primary responsibility for computing wartime mobilization requirements. The source function is responsible for obtaining the suppliers needed to support wartime mobilization. The percent of NSNs with two-MRC planning factors measures the thoroughness of DoD planning for the worst-case contingency.

SOURCE

Source, as defined in the SCOR model, includes all activities involved with materiel acquisition and the source infrastructure. Materiel acquisition includes obtaining, receiving, inspecting, holding, and issuing materiel (to its initial storage

location). Managing the source infrastructure includes vendor certification and feedback, contracting, source quality, in-bound freight, component engineering, and initiation of vendor payments. In this framework, vendors include traditional suppliers (the source for purchasing new items) as well as maintenance depots (the source for obtaining repaired materiel).

Functional Metrics

We examined metrics, including those at the functional level, within the balanced framework of customer satisfaction, cost, and readiness and flexibility. We recommend the metrics for source in Table 5-2.

Table 5-2. Functional Metrics for Source

Functional measure	Customer satisfaction	Cost	Readiness and sustainability
Percent of perfect order fulfillment (from suppliers)	X		
Percent of change in materiel price as compared to inflation [a]		X	
Materiel acquisition costs as a percent of sales at standard price		X	
Total source cycle time			X
Surge volume as a percent of total surge volume			X
Upside production flexibility—source [b]			X

[a] Materiel price is represented by a market basket of technology, similar to the basket of goods used in the CPI. The market basket of technology reflects the DoD practice of replacing many secondary items (e.g., radar systems) with recent technological versions rather than the original versions.

[b] Upside production flexibility should be measured for the existing network of suppliers and the process of adding new suppliers. This measure indicates how quickly more materiel can be obtained from the existing supplier network and how quickly new suppliers can be added and provide materiel.

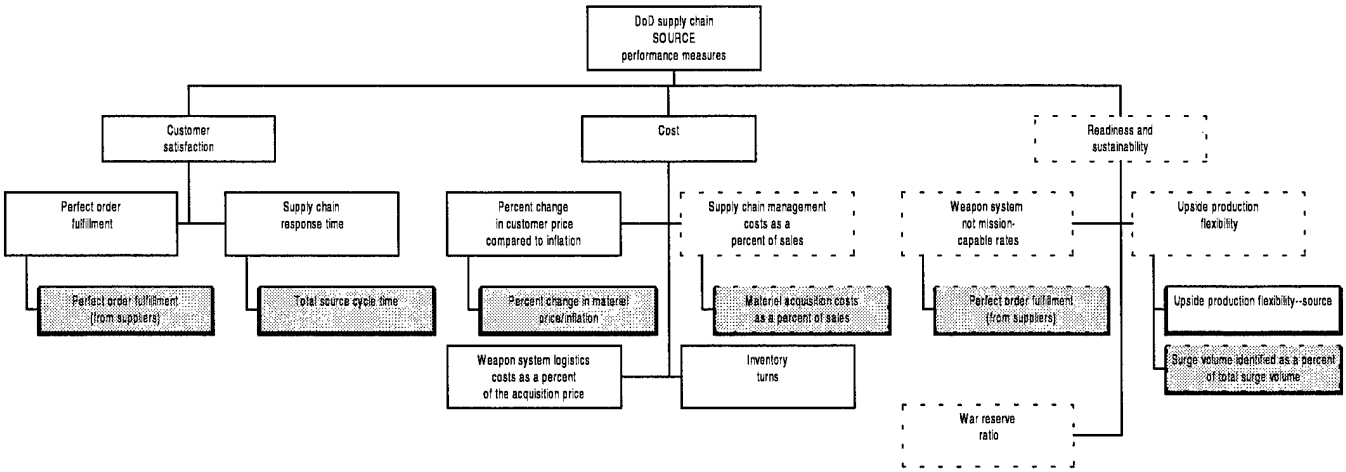
The metrics represent a balanced view of how effectively the source function is being managed in concert with DoD strategies. The overall source performance depends on managing suppliers and materiel prices, performing the management at an acceptable cost, and achieving DoD readiness requirements.

Perfect order fulfillment (from suppliers), change in materiel price as compared to inflation, and total source cycle time measure how well the source function is managing the supplier base and the price of materiel. Materiel acquisition costs as a percent of sales at standard price measures how effectively source performs. Surge volume as a percent of total surge volume and upside production flexibility—source measure how well source is meeting DoD readiness requirements.

Enterprise Relationship

As stated in Chapter 3, the metrics in the architecture are linked. Functional metrics are linked to enterprise metrics and measure the performance of the function. The link for the source functional metrics is depicted in Figure 5-2.

Figure 5-2. Source Functional Metrics



For each enterprise metric, the contribution of the source function is described, and a metric for measuring the contribution is presented.

- *Perfect order fulfillment.* Difficulty with perfect order fulfillment (from suppliers) affects perfect order fulfillment to customers.

- *Supply chain response time.* The total source cycle time is a part of the formula for supply chain response time.

- *Percent change in customer price compared to inflation.* The percent change in materiel price is part of the formula for percent change in customer price.

- *Supply chain management costs as a percent of sales.* Materiel acquisition costs as a percent of sales at standard price represent (at standard price) the source portion of the supply chain management costs.

- *Weapon system NMC rates.* Difficulty with perfect order fulfillment (from suppliers) may manifest in weapon systems that are not mission-capable because materiel is not available.

- *Upside production flexibility.* Upside production flexibility—source represents source's contribution to the overall enterprise measurement. Plan, maintain, and deliver contribute the other portions. Surge volume identified as a percent of total surge volume captures the degree that source

managers have identified and contracted with sources of supply to meet surge requirements. This metric is very important if surge requirements for an item are to be met by several suppliers with capacity restrictions.

MAINTAIN

For this report, we redefine the SCOR's make function to maintain. Maintain encompasses all processes to transform unserviceable assets to a finished state for meeting planned or actual demands. The activities include scheduling repair, issuing unserviceable carcasses and repair parts, repairing and testing, and staging and releasing repaired items to the deliver function.

Functional Metrics

For this report, we limited our analysis of the maintenance function to only functional and process measures that directly affect the supply chain's ability to fulfill customer demands. We excluded metrics related to the cost of repair operations.[1] We recommend the maintain functional metrics in Table 5-3.

Table 5-3. Functional Metrics for Maintain

Functional measure	Customer satisfaction	Cost	Readiness and sustainability
Upside production flexibility—maintain			X
Performance to customer-request date—maintain [a]	X		
Repair cycle time	X		

[a] This metric can be incorporated eventually into performance to customer-request date—source because repair is another source for serviceable assets.

Upside production flexibility for maintenance is an important metric. During wartime, the depot maintenance activities expect significant increases in repair workload. Careful planning in peacetime is necessary to ensure that the depots can respond to the surge requirement.

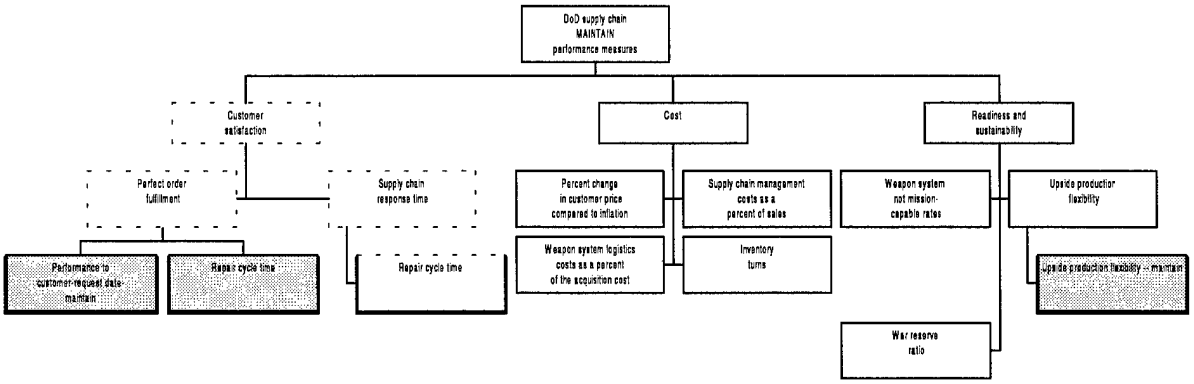
Two key metrics that impact supply's ability to fill customer orders for reparable items are performance to customer-request date and repair cycle time. The customers are the ICPs and retail supply activities that order repaired items from the maintenace depots and intermediate maintenance activities.

[1] For wholesale supply operations, the cost of repair (labor, materiel, and overhead) is reflected in the materiel price that customers pay for a serviceable asset (assuming a carcass is returned). The cost is included in the "cost of goods sold" metric. The surcharge added to this cost is synonymous to the SCOR supply chain cost metric. Although maintenance activities below the depot level are not funded in the DWCF, the same relationships should apply for capturing costs.

Enterprise Relationship

The link between the maintain functional and enterprise metrics is shown in Figure 5-3.

Figure 5-3. Maintain Functional Metrics



For each enterprise metric, the contribution of the maintain function is described, and a metric for measuring the contribution is presented.

- *Perfect order fulfillment.* Performance to customer-request date—maintain impacts the ability of the inventory control point to fulfill customer orders for reparable items. Additionally, the repair cycle time (when greater than planned) can negatively impact perfect order fulfillment.

- *Supply chain response time.* The repair cycle time is part of the formula for supply chain response time.

- *Upside production flexibility.* Upside production flexibility—maintain represents the maintain contribution to the overall measurement.

DELIVER

The deliver function in the SCOR model includes all activities associated with delivering the materiel and the deliver infrastructure. The activities include the following components: order management, warehouse management, transportation, and installation management.

Functional Metrics

After analyzing the performance measures for the deliver function and determining its applicability to the DoD framework, we recommend the metrics in Table 5-4 for deliver.

Table 5-4. Functional Metrics for Deliver

Functional measure	Customer satisfaction	Cost	Readiness and sustainability
Percent of on-time delivery	X		
Percent of correct quantity delivered	X		
Percent of defect-free delivery	X		
Percent of deliveries with correct documentation	X		
Performance to customer commit date	X		
Order management costs (as a percent of sales) [a]		X	
Order fulfillment lead-time [b]	X		
Fill rate [c]	X		X
Upside production flexibility—deliver			X

[a] For the deliver function, the costs consist of order entry, maintenance, order fulfillment, transportation, outbound freight, duties, distribution, and incoming materiel costs.

[b] Also known as deliver lead-time; defined as the average lead-times consistently achieved from customer and signature authorization to order receipt, order receipt to order entry complete, order entry complete to start build, start build to order ready for shipment, order ready for shipment to customer receipt of order, and customer receipt of order to installation complete.

[c] The percent of ship-from-stock orders shipped within 24 hours of order receipt.

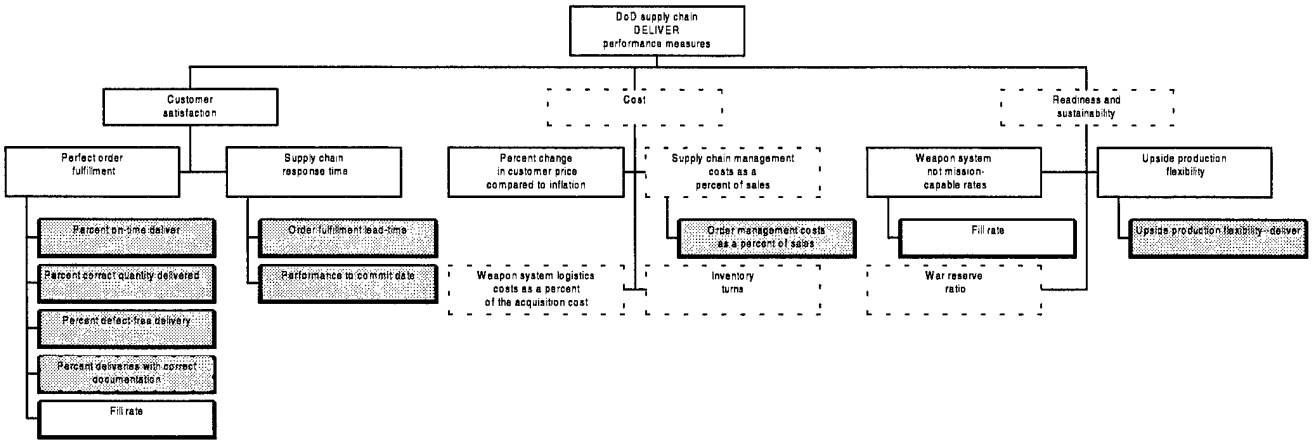
We recommend the functional metrics in Table 5-4 because they are important for providing a balance between the deliver enterprise and processes while conforming to DoD's readiness, costs, and customer needs. Deliver achievement depends on how well order, warehouse, transportation, and distribution activities are measured and performed.

The percent of on-time delivery, percent of correct quantity delivered, percent of defect-free delivery, and percent of deliveries with correct documentation are necessary because they measure how well our customer's needs are being met. Performance to customer commit date is a measure of the ability to meet delivery dates promised to customers; otherwise, customers are unable to perform their jobs when scheduled. Order management costs and order fulfillment time measure the total order costs and times to carry out an order. The fill rate measures the ability to meet a customer's immediate needs and can have an indirect effect on perfect order fulfillment. Upside production flexibility—deliver is necessary in the event of a two-MTW scenario.

Enterprise Relationship

The link between the functional and enterprise metrics is depicted in Figure 5-4.

Figure 5-4. Deliver Functional Metrics



For each enterprise metric, the contribution of the deliver function is described, and a metric for measuring the contribution is presented.

- *Perfect order fulfillment.* This metric is composed of four key functional metrics: percent of on-time delivery, percent of correct quantity delivered, percent of defect-free delivery, and percent of deliveries with correct documentation. The four components reflect the ability to provide excellent customer service. The fill rate at the functional level indirectly links to the enterprise metric. If DoD cannot fill its customer's needs in the allotted time, a perfect order does not exist.

- *Supply chain response time.* Order fulfillment lead-time (deliver lead-time) is the deliver portion of the total supply chain response time. Performance to customer commit date is also diagnostic to supply chain response time.

- *Supply chain management costs as a percent of sales (at standard price).* Order management costs are expressed as a percent of sales and represent the deliver cost portion of the supply chain.

- *Weapon system NMC rates.* If perfect order fulfillment and fill rate are not achieved, NMC rates are affected negatively.

- *Upside production flexibility.* Upside production flexibility—deliver represents the deliver portion of upside production flexibility—measurement.

SUMMARY

The functional performance measures presented in this chapter can diagnose the enterprise measures. Appendix D describes several process metrics to diagnose the functional metrics.

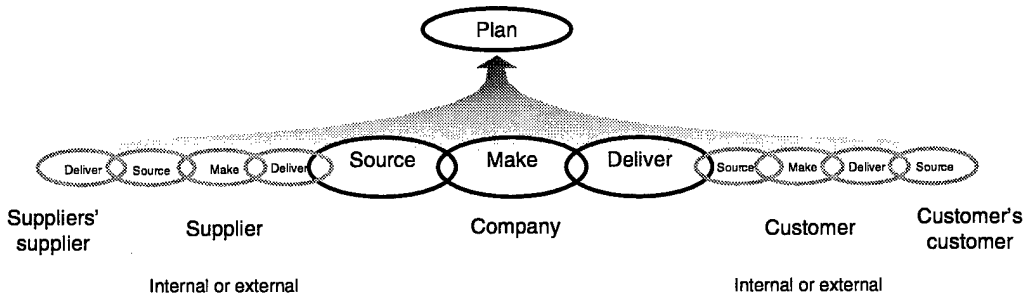
Appendix A
SCOR Model

A process model frequently is used to describe a supply chain to make it understandable. The Supply Chain Council created the SCOR model to allow companies to

- communicate using common terminology and standard descriptions;
- leverage metrics and benchmarking to determine performance goals, set priorities, and quantify the benefits of process changes;
- understand the practices yielding the best performance;
- understand the supply chain management process and evaluate overall performance; and
- identify the best software tools for their process requirements.

Figure A-1 depicts the SCOR model supply chain thread. Each link in the supply chain is made up of a SCOR level 1 process (plan, source, make, or deliver).

Figure A-1. SCOR Model Supply Chain Thread



Level 2 processes, the next level of the SCOR model, comprises the elements of the level 1 processes (Table A-1).

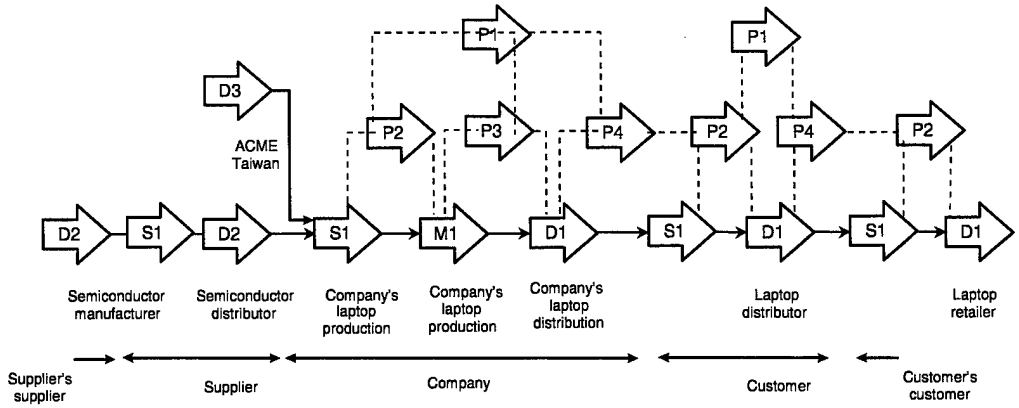
Table A-1. SCOR Level 2 Processes

L1	L2	Name	Definition
P	0	*Plan infrastructure*	
P	1	Plan supply chain	The development and establishment of courses of action that represent a projected appropriation of supply chain resources to meet supply chain requirements
P	2	Plan source	The development and establishment of courses of action that represent a projected appropriation of materiel resources to meet supply chain requirements
P	3	Plan make	The development and establishment of courses of action that represent a projected appropriation of production resources to meet production requirements
P	4	Plan deliver	The development and establishment of courses of action that represent a projected appropriation of delivery resources to meet delivery requirements
S	0	*Source infrastructure*	
S	1	Source stocked materiel	The procurement, delivery, receipt, and transfer of raw materiel and subassemblies
S	2	Source make-to-order materiel	The procurement and deliver of materiel built to a design or configured based on the requirements of a customer order
S	3	Source engineer-to-order materiel	The negotiation, procurement, and delivery of engineer-to-order assemblies that are designed and built on the requirements or specifications of a customer order or contract
M	0	*Make infrastructure*	
M	1	Make to stock	The process of manufacturing products (make-to-stock products are intended to be shipped from finished goods or "off the shelf," completed before receipt of a customer order, and produced generally in accordance with a sales forecast)
M	2	Make to order	The process of manufacturing products (make-to-order products are intended to be completed after receipt of a customer order and are built or configured only in response to a customer's order)
M	3	Engineer to order	The process of manufacturing distinct items (e.g., parts that retain their identity through the transformation process) that are intended to be completed after receipt of a customer order (although make to order includes standard products built only in response to a customer order or products configured in response to a customer order, engineer to order includes custom products designed, developed, and manufactured in response to a customer request)
D	0	*Deliver infrastructure*	
D	1	Deliver stocked product	The process of delivering a product maintained in a finished goods state before the receipt of a firm customer order
D	2	Deliver make-to-order products	The process of delivering a product manufactured, assembled, or configured from standard parts or subassemblies; manufacture, assembly, or configuration begins only after the receipt and validation of a firm customer order
D	3	Deliver engineer-to-order products	The process of delivering a product designed, manufactured, and assembled from a BOM that includes custom parts; design begins only after the receipt and validation of a firm customer order

Note: L1 = level 1; L2 = level 2.

The SCOR level 2 processes are used to display supply chain threads, such as the map example in Figure A-2.

Figure A-2. SCOR Process Map



Level 3 of SCOR divides the level 2 processes into subprocesses. Figure A-3 is an example of a SCOR level 3 process.

Figure A-3. SCOR Level 3 Subprocesses for Deliver Stocked Product

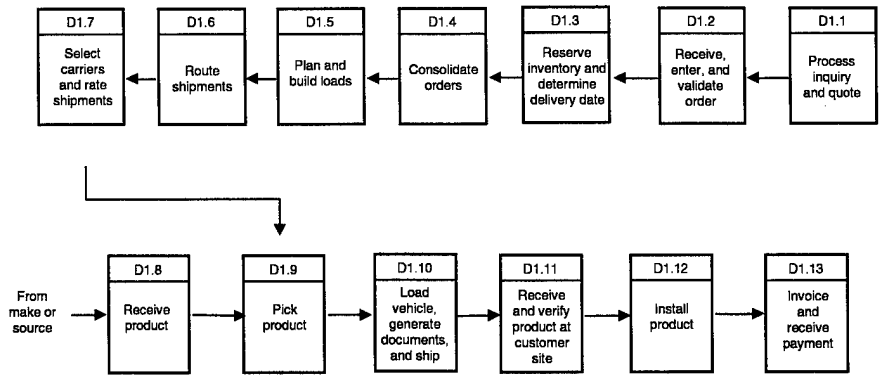


Table A-2 identifies the SCOR level 3 processes.

Table A-2. SCOR Level 3 Processes

L1	L2	L3	Name	Definition
P	1	1	Identify, prioritize, and aggregate supply chain requirements	The process of identifying, prioritizing, and considering all sources of demand, as a whole with constituent parts, in the supply chain of a product or service
P	1	2	Identify, assess, and aggregate supply chain resources	The process of identifying, prioritizing, and considering all sources of demand, as a whole with constituent parts, in the supply chain of a product or service
P	1	3	Balance supply chain resources with supply chain requirements	The process of developing a time-phased course of action that commits supply chain resources to meet supply chain requirements

Table A-2. SCOR Level 3 Processes (Continued)

L1	L2	L3	Name	Definition
P	1	4	Establish supply chain plans	The establishment of courses of action that represent a projected appropriation of supply chain resources to meet supply chain requirements
P	2	1	Identify, prioritize, and aggregate materiel requirements	The process of identifying, prioritizing, and considering all sources of demand, as a whole with constituent parts, for materiel in the supply chain of a product or service
P	2	2	Identify, assess, and aggregate materiel resources	The process of identifying, evaluating, and considering all materiel, as a whole with constituent parts, used to add value in the supply chain of a product or service
P	2	3	Balance materiel resources with materiel requirements	The process of developing a time-phased course of action that commits materiel resources to meet materiel requirements
P	2	4	Establish detailed sourcing plans	The establishment of courses of action that represent a projected appropriation of supply resources to meet sourcing plan requirements
P	3	1	Identify, prioritize, and aggregate production requirements	The process of identifying, prioritizing, and considering all sources of demand, as a whole with constituent parts, in the production of a product or service
P	3	2	Identify, assess, and aggregate production resources	The process of identifying, evaluating, and considering all aspects, as a whole with constituent parts, that add value in the production of a product
P	3	3	Balance production resources with production requirements	The process of developing a time-phased course of action that commits production resources to meet production requirements
P	3	4	Establish detailed production plans	The establishment of courses of action that represent a projected appropriation of supply resources to meet production plan requirements
P	4	1	Identify, prioritize, and aggregate delivery requirements	The process of identifying, prioritizing, and considering all sources of demand, as a whole with constituent parts, in the delivery of a product or service
P	4	2	Identify, assess, and aggregate delivery resources	The process of identifying, evaluating, and considering all aspects, as a whole with constituent parts, that add value in the delivery of a product
P	4	3	Balance delivery resources with delivery requirements	The process of developing a time-phased course of action that commits delivery resources to meet delivery requirements
P	4	4	Establish detailed delivery plans	The establishment of courses of action that represent a projected appropriation of delivery resources to meet delivery requirements
S	1	1	Schedule materiel deliveries	Scheduling and managing the deliveries of materiel for a contract or purchase order (the requirements for materiel releases are based on the sourcing plan or other types of materiel pull signals)
S	1	2	Receive and verify materiel	The receipt and acceptance of materiel deliveries, including all activities associated with receiving, verifying, and accepting materiel deliveries
S	1	3	Transfer materiel	The transfer of accepted materiel to the appropriate stocking location in the supply chain (including all activities associated with repackaging, staging, transferring, and stocking materiel)
S	2	1	Schedule materiel deliveries	Scheduling and managing the deliveries of materiel for the contract; the requirements for deliveries are based on the sourcing plan; this function includes all aspects of managing the contract schedule, including prototypes and qualifications

Table A-2. SCOR Level 3 Processes (Continued)

L1	L2	L3	Name	Definition
S	2	2	Receive and verify materiel	The receipt and acceptance of materiel deliveries for the contract requirements (including all activities associated with receiving, qualifying, verifying, and accepting materiel deliveries)
S	2	3	Transfer materiel	The transfer of accepted materiel to the appropriate stocking location in the supply chain (including all activities associated with repackaging, staging, transferring, and stocking materiel)
S	3	1	Identify sources of supply	The identification of potential suppliers capable of designing and delivering materiel that meet all required product specifications
S	3	2	Select final suppliers and negotiate	The identification of final suppliers based on the evaluation of request for quotes, supplier qualifications, and the generation of a contract defining the costs, terms, and conditions of materiel availability
S	3	3	Schedule materiel deliveries	Scheduling and managing the deliveries of materiel for the contract (the requirements for deliveries are based on the sourcing plan; this function includes all aspects of managing the contract schedule, including prototypes and qualifications)
S	3	4	Receive and verify materiel	The receipt and acceptance of materiel deliveries for the contract requirements (including all activities associated with receiving, qualifying, verifying, and accepting materiel deliveries)
S	3	5	Transfer materiel	The transfer of accepted materiel to the appropriate stocking location in the supply chain (including all activities associated with repackaging, staging, transferring, and stocking materiel)
M	1	1	Schedule manufacturing activities	The scheduling of operations to be performed in accordance with plans for the manufacture of parts, products, and formulations in quantities and planned availability of required materiel (scheduling includes sequencing and, depending on the factory layout, standards for setup and run; intermediate manufacturing activities are generally coordinated before scheduling operations performed in producing a finished product)
M	1	2	Issue materiel	The physical movement of materiel (e.g., raw materiel, fabricated components, manufactured subassemblies, required ingredients or intermediate formulations) from a stocking location (e.g., stockroom, a location on the production floor, a supplier) to a point of use (issuing materiel includes the corresponding system transaction; the BOM, routing information, or recipe-production instructions determine the materiel to be issued to support manufacturing operations)
M	1	3	Manufacture and test	The activities to convert materiel from the raw or semifinished state to a state of completion and greater value; the processes associated with the validation of product performance to ensure conformance to defined specifications and requirements
M	1	4	Package	The activities that containerize completed products for storage or sale to users; packaging in some industries includes cleaning or sterilization
M	1	5	Stage product	The movement of packaged products to a temporary holding location to await movement to a finished goods location (products made to order may remain in the holding location to await shipment per the associated customer order; the actual move transaction is part of the deliver process)

Table A-2. SCOR Level 3 Processes (Continued)

L1	L2	L3	Name	Definition
M	1	6	Release product to deliver	Activities (e.g., assembly of batch records for regulatory agencies, laboratory tests for potency or purity, creating certificate of analysis, and signoff by the quality organization) associated with post-production documentation, testing, or certification before a product is delivered to a customer
M	2	1	Schedule manufacturing activities	The scheduling of operations to be performed in accordance with plans for the manufacture of parts, products, or formulations in quantities and planned availability of required materiel (scheduling includes sequencing and, depending on the factory layout, standards for setup and run; intermediate manufacturing activities are generally coordinated before scheduling operations performed in producing a finished product)
M	2	2	Issue materiel	The physical movement of materiel (e.g., raw materiel, fabricated components, manufactured subassemblies, required ingredients, or intermediate formulations) from a stocking location (e.g., stockroom, a location on the production floor, a supplier) to a point of use (issuing materiel includes the corresponding system transaction; the BOM, routing information, or recipe-production instructions determine the materiel to be issued to support manufacturing operations)
M	2	3	Manufacture and test	The activities to convert materiel from the raw or semifinished state to a state of completion and greater value; the processes associated with the validation of product performance to ensure conformance to defined specifications and requirements
M	2	4	Package	The activities that containerize completed products for storage or sale to users; packaging in some industries includes cleaning or sterilization
M	2	5	Stage product	The movement of packaged products to a temporary holding location to await movement to a finished goods location (products made to order may remain in the holding location to await shipment per the associated customer order; the actual move transaction is part of the deliver process)
M	3	1	Finalize engineering	Engineering activities after acceptance of order but before product can be manufactured; may include generation and delivery of final drawings, specifications, formulas, and part programs (generally the last step in completing preliminary engineering work as part of the quotation process)
M	3	2	Schedule manufacturing activities	The scheduling of operations to be performed in accordance with plans for the manufacture of parts, products, or formulations in quantities and planned availability of required materiel (scheduling includes sequencing and, depending on the factory layout, standards for setup and run; intermediate manufacturing activities are generally coordinated before scheduling operations performed in producing a finished product)
M	3	3	Issue materiel	The physical movement of materiel (e.g., raw materiel, fabricated components, manufactured subassemblies, required ingredients, or intermediate formulations) from a stocking location (e.g., stockroom, a location on the production floor, a supplier) to a point of use (issuing materiel includes the corresponding system transaction; the BOM, routing information, or recipe-production instructions determine the materiel to be issued to support the manufacturing operations)

Table A-2. SCOR Level 3 Processes (Continued)

L1	L2	L3	Name	Definition
M	3	4	Manufacture and test	The activities to convert materiel from the raw or semifinished state to a state of completion and greater value; the processes associated with the validation of product performance to ensure conformance to defined specifications and requirements
M	3	5	Stage product	The activities that containerize completed products for storage or sale to users; packaging in some industries includes cleaning or sterilization
M	3	6	Release product to deliver	The movement of packaged products to a temporary holding location to await movement to a finished goods location (products made to order may remain in the holding location to await shipment per the associated customer order; the actual move transaction is part of the deliver process)
D	1	1	Process inquiry and quote	The actions to receive and respond to customer inquiries and requests for quotes
D	1	2	Receive, enter, and validate order	The actions to receive orders from a customer and enter them in a company's order processing system (orders can be received through phone, fax, or electronic media); examine orders "technically" to ensure an orderable configuration and provide accurate price, and check the customer's credit
D	1	3	Reserve inventory and determine delivery date	The actions to identify and reserve inventory (on-hand and scheduled) for orders and schedule a delivery date
D	1	4	Consolidate orders	The process of analyzing orders to determine the groupings that result in least cost and best service fulfillment and transportation
D	1	5	Plan and build loads	The actions to select transportation modes and build efficient loads
D	1	6	Route shipments	The actions to consolidate and route loads by mode, lane, and location
D	1	7	Select carriers and rate shipments	The actions to select carriers by lowest cost per route and rate and tender shipments
D	1	8	Receive product	The activities (e.g., receiving product, verifying, recording product receipt, determining put-away location, putting away, and recording location) that a company performs at its warehouses and that sometimes include quality inspection
D	1	9	Pick product	The activities (including retrieving orders to pick, determining inventory availability, building the pick wave, picking the product, recording the pick, and delivering product to shipping) in response to an order
D	1	10	Load vehicle, generate shipping documents, and ship	The tasks of placing product on vehicles; generating the documentation to meet internal, customer, carrier, and government needs; and sending the product to the customer
D	1	11	Receive and verify product at customer's site	The process of receiving the shipment at the customer's site and verifying that the shipped order is complete and the product meets quality requirements
D	1	12	Install product	The process of preparing and installing the product at the customer's site (the product is fully functional after completion)
D	1	13	Invoice and receive payment	The actions to send a signal to the financial organization that the order has been shipped and that the billing process should begin (payment is received from the customer within the payment terms of the invoice)

Table A-2. SCOR Level 3 Processes (Continued)

L1	L2	L3	Name	Definition
D	2	1	Process inquiry and quote	The actions to receive and respond to customer inquiries and requests for quotes
D	2	2	Receive, configure, enter, and validate order	The actions to receive orders from a customer and enter them in a company's order processing system (orders can be received through phone, fax, or electronic media), configure product to the customer's needs based on standard available parts or options, examine order to ensure an orderable configuration and provide accurate price, and check the customer's credit
D	2	3	Reserve resources and determine delivery date	The actions to identify and reserve inventory or planned capacity for orders and schedule a delivery date
D	2	4	Consolidate orders	The process of analyzing orders to determine the groupings that result in least-cost and best-service fulfillment and transportation
D	2	5	Plan and build loads	The actions to select transportation modes and build efficient loads
D	2	6	Route shipments	The actions to consolidate and route loads by mode, lane, and location
D	2	7	Select carriers and rate shipments	The actions to select carriers by lowest cost per route and rate and tender shipments
D	2	8	Pick staged product	The activities (including retrieving orders to pick, verifying inventory availability, building the pick wave, picking the product, recording the pick, and delivering product to shipping) performed in the distribution center in response to an order
D	2	9	Load vehicle, generate shipping documents, and ship	The tasks of placing product on vehicles; generating the documentation to meet internal, customer, and government needs; and sending the product to the customer
D	2	10	Receive and verify product at customer's site	The process of receiving the shipment at the customer's site and verifying that the shipped order is complete and the product meets quality requirements
D	2	11	Test and install product	The process of preparing, testing, and installing the product at the customer's site; the product is fully functional after completion
D	2	12	Invoice and receive payment	The actions to send a signal to the financial organization that the order has been shipped and that the billing process should begin (payment is received from the customer within the payment terms of the invoice)
D	3	1	Obtain and respond to request for proposals and request for quotes	The process of delivering a product designed, manufactured, and assembled from a BOM that includes custom parts (design begins only after the receipt and validation of a firm customer order)
D	3	2	Negotiate and receive contract	The process of negotiating order details (e.g., price, schedule, product performance) with customers and finalizing the contract
D	3	3	Enter order, commit resources, and launch program	The process of entering and finalizing the customer order, approving the planned resources (e.g., engineering, manufacturing), and officially launching the program
D	3	4	Schedule installation	The process of evaluating the design and build schedules relative to customer's requested installation date to determine installation schedule

Table A-2. SCOR Level 3 Processes (Continued)

L1	L2	L3	Name	Definition
D	3	5	Plan and build loads and shipments	The process of scheduling simultaneous and consolidated shipments, and planning and building loads
D	3	6	Route shipments and select carrier	The process of consolidating and routing shipments by mode, lane, and location (carriers are selected and shipments are rated)
D	3	7	Pick staged product	The activities of retrieving orders to pick, verifying inventory availability, building the pick wave, picking the product, recording the pick, and delivering product to shipping performed in the distribution center in response to an order
D	3	8	Load vehicle, generate shipping documents, and ship	The tasks of placing product on vehicles; generating the documentation to meet internal, customer, and government needs; and sending the product to the customer
D	3	9	Receive and verify product at customer's site	The process of receiving the shipment at the customer's site and verifying that the shipped order is complete and the product meets quality requirements
D	3	10	Test and install product	The process of preparing, testing, and installing a product at the customer's site; product is fully functional after completion
D	3	11	Invoice receive payment	The actions to send a signal to the financial organization that the order has been shipped and that the billing process should begin (payment is received from the customer within the payment terms of the invoice)

Note: L3 = level 3.

For each of the SCOR processes, the model provides several performance measures (Table A-3).

Table A-3. SCOR Performance Measures

Term	Definition	Process category and process element numbers
Actual-to-theoretical cycle time	See note	P1.2, P3, P3.4
Asset turns	Total gross product revenue divided by total net assets	M1, M1.3, M1.4, M2, M2.3, M2.4, M3, M3.4, M3.5
Average plant-wide salary	Total payroll for salaried employees divided by total headcount	M1, M2, M3
Build cycle time	Average cycle time for build-to-stock products calculated as the average number of units in process divided by the average daily output in units	
Build-to-ship cycle time	Average time from when a unit or product is deemed shippable by manufacturing until the unit or product is shipped to a customer	M1.4, M1.5, M2.4, M2.5, M3.5, M3.6

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Capacity utilization	Measure of how intensively a resource is used to produce a good or service that considers several factors (e.g., internal manufacturing capacity, constraining processes, direct labor availability, and key components and materiel availability)	P1, P1.3, M1, M1.1, M1.3, M1.4, M2, M2.1, M2.3, M3, M3.1, D2.3
Cash-to-cash cycle time	Inventory days of supply (DOS) plus days sales outstanding minus average payment period for materiel (time for funds to flow back into a company after being spent for raw materiel)	P1, M1.2, M2.2, M3.3, D2.12, D3.11
Commodity management profile	Number of distinct part numbers (purchased commodities) sourced in the following areas: within 200 miles, country, continent, and offshore	P2, P2.2, P2.4
Complete manufacture to order ready for shipment time	Time to pick, pack, and prepare for shipment time (in calendar days)	D2.8, D2.9
Create customer order costs	Costs for creating and pricing configurations to order and preparing order documents	D1.2, D2.2, D3.2
Cross-training	Training or experience provided in several areas (e.g., training an employee on several machines rather than one); cross-training provides workers in case the primary operator is unavailable	M3.2
Cumulative source and make cycle time	Cumulative external and internal lead-time to build a shippable product (begun with no inventory on-hand, no parts on-order, and no prior forecasts with suppliers) in calendar days	P1, P2, P3, P3.3, P3.4
Customer invoicing and accounting costs	Costs for invoicing, processing customer payments, and verifying customer satisfaction	D1.13, D2.12, D3.11
Customer receipt of order to installation complete	Time for product installation, acceptance, and initiation of operations (in calendar days)	D2.10, D2.11, D3.9, D3.10
Customer signature and authorization to order receipt time	Time (in calendar days) from when the customer authorizes an order to the time that the order is received	D1.2, D2.2, D3.2
Days sales outstanding	5-point annual average of gross accounts receivable divided by the total gross annual sales that has been divided by 365	D1.13, D2.12, D3.11
Delivery performance to customer-request date	Percent of orders fulfilled on or before the customer's requested date	P1, P1.3, P4, P4.3, P4.4, M1, M2, M3, D1.10, D2, D2.9, D3, D1.3, D3.8
Delivery performance to scheduled commit date	Percent of orders fulfilled on or before the original scheduled or committed date	M1, M2, M3, M3.1, D1.10, D2, D2.9, D3, D3.8
Demand and supply planning costs	Costs associated with forecasting, developing finished goods or end item inventory plans, and coordinating demand and supply process across entire supply chain, including all channels (but excluding MIS-related costs)	P1

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Distribution costs	Costs for warehouse space and management, finished goods receiving and stocking, processing shipments, picking and consolidating, selecting carriers, and staging products and systems	D1.8, D1.9, D2.4, D2.5, D2.6, D2.7, D2.8, D3.5, D3.6, D3.7
Engineering change order (ECO) cost	Cost incurred from revisions to a blueprint or design released by engineering to modify or correct a part (the request for the change can be from a customer, production quality control, or another department)	M3, M3.1
End-of-life inventory	Inventory on-hand that will satisfy future demand for products no longer in production at an entity	D1.8
Faultless invoices	Number of invoices issued without error; examples of invoice defects are: • Change from customer purchase order without proper customer involvement • Wrong customer information (e.g., name, address, telephone number) • Wrong product information (e.g., part number, product description) • Wrong price (e.g., discounts not applied) • Wrong quantity, terms, or date	D1.13, D2.12, D3.11
Field finished goods inventory	Inventory kept at locations (e.g., distribution center, warehouse) outside the manufacturing plant	D2.9, D2.11, D3.10
Fill rates	Percent of ship-from-stock orders shipped within 24 hours of order receipt	P1, P1.3, P4, P4.4, M1.3, D1, D1.3, D1.9, D2
Finished goods inventory carrying costs	Costs (e.g., opportunity cost, shrinkage, insurance and taxes, total obsolescence, channel obsolescence and field sample obsolescence) associated with finished goods inventory	P4, P4.3
Finished goods inventory DOS	Gross finished goods inventory divided by the average daily value of transfers	P4, P4.4, D1, D1.8, D2, D3, D3.8
Finished goods shrinkage	Costs associated with breakage, pilferage, and deterioration of finished goods inventories	P4
Forecast accuracy	Forecast sum (the sum of the units or dollars forecasted to be shipped each month based on the forecast generated 3 months earlier) minus the sum of variances (the sum of the absolute values, for the forecasted line item, of the differences between each month's forecast and actual demand for the month) divided by the forecast sum (forecast accuracy is calculated in units and dollars by shippable end product for each distribution channel)	P1, P1.1, P2.1, P3.1, P4, P4.1, P4.2

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Forecast cycle	Time between forecast regenerations that reflect true changes in marketplace demand for shippable end products; only valid "bottom-up" forecasts are counted (e.g., if weekly or monthly updates to the forecast only shift dates for the forecast to avoid changing the annual dollar-based forecast, they should not be considered forecast regenerations)	P1.1, P2.1
Incoming materiel quality	Number of received parts that fail inspection divided by the total number of parts received	D1.8
Indirect-to-direct labor headcount ratio	Ratio of number of employees to support production in general without being related to a product (indirect labor) to the number of employees applied to the product being manufactured or used in the performance of the service (direct labor)	M1, M2, M3
In-process failure rates	See note	M3.4
Installation costs	Costs for verifying site preparation, installing, certifying, and authorizing billing	D2.11, D3.10
Intramanufacturing replan cycle	Time between the acceptance of a regenerated forecast by locations that produce the end product and the reflection of the revised plan in the master production schedule of all affected plants, excluding external vendors	M1.3, M2.3, M3.4
Inventory accuracy	Absolute value of the sum of the variances between physical inventory and perpetual inventory	P2.2, M1.2, M2.2, M3.3
Inventory aging	Percent of total gross inventory (based on value) covered by expected demand within time periods	M1, M2, M3
Inventory carrying costs	Sum of opportunity cost; shrinkage; insurance and taxes; total obsolescence for raw materiel, work-in-process (WIP), and finished goods inventory; channel obsolescence; and field sample obsolescence	P1
Inventory cycle-counting accuracy	Absolute value of the sum of the variances between physical inventory and perpetual inventory	P1.2
Inventory DOS	Total gross value of inventory at standard cost before reserves for excess and obsolescence (only includes inventory on company books; future liabilities should not be included) calculated using the 5-point annual average of the sum of all gross inventories (e.g., raw materiel, WIP, plant finished goods, field finished goods, field samples) divided by the cost of goods sold that has been divided by 365	P1, P1.3, S1, S2, S3, M1.1, M2.1, M3.2
Inventory obsolescence as a percent of total inventory	Annual obsolete and scrap reserves taken for inventory obsolescence expressed as a percent of annual average gross inventory value	P1, P3, P3.3, P3.4, M1, M1.2, M2.1, M2.2, M3.3, D1.8, D2
Machine wait-time	See note	M1.1, M2.1

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Make cycle time	Sum of the following average times: Order release to start actual build, total build cycle, and end build to leaves plant (i.e., moves to on- and off-site distribution or goes to customer); for continuous and mixed processes, manufacturing cycle time is calculated as the average number of units (e.g., doses, kilos, pounds, gallons) in process divided by the average daily output in units	M1.2
Make flexibility	Time to implement a sustainable unplanned increase in end product supply of 20 percent if each of the following factors is the only constraint: • Internal manufacturing capacity • Direct labor availability • Constraining processes • Key components and materiel availability • Direct labor availability	P3, P3.3
Materiel acquisition costs	Costs for production materiel (materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, and materiel process engineering and tooling costs)	S1, S2, S3, D1.8
Materiel management and planning costs as a percent of materiel acquisition costs	Costs associated with supplier sourcing, contract negotiation, and qualification and the preparation, placement, and tracking of a purchase order expressed as a percent of materiel acquisition costs; category includes all costs related to buyers and planners	P2.3, S1.1, S2.1, S3.2, S3.3
Materiel overhead cost per dollar of materiel expenditure	See note	P3
Materiel process engineering as a percent of materiel acquisition costs	Costs associated with tasks to document and communicate materiel specification as well as reviews to improve the manufacturability of the purchased item expressed as a percent of materiel acquisition costs	S3.1
Materiel requisition cycle time	See note	M1.2, M2.2, M3.3
Number of call backs as a percent of total inquiries	Number of call backs divided by total inquiries	D1.1, D2.1
Number of ECOs	Number of revisions to a blueprint or design released by engineering to modify or correct a part (the request for the change can be from a customer, production quality control, or another department)	M3, M3.1
Number of end products and stock-keeping units	Number of end item offerings individually planned and managed	P3, P3.2
Number of orders not delivered complete	Number of orders that all items on order are not delivered in the quantities requested	D2.8
Number of orders with complete and accurate documentation	Number of orders with correct documentation supporting the order, including packing slips, bills of lading, and invoices	D2.8
Number of supply sources	Number of internal and external direct production materiel suppliers used	P2, P2.2, P2.4

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Order consolidation profile	Consolidation consists of activities associated with filling a customer order by bringing together all line items ordered by the customer (some items may come directly from the production line; others may be picked from stock); the following profiles are captured: • Shipped direct to customer's dock from point of manufacture (no consolidation) • Shipped direct to customer with consolidation completed local to customer by organic transport company • Moved to on-site staging location for consolidation and shipment direct to customer • Moved to on-site stockroom for later pick, pack, and ship • Shipped to different locations for consolidation or later pick, pack, and ship	D1.4
Order entry and maintenance costs	Costs for maintaining the customer database, checking credit, accepting new orders, and adding them to the order system as well as later order modifications	D1.2, D2.2
Order entry complete to order ready for shipment time	Release to manufacturing, order configuration verification, production scheduling, build, pick-pack, and prepare for shipment time (in calendar days)	D1.4, D1.5, D1.6, D1.7, D1.9, D1.10, D3.5, D3.6, D3.7
Order entry complete to start manufacture time	Time from completion of order entry to the release to manufacturing (in calendar days)	D2.4, D2.5, D2.6, D2.7, D3.4
Order fulfillment costs	Costs for processing the order, allocating inventory, ordering from the internal or external supplier, scheduling the shipment, reporting order status, and initiating shipment	D1.3, D2.3, D3.3, D3.4
Order fulfillment lead-times	Average actual lead-times consistently achieved from customer signature and authorization to order receipt, order receipt to order entry complete, order entry complete to start build, start build to order ready for shipment, order ready for shipment to customer receipt of order, and customer receipt of order to installation complete	M3, M3.1, D1, D2, D3
Order management costs	Aggregation of the following cost elements (defined in Appendix E): • Create customer order costs • Order entry and maintenance costs • Contract, program, and channel management costs • Installation planning costs • Order fulfillment costs • Distribution costs • Transportation costs • Installation costs • Customer invoicing and accounting costs	P1, P4, P4.1, P4.2, D1, D1.1, D2, D2.1, D3, D3.1

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Order management cycle time	See note	P4, P4.1, P4.2
Order ready for shipment to customer receipt of order time	Time that includes total transit time (all components to consolidation point), consolidation, queue time, and additional transit time to customer receipt of order (in calendar days)	D1.11, D2.9, D3.8
Order receipt to order entry complete time	Time (in calendar days) for order revalidation, configuration check, credit check, and scheduling of received orders	D1.2, D1.3, D2.2, D2.3, D3.3
Overhead cost	Costs of operating a business that cannot be directly related to the products or services produced; the costs (e.g., light, heat, supervision, and maintenance) are grouped in several pools and distributed to units of product or service by a standard allocation method (e.g., direct labor hours, direct labor expenses, or direct materiel expenses)	M1, M2, M3
Percent defective	See note	S1, S1.1, S3
Percent of EDI transactions	Percent of orders received via EDI	S1.1, S2.1, S3.3
Percent of faultless installations	Number of faultless installations divided by total number of units installed	D1.12, D2.11, D3.10
Percent of orders scheduled to customer request	Percent of orders with delivery scheduled within an agreed time frame of the customer's requested delivery date	M2.1, M3.2, D2.3
Percent of parts delivered to point of use	Percent of materiel receipts delivered directly to production or a consolidation point or point of use on the production floor with no inspection or only minor visual and paperwork inspection	M1.2, M2.2, M3.3
Perfect order fulfillment	Orders that meet all of the following standards: • Delivered complete; all items on order delivered in the quantities requested • Delivered on time, using the customer's definition of on-time delivery • Complete and accurate documentation (including packing slips, bills of lading, and invoices) to support the order • Delivered in perfect condition, correct configuration, customer-ready, no damage, and faultlessly installed (as applicable)	D1.10, D1.11, D2, D2.2, D2.9, D2.10, D3, D3.8, D3.9
Plan stability	See note	P1.4
Plant cost per hour	See note	M1, M2
Plant finished goods inventory DOS	Gross plant finished goods inventory divided by the average daily value of transfers	M1.5, D2.8, D3.7

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Plant-level order management costs	Aggregation of the following cost elements (defined in Appendix E) for which manufacturing is the central focal point of orders: • Create customer order costs • Order entry and maintenance costs • Contract, program, and channel management costs • Installation planning costs • Order fulfillment costs • Distribution costs • Transportation costs • Installation costs • Customer invoicing and accounting costs	M2.1, M3.2
Product and grade changeover time	See note	M1, M1.3, M2, M2.3
Product and process data accuracy (e.g., BOMs, routings, planning factors)	See note	P1, P1.2
Production flexibility	Upside flexibility—number of days to achieve an unplanned sustainable 20 percent increase in production Downside flexibility—percent of order reduction sustainable at 30 days before delivery with no inventory or cost penalties	M1.1, M2.1, M3.2
Production plan adherence	See note	P3, P3.4
Published delivery lead-times	Standard lead-time (after receipt of order) published to customers by the sales organization for only typical orders (not standing and resupply orders)	D1, D2
Purchased materiel by geography	Number of the distinct part numbers of raw materiel, externally manufactured components, manufactured finished products, packaging materiel, and labeling materiel sourced in the following areas: within 200 miles, country, continent, and offshore	S3.1
Quality levels	See note	M1.3, M2.3
Quarantine time	Time for setting items aside from availability for use or sale until required quality tests have been performed and conformance certified	M1.6, M2.6
Ratio of actual to theoretical cycle time	See note	M1.3, M1.4, M2.3, M3.4
Raw materiel and WIP inventory DOS	Gross raw materiel and WIP inventory divided by the average daily value of transfers	P2, P3, D2, D3
Raw materiel DOS	Gross raw materiel inventory divided by the average daily value of transfers	P2, P2.3, M1.2, S1.1, S2.1, S3.2, S3.3
Raw materiel inventory carrying costs	Costs associated with raw materiel inventory (e.g., opportunity cost, shrinkage, insurance and taxes, and obsolescence)	P2

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Raw materiel shrinkage	Costs associated with breakage, pilferage, and deterioration of raw materiel inventories	P2
Receiving and materiel storage costs as a percent of materiel acquisition costs	Costs associated with taking possession of and storing materiel; includes warehouse space and management, materiel receiving and stocking, processing work orders, pricing, and internal materiel movement but does not include incoming inspections	S1.3, S2.3, S3.5
Receiving and put away cycle time	See note	M3.3
Receiving costs as a percent of materiel acquisition costs	Costs associated with taking possession of materiel (excluding inspection) expressed as a percent of materiel acquisition costs	S1.2, S2.2, S3.4
Replan cycle time	Time between the initial creation of the regenerated forecast and its reflection in the master production schedule of the production facilities for the end product	P1, P1.1, P1.3, P1.4, P2.3, M1, M2
Responsiveness lead-time	See note	M1.1, M2.1, M3.2
Return on assets	Financial measure of the income-producing value of an asset calculated as net income divided by total assets	P1
Routing data accuracy	See note	P0
Schedule achievement	Percent of time that a plant achieves its production schedule based on the number of scheduled end items or volume for a period (overshipments do not make up for undershipments)	M1.1,M2.1, M3.2
Scrap expense	Expense incurred from materiel being outside specifications and possessing characteristics that make rework impractical	M1.3, M2.3, M3.4
Shrinkage	Costs associated with breakage, pilferage, and deterioration of inventories	P4
Source cycle time	Cumulative lead-time (total average combined inside-plant planning, supplier lead-time [internal or external], receiving, and handling from demand identification at the factory until materiel are available in the production facility) to source 95 percent (chosen to eliminate outlying data) of the value of materiel from internal and external suppliers	S1.2, S2.2, S3.4
Source flexibility	See note	P2, P2.3
Supplier cycle time	See note	P2, P2.4
Supplier fill rate	See note	P2, P2.4
Supplier on-time delivery performance	Percent of orders fulfilled on or before the customer's requested date (supplier's performance measured by the customer)	P2, P2.3, P2.4, S1.2, S2.2, S3.4
Supply chain finance costs	Costs associated with paying invoices, auditing physical counts, performing inventory accounting, and collecting accounts receivable (does not include customer invoicing and accounting costs)	P1.3

Table A-3. SCOR Performance Measures (Continued)

Term	Definition	Process category and process element numbers
Total build time	Average time for build-to-stock or configure-to-order products from when production begins on the released work order until the build is completed and unit deemed shippable	M1.3, M2.3, M3.4
Total logistics costs	All supply chain-related MIS, finance and planning, inventory carrying, materiel acquisition, and order management costs	P4
Total manufacturing employment	See note	M1.3, M2.3, M3.4
Total source lead-time	Cumulative lead-time to source 95 percent of the value of materiel from internal and external suppliers	S1, S1.1, S2, S2.1, S3, S3.1, S3.2, S3.3
Total WIP inventory DOS	Gross WIP inventory divided by the average daily value of transfers	P3, P3.3, P3.4
Training and education	See note	M1.3, M2.3
Transportation costs	Company-paid freight and duties from point of manufacture to end customer or channel	D1.4, D1.5, D1.6, D1.7, D2.9, D3.8
Unit cost	Total labor, materiel, and overhead cost for one unit of production (e.g., part, gallon, pound)	M2, M3
Value-added employee productivity	Total product revenue minus total materiel purchases divided by total employment (in full-time equivalents)	P1, M1, M1.3, M2, M2.3, M3, M3.4
Warranty and returns	Number of returns in the warranty period (a warranty is a commitment, expressed or implied, that a fact regarding the subject matter of a contract is or will be true)	M1.3, M1.4
Warranty costs	Costs associated with materiel, labor, and problem diagnoses for product defects	M1, M1.3, M1.4, M2, M2.3, M2.4, M3, M3.4, M3.5
WIP shrinkage	Costs associated with breakage, pilferage, and deterioration of WIP inventories	P3
WIP inventory carrying costs	Costs associated with WIP inventory (e.g., opportunity cost, shrinkage, insurance and taxes, and total obsolescence)	P3, P3.4
Yield	Ratio of usable output from a process to its input	M1, M1.3, M2, M2.3, M2.4, M3.4
Yield variability	Condition that occurs when the output of a process is not consistently repeatable in quantity or quality	M1.3, M2.3, M3.4

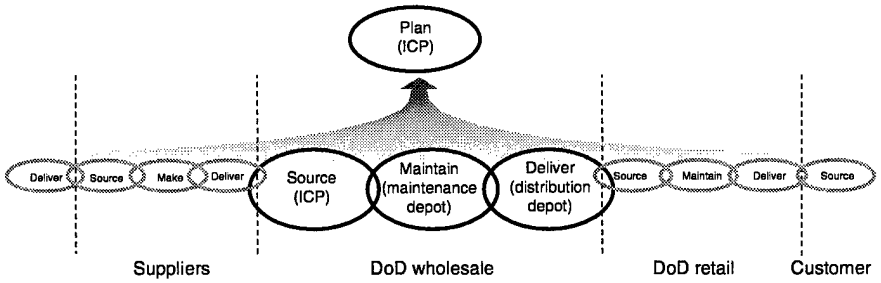
Note: Term not defined by SCOR model.

Appendix B
DoD Supply Chain

DoD Supply Chain

Figure B-1 is an adaptation of the high-level SCOR model to the DoD supply chain. For our analysis we rename the "make" process as "maintain" for the DoD organizations because maintenance activities generally perform the functions of a manufacturer. The DoD supply chain includes many participants, including ICPs, maintenance organizations, distribution depots, and retail activities.

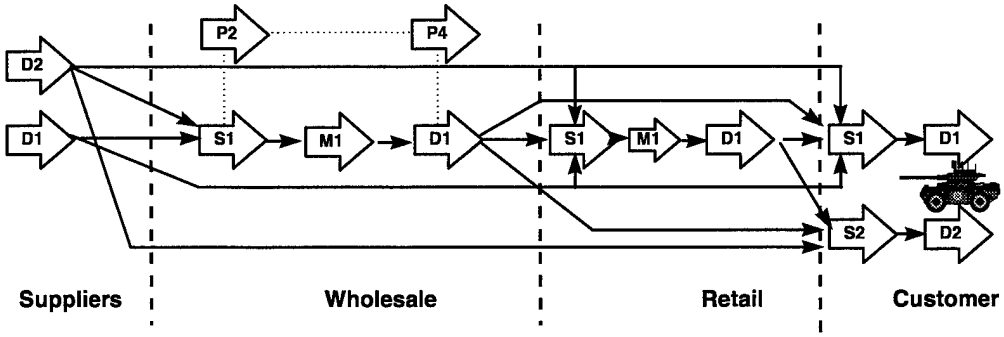
Figure B-1. DoD Supply Chain



DoD Supply Chain Description

Figure B-2 shows the SCOR level 2 configuration for DoD.

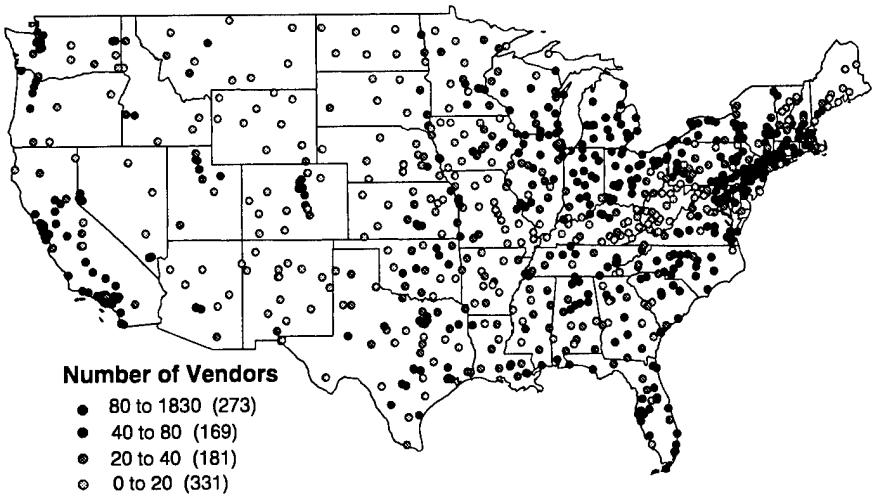
Figure B-2. DoD SCOR Level 2 Supply Chain Diagram



In Figure B-2, materiel flows from left to right beginning with DoD's suppliers. DoD has two basic types of suppliers: suppliers that stock items in

anticipation of receiving orders and suppliers that make items for delivery after orders are received. DoD has more than 100,000 active suppliers. Figure B-3 shows their locations.[1]

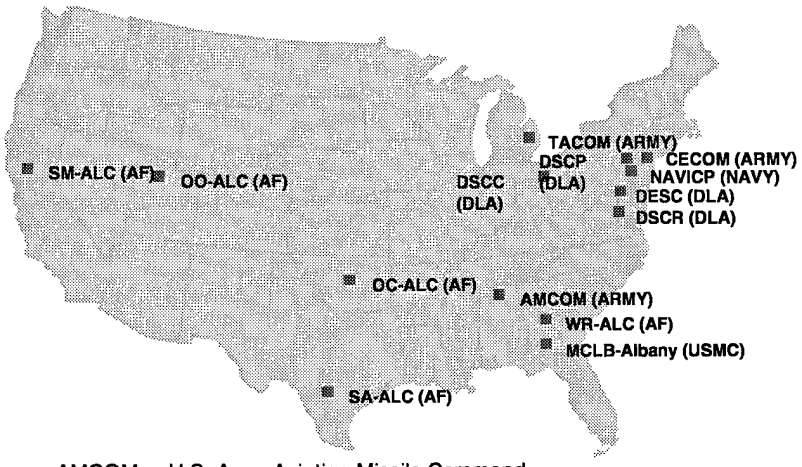
Figure B-3. DoD Supplier Locations



The DoD wholesale supply chain thread consists of 14 ICPs, 22 maintenance depots managed by the military services, and 22 DLA-managed distribution depots (Figure B-4 through Figure B-6). Items stocked in the wholesale system are procured from vendors (or repaired in maintenance depots) and stored in the distribution depots. The items are shipped to retail supply activities to replenish their inventory or directly to customers. The wholesale system also manages and arranges for nonstocked items to be shipped directly from the vendors to retail supply activities or customers.

[1] Location data were extracted from Information Handling Services Haystack.

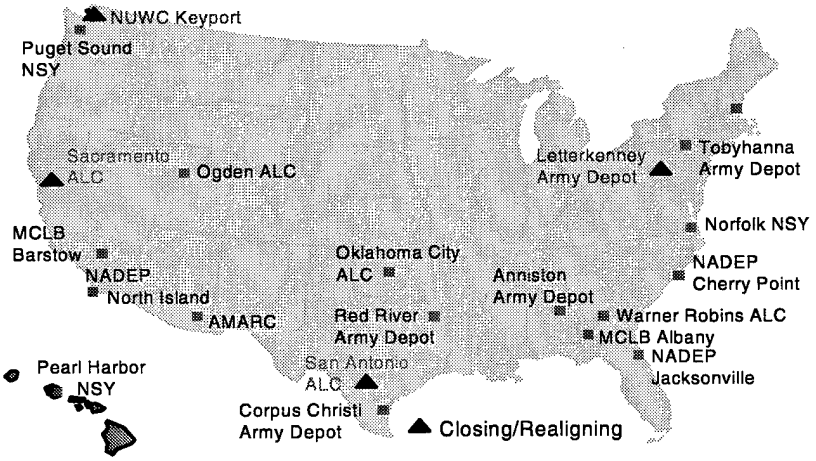
Figure B-4. Inventory Control Points



AMCOM	U.S. Army Aviation Missile Command
CECOM	U.S. Army Communications-Electronics Command
DESC	Defense Energy Support Center
DSCC	Defense Supply Center, Columbus
DSCP	Defense Supply Center, Philadelphia
DSCR	Defense Supply Center, Richmond
MCLB	Marine Corps Logistics Base
NAVICP	Naval Inventory Control Point
OC-ALC	Oklahoma City Air Logistics Center
OO-ALC	Ogden Air Logistics Center
SA-ALC	San Antonio Air Logistics Center
SM-ALC	Sacramento Air Logistics Center
TACOM	U.S. Army Tank-automotive and Armaments Command
WR-ALC	Warner-Robins Air Logistics Center

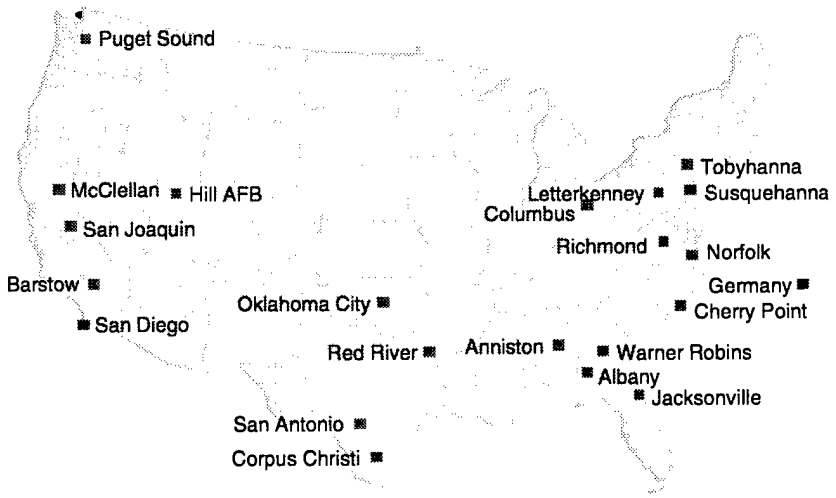
Note: AF = Air Force; USMC = United Stated Marine Corps.

Figure B-5. Maintenance Depots



Note: ALC = Air Logistics Center; AMARC = Aerospace Maintenance and Regeneration Center; NADEP = naval aviation depot; NSY = naval shipyard; NUWC = Naval Undersea Warfare Center.

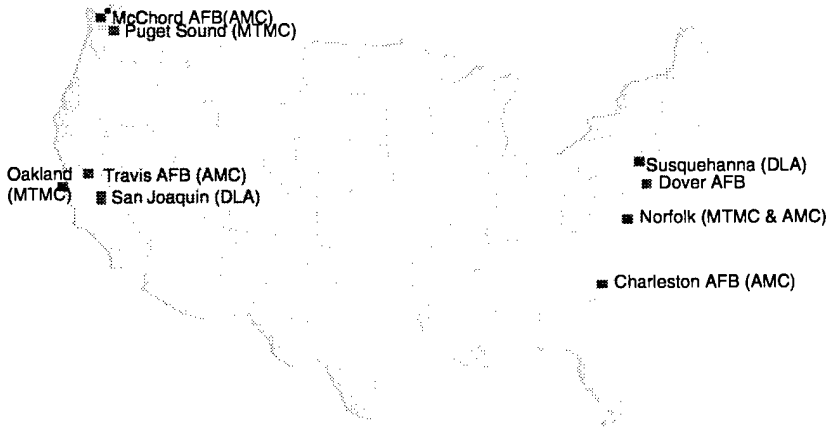
Figure B-6. Distribution Depots



Note: AFB = Air Force Base.

The DoD delivery system includes cargo consolidation points (Figure B-7), commercial carriers on contract, military air ports (11 in the United States and 32 overseas), and military seaports (17 in the United States and 27 overseas).

Figure B-7. Cargo Consolidation Points



Note: AMC = Air Mobility Command; MTMC = Military Traffic Management Command.

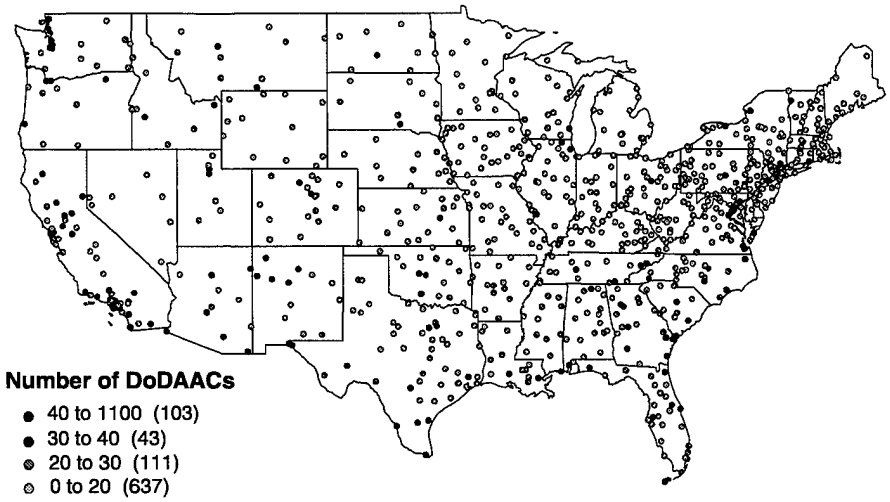
The DoD retail supply chain is made up of hundreds of retail supply and intermediate-level maintenance activities that stock, repair, and store assets. They replenish their inventory from the wholesale supply system or directly from suppliers.

At the end of the supply chain are the customers. Their orders are filled from organizational supplies, designated retail supply activities, the wholesale supply system, or directly from vendors. The DoD Activity Address Directory, maintained by the Defense Automatic Addressing System Center, contains the DoD

Activity Address Codes (DoDAACs), which identify every unit, activity, and organization that has the authority to requisition or receive materiel. More than 30,000 DoD customers (i.e., requisitioners) place materiel orders.

Figure B-8 shows the distribution of CONUS DoDAACs.

Figure B-8. DoD CONUS Customers



Appendix C
OSD, Military Service, and DLA Enterprise Performance Measures

This appendix presents OSD, military service, and DLA enterprise performance measures.

OSD

OSD uses secondary item supply chain performance measures from two main sources: the MDM Annual Fact Book and DoD Supply Executive Information Management System.[1] The measures are briefly described in Table C-1.

Table C-1. OSD Performance Measures

Name	Description	Primary data source
Wholesale supply management cost of operations	Nonmateriel costs to the supply working capital fund	President's Budget
Wholesale supply management personnel (military and civilian)	Number of military and civilian personnel assigned to wholesale supply management	President's Budget
Net wholesale materiel sales	Sales (excluding fuel) at acquisition cost for the past fiscal year	President's Budget
Wholesale materiel obligations	Past fiscal year obligations at latest acquisition cost	President's Budget
Number of DoD items managed by components	Number of NSN items managed by primary control activities	DLIS
Number of DoD items managed	Number of NSNs managed during the last 6 years	DLIS
Secondary item inventory by component	Prior-year inventory value at latest acquisition cost	Supply System Inventory Report (SSIR)
Secondary item inventory value	Value of the DoD inventory for the last 7 years at acquisition cost	SSIR
DoD active inventory and inactive inventory to total inventory	Percent of inventory that is active and inactive for each of the last 7 years	SSIR
Secondary inventory by item type	Percent of reparable and consumable inventory for the last year, the division between active and inactive inventory, and values at acquisition cost	SSIR

[1] Both sources are available on the Internet at http://www.acq.osd.mil/log/mdm/exinfo.htm.

Table C-1. OSD Performance Measures (Continued)

Name	Description	Primary data source
Secondary inventory by management level	Percent of wholesale and retail inventory for the last year, the division between active and inactive inventory, and values at acquisition cost	SSIR
Number of items and secondary inventory by type	Number and value of reparables and consumables for the last year	DLIS and SSIR
Consumable items and secondary inventory by component	Number and value of consumables by military service for the last year	DLIS and SSIR
Reparable items and secondary inventory by component	Number and value of reparables by military service for the last year	DLIS and SSIR
Inventory goals versus inventory	Inventory goals and actual inventory values for each year beginning in 1989; goals are based on the DoD Logistics Strategic Plan	SSIR and DoD Logistics Strategic Plan
Wholesale inventory turnover	Number of times the value of the active and total inventory by military service turned over in the last year	SSIR and President's Budget
Wholesale inventory requirements levels	DoD average (in days) of safety level, administrative lead-times, production lead-times, and repair cycle for the last year	DWCF submissions
Requisitions for wholesale stocked items	Number of requisitions for stocked items submitted by issue priority group for the last year	LMARS
Requisitions for wholesale stocked items by year	Number of stocked item requisitions over the last 7 years	Military Supply and Transportation Evaluation Procedures (MILSTEP) (1990–1996) and LMARS (after 1997)
Stock availability for wholesale stocked items	Percent of stocked item requisitions filled immediately for each military service	President's Budget
Requisitions for wholesale nonstocked items	Number of requisitions for nonstocked items submitted by issue priority group for the last year	LMARS
Time for ICP to receive requisition from user	Average number of days for CONUS and OCONUS requisitioners to submit orders to the ICP by issue priority group for the last year	LMARS
Time for ICP to receive requisition from user by year	Average number of days for CONUS and OCONUS requisitioners to submit orders to the ICP for the last 8 years	MILSTEP (1990–1996) and LMARS (after 1997)
ICP time to process requisition	Average time for ICPs to process a requisition from receipt date to materiel release order date for the last year	LMARS
Distribution management cost of operations and personnel	Cost of distribution management operations over 2 years and the number of personnel	President's Budget
Storage space	Actual and projected capacity of warehouses measured in millions of cubic feet as compared to the space that is occupied	DoD Storage and Space Management Report
Distribution depots workload	Number of bin, bulk, and hazardous receipts and issues processed by distribution depots in the last year	DLA Distribution Management Information System

Table C-1. OSD Performance Measures (Continued)

Name	Description	Primary data source
Distribution depots processing time	Average depot processing times for routine and high-priority issues for the last fiscal year	DLA Distribution Management Information System
Distribution depots total processing time by year	Average depot processing times for CONUS and OCONUS for the last 8 years	MILSTEP (1990–1996) and DLA Distribution Management Information System (after 1997)
Materiel location accuracy	Accuracy of location records (excluding ammunition and subsistence) for the last 8 years	Defense Logistics Management Standards Office (DLMSO) Inventory Control Effectiveness Report
Warehouse denials	Percent of materiel release orders (MROs) (excluding ammunition and subsistence) that result in warehouse denials for the last 8 years	DLMSO Inventory Control Effectiveness Report
Materiel transferred to disposal system	Value of disposals (excluding aircraft, ships, and ammunition from end users) for the last 8 years	DLA's Program Administrator's Report
Secondary item inventory projections	Projected value of inventory for each military service (interactive Web application)	DoD inventory projection model
Inventory on hand at end of fiscal year	Interactive Web-based tool to drill down through on-hand inventory values of military services; categories are military service, commodity, stock type, and funding source	SSIR
Disposal of declared excess by year	Disposal statistics by commodity by year (interactive Web application)	DLA's Program Administrator's Report (DD Form 1143)
Inventory control effectiveness	Effectiveness of inventory control	DLMSO Inventory Control Effectiveness Report

ARMY

The Army periodically reviews logistics performance metrics at the enterprise level at the following three forums: Deputy Chief of Staff for Logistics (DCSLOG) Quarterly Review, Inventory Management Review, and Army Performance Review. In each review, several metrics are presented. Although no metric conveys a holistic look, together they present a comprehensive picture of Army logistics.

DCSLOG Quarterly Review

The DCSLOG Quarterly Review is the most comprehensive review of enterprise metrics. The metrics range from "end objective" metrics (e.g., operational readiness) to key process metrics (e.g., order-ship time). The review consists of the following metrics: operational readiness by weapon system; number of S-4 (low sustainability) units; unit breakouts; stock availability by weapon system and component; consumable and reparable status by activity (e.g., wholesale, retail); NMCS items; items managed by the Army and DLA; order-ship time by

command, issue priority group, location (e.g., CONUS, OCONUS), process step, and materiel class; inventory levels by activity and materiel class; approved stockage list requirements on backorder by command; percent of requisitions on backorder; administrative lead-time and production lead-time; Defense Reutilization and Marketing Office actions by command and item condition; redistributable Class IX assets; and several maintenance metrics. The metrics are also presented in several dimensions to provide a "drilldown" diagnostic capability.

Inventory Status Review

The Inventory Status Review contains metrics that the Army Materiel Command and DLA present to the DCSLOG to describe their performance of inventory management.

The Army Materiel Command's metrics include the following: requirements objective by command and requirements stratification; procurement due-in beyond the requisitioning objective as a percentage of total due-in by command; inducted assets beyond repair by command; on-hand inventory by command and stratification requirements; requisition processing time; requisition volume by weapon system (NMCS and all items); fill rate (NMCS and all items); demand accommodation (NMCS and all items); backorders (nonstocked) for NMCS and all items and retail and wholesale levels; average number of NMCS days by weapon system; MC rate by weapon system; stock availability for stocked and nonstocked items by weapon system and command for depot maintenance, Army, and non-Army customers; order-ship time (for Class IX, approved stockage list, and non-backorders) by command; average number of days of materiel returns by process step and location for automatic return and standard items; and percent of materiel returns within target by process step and location for automatic return and standard items.

The DLA metrics include the following: gross requisitions by weapon system; supply availability by ICP and weapon system; and backorders for stocked and nonstocked items by ICP, military service, and weapon system.

Quarterly Army Performance Review

In the Quarterly Army Performance Review, the DCSLOG presents the status of the Army logistics system to the Secretary of the Army and the Army Chief of Staff. This presentation contains primarily high-level sizing metrics (i.e., metrics that describe size and makeup of the system rather than its performance).

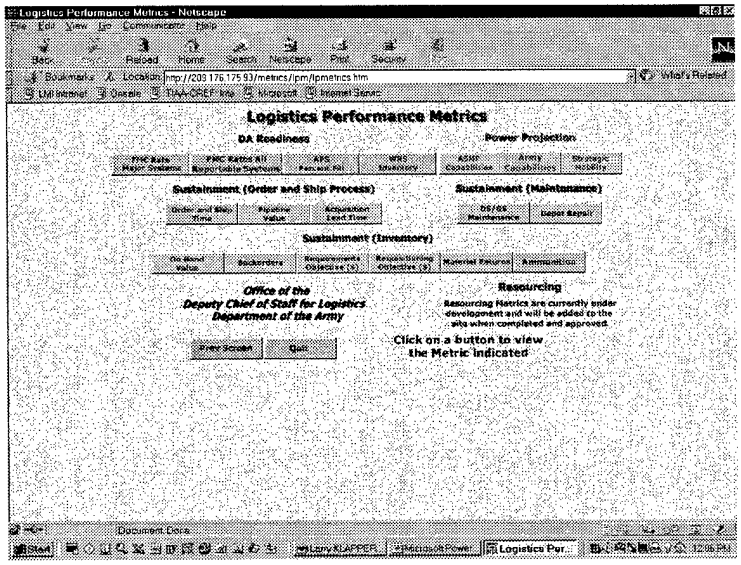
The review consists of the following metrics: Army working capital fund secondary item inventory level by commodity and requirements stratification for retail and wholesale levels, Army portion of DoD Class IX stock-funded inventory, and administrative lead-time by installation. The metrics also convey the Army's

use of DoD resources relative to other military services and the status of key initiatives.

Logistics Metrics Web Page

In addition to the periodic reviews, the Army has developed a Web page (Figure C-1) that contains most metrics it uses to monitor logistics performance. The Web page is one of the most advanced DoD applications of information technology in logistics performance measurement.

Figure C-1. Army Logistics Performance Metrics Web Site



The Web site categorizes dozens of metrics under four headings: readiness, sustainment, power projection, and resourcing. Table C-2 presents the list.

Table C-2. Army Logistics Performance Metrics Web Site

Readiness	Sustainment	Power projection	Resourcing
FMC rates	Order-ship time	(Transportation metrics)	(Metrics under development)
Percent fill of pre-positioned stocks	Pipeline asset levels		
War reserve inventory levels	Administrative lead-time		
	Production lead-time		
	On-hand inventory		
	Backorder level		
	Requirements objectives		
	Requisitioning objectives		
	Materiel returns		
	Process time to induct and release materiel returns		

The Web site also provides subcomponents for each metric by several dimensions, similar to the dimensions used in the briefings. This set of metrics was selected from more than 1,000 metrics used by the Army. The set continues to evolve to meet user needs.

NAVY

The Navy is proposing that the metrics in Table C-3 be used at the Navy enterprise level to indicate the performance of its supply chain. The Navy has decided to display its metrics in a balanced scorecard form with metrics in three general categories: customer satisfaction and quality, cost, and readiness.

Table C-3. Recommended Key Supply Chain Management Metrics

Recommended key supply chain management metrics	Customer satisfaction and quality	Cost	Readiness
Customer wait time (part of response to customer)	X		
Response to failure (part of response to customer)	X		
Asset visibility (part of TAV)	X		
Asset access (part of TAV)	X		
Supply materiel availability	X		
Materiel obligations outstanding	X		
Inventory level		X	
Total sales		X	
Cost recovery		X	
Net cash		X	
Workforce level		X	
Level percent of time free of casualty reports (CASREPs)			X
MC and FMC rates			X
Percent of downtime due to maintenance or supply			X

The Navy defines the metrics in Table C-3 as follows:

- *Response to customer.* Consists of two customer-focused metrics—customer wait time and response to failure—that provide a snapshot of the mean wait time for parts delivery to customers and a distribution curve of the mean time for repair equipment failure:
  - *Customer wait time.* A time measure from the Julian date of a customer's requisition to the receipt date that is derived by using the LRT metric from DLA's LMARS and modifying it as follows:
    - Adding retail issues
    - Adding requisitions not processed by the Defense Automated Addressing System (DAAS)
    - Removing nonreadiness elements (e.g., publications, forms, General Services Administration items, stock replenishments).
  - *Response to failure.* A distribution curve that charts the mean wait time to complete a repair job compared to the percent of time it takes to meet the mean wait time; metric is derived for aviation, surface, and subsurface customers with data from maintenance information systems.
- *Total asset visibility.* A ratio of the value of inventory in which TAV has been achieved to the value of inventory targeted for TAV. TAV will be reported in the following two ways:
  - *Visibility achieved.* The ability to see the asset electronically.
  - *Access achieved.* The ability to redistribute the asset (using business policies).
- *Supply materiel availability.* A measure of wholesale (i.e., ICP) effectiveness in filling customer requisitions (for stocked items).
- *Materiel obligations outstanding.* A measure of the number and average age of backordered requirements.
- *Inventory level.* The value of wholesale inventories managed by the NAVICP for the Navy Working Capital Fund (NWCF); inventory is derived from the SSIR published annually during the second quarter of each fiscal year.
- *Total sales.* A measure of the value (at standard price) of wholesale and retail net and credit sales of NWCF-owned materiel.

- *Cost recovery rate.* A measure of the value of the controllable supply system costs, including maintenance, supply operations, and payments to others.

- *Net cash.* A measure of cash flow for the NWCF; net cash is derived from subtracting total expenditures from total collections.

- *Workforce level.* A measure of the number of military and civilian end strength.

- *Percent of time free of C-3 and C-4 casualty reports.* A measure of ship mission readiness that focuses on operational periods only (i.e., excluding time in scheduled maintenance availabilities); compiled from data in the CASREP database maintained at NAVICP.

- *MC and FMC rates.* Measurements of mission readiness.

  - *MC.* The materiel condition of an aircraft or aircraft population that indicates the ability to perform at least one and potentially all assigned missions. Subsystem Capability Impact Reporting (SCIR) information is used to determine historical MC rates.

  - *FMC.* The materiel condition of an aircraft or population of aircraft indicating the ability to perform all assigned missions. SCIR information is used to determine historical FMC rates.

- *Downtime due to maintenance or supply.* A measurement of the percent of time an aviation or ship asset is not operational due to maintenance or supply. Aviation downtime due to maintenance is NMCM, and downtime due to supply is NMCS; both times are derived from historical SCIR data. For ship (surface and subsurface) assets, the percent of downtime due to maintenance or supply is compiled from data in the CASREP database maintained at NAVICP.

Systems

The Navy uses the Consumable Item Support System to provide visibility and measure the effectiveness of the Naval Supply Systems Command (NAVSUP). The system reports several categories—readiness, supply support, financial, contracting, and inventory—of measurement. A user can select a complete list of indicators or indicators from shorter lists associated with executive, fleet and industrial supply center, ICP, fleet, DLA, weapon system, and personal categories.

Logistics Initiatives

The Navy has several logistics initiatives to improve its performance (Table C-4).

Table C-4. Navy Logistics Initiatives

Category	Initiative
Cost	Surcharge reduction
	Decrease total ownership costs through simulation-based acquisition
Procurement and contracting	Expand purchase card management
	Expand the afloat purchase card program
	Navy electronic commerce on-line
	NAVSUP contracting consolidation
	Develop creative support methods for new acquisitions through the alternative logistics support office
Customer service and LRT	Backorder reduction

AIR FORCE

The Supply Management Activity Group of the Air Force Materiel Command tracks measurements in three categories: financial, customer support, and readiness. The financial measures are in Table C-5, support measures are in Table C-6, and readiness indicators are in Table C-7.

Table C-5. Financial Indicators

Indicator	Definition	Frequency of reporting
Net operating result	Revenue minus expenses [a]	Monthly
Unit cost target	Cost divided by sales; target generally set at 1:1 or less	Monthly
Inventory reduction	Response to inventory reduction goals	Semiannually
Inventory turn	Measure of inventory use relative to its size	Semiannually
Price index	Measure of how prices are performing relative to a base year	Yearly
Materiel cost recovery	Measure of how well materiel costs are covered by revenue	Monthly

[a] Revenue and expenses are also individually reported monthly.

Initial spares obligations, capital obligations, and credit returns are also reported monthly. A method for capturing cost per unit of output is being developed.

Table C-6. Customer Support Indicators

Indicator	Definition	Frequency or type of reporting
Retail stockage effectiveness	Percent of time stocked reparable items are issued upon request from base supply	Monthly
Retail issue effectiveness	Percent of time reparable items are issued upon request at base supply	Monthly
On-order excess	Amount of on-order materiel that has no projected use within 2½ years	Semiannually
Order and ship time (days)	Time between when an item is ordered and it is received	Semiannually
Pipeline standard	Time to return an item to serviceability	Semiannually
Acquisition lead-time	Time between when a purchase request is initiated and at least 10 percent of the materiel is delivered	Semiannually
Logistics response time	As defined by LMARS	Per requisition
Backorder quantity	Number of orders not filled by base supply when requested	By ALC and priority
Exchangeable production	Comparison between budgeted and actual amounts	Supply Management Activity Group

Table C-7. Readiness Indicators

Indicator	Type
MC rates	By weapon system
NMCS rates	By weapon system

Reparable Pipeline

The Air Force seems to be unique in that it measures the reparable pipeline in total and by segment:

Pipeline = Base repair + Retrograde + Depot repair + LRT (for reparables)

where:

Base repair = Pre-repair time + Awaiting parts + Repair time + Post-repair time

Retrograde = Supply to base shipment time + Base to depot move time

Depot repair	=	DLA reparable processing time + Total shop repair time + DLA serviceable processing time
LRT	=	Base requisition time + Depot asset release time + DLA shipment processing time + Depot to base move time.

Systems

The Pipeline Tracking Analysis and Metrics System (PTAMS) is a new system being developed for the Air Force by the Navy. It will replace several visibility and tracking systems, incorporate the best functionality of these systems, and remove the data duplication caused by operating several systems. PTAMS will allow a user to perform custom data queries and the ALCs and major commands to view the data to the NSN level.

Logistics Initiatives

The Air Force Materiel Command has begun the following logistics initiatives to improve its performance:

- Lean logistics pipeline reduction
- Acquisition lead-time reduction
- Maintain and improve economic retention policy
- Reduce repair backlog
- Reduce cost of operations
- Maintain and improve the contract and depot repair enhancement programs
- Ensure functions of the contract repair enhancement program mirror the functions of the depot repair enhancement program
- Implement and support Joint TAV
- Realign materiel management responsibilities
- Implement and support seamless supply chain management
- Identify and implement alternative inventory management business processes
- Develop and implement PTAMS.

MARINE CORPS

The Marine Corps is in the early stages of developing its performance measurement system as part of the Precision Logistics program. Although metrics have been used for several years to examine logistics performance, the Marine Corps is bringing the metrics together and displaying them on a Web site to provide an understanding of logistics behavior. The system generally focuses on three metrics: fill rate, order-ship time, and repair cycle time.

Fill rate is measured at the retail level. When all items to complete an equipment repair order are available, it is considered filled. If an item has to be backordered, the equipment repair order is considered not filled. Hence, this metric is more directly tied to maintenance of a weapon system than is general supply availability. Order-ship times are identified by wholesale and retail levels as well as by organization and process segment.

DEFENSE LOGISTICS AGENCY

Performance monitoring has been a consistent feature of DLA performance management. To achieve timely and accurate performance measurement, DLA instituted the Director's Quarterly Review and Analysis to provide a periodic review of performance and relate it to the goals and objectives in the DLA Strategic Plan.

DLA defines a performance goal as "a target level of performance expressed as a tangible, measurable objective, against which actual achievement can be compared, including a goal expressed as a quantitative standard, value, or rate." DLA uses a performance measurement system that is based on the goals and targets that set forth in its strategic plan. The plan includes the following five strategic goals:

- Consistently provide responsive, best-value supplies and services to customers
- Serve as a catalyst for the revolution in business affairs and acquisition reform
- Ensure the workforce is enabled to deliver and sustain world-class performance
- Rapidly exploit technology to provide agile, responsive, interoperable solutions
- Aggressively pursue partnerships with industry and suppliers.

DLA Definitions

The following definitions describe DLA's interpretation of goals, objectives, measurements, indicators, and targets:

- *General goal.* This goal defines how an agency will carry out its mission. The goal is expressed in a manner that allows a future assessment to determine if the goal was or is being achieved. The goal may have a programmatic, policy, or management nature. General goals are predominately outcome-oriented.

- *General objective.* Objectives are paired with a general goal and can be used to assess if a general goal was or is being achieved. An objective usually describes a more specific level of achievement than a general goal.

- *Outcome measure.* An assessment of the result of a program activity compared to its intended purpose.

- *Output measure.* The tabulation, calculation, or recording of activity or effort and expressed in a quantitative or qualitative manner.

- *Performance indicator.* A value or characteristic to measure an output or outcome. Performance indicators are associated with performance targets or goals.

- *Performance target.* Used by DLA to differentiate between DLA strategic goals (that relate to the Office of Management and Budget's definition of general goals and objectives) and the supporting measures that appear in performance plans and long-range business plans; sometimes called a performance goal.

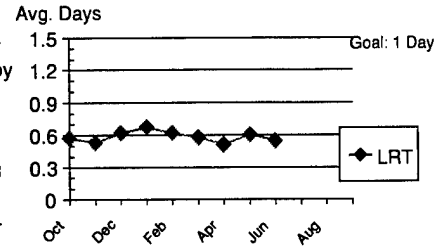
Metric Example

DLA uses the following format for each metric that depicts the goal-objective relationship, identifies issues and concerns, and presents current status (Figure C-2). The example presents information on Goal 1, Objective 1, which is to "exceed a 95 percent reliability rate for on-time products and services by FY 2000." Each DLA strategic goal is linked to a goal in the *DoD Logistics Strategic Plan.*

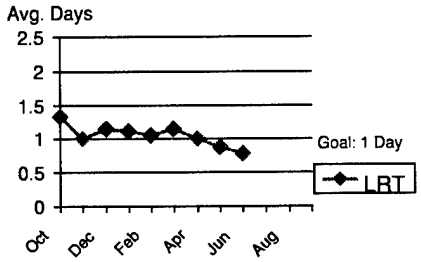
Figure C-2. DLA Metric Example

DLA Goal	Consistently provide responsive, best-value supplies and services to our customers
DLA Objective 1.1	Exceed a 95% reliability rate for on-time products and services by 2000
DLA Performance Contract Measure	The average depot processing LRT for both *high-priority* and *routine* requisitions during FY98 is less than 1 day. In FY99 the goal will remain less than 1 day.
DoD Logistics Strategic Plan Goal 1.1	Reduce LRT to 18 days by February 2000

Depot Logistics Response Time
High-Priority



Depot Logistics Response Time
Routine



Issues and Concerns

- Goal for routine requisitions changed from 4 days in FY97 to I day in FY98
- Process and data measurement will improve with implementation of DSS
- DSS will capture response time in hours by FY98; distribution MIS will report time in hours by FY99

Note: DSS = Distribution Standard System.

Table C-8 lists the 35 indicators that DLA uses to track its performance as presented in the DLA FY97 Performance Report. The indicators are snapshots of DLA's performance in accordance with GPRA requirements; in addition, some performance indicators are being developed. The table presents the indicator and the associated business (e.g., Defense Logistics Support Command [DLSC], Defense Reutilization and Marketing Service [DRMS], DLIS, Defense National Stockpile Center [DNSC], Defense Distribution Center, Defense Contract Management Command [DCMC]). Additionally, it presents the target goal for FY97 and the performance level achieved. Table C-9 presents DLA's definitions of the performance indicators.

Table C-8. FY97 Performance

Indicator	Business	Target	Actual
Customer complaints	Distribution	0.50%	0.38%
Customer price change	Supply (non-fuels)	–2.1%	–2.1%
Customer satisfaction	DLSC	65%	79%
Customer satisfaction rating (right reception)	DCMC	4.0	5.3
Disposal release order processing time	Distribution	≤21 days	2.17 days
Disposal unit cost (hazardous item)	DRMS	$219.57	$265.06
Disposal unit cost (nonhazardous)	DRMS	$0.47	$0.46

Table C-8. FY97 Performance (Continued)

Indicator	Business	Target	Actual
DLIS percent of real-time inquiries completed within 2 seconds	DLIS	90%	95%
DLIS processing time (batch inquiries)	DLIS	≤18 hours	11.17 hours
DLIS publications on-time distribution	DLIS	99.1%	99.8%
DNSC sale revenue (less diamonds)	DNSC	$273 million	$478.2 million
Increase acquisition planning and request for proposal review participation (right advice)	DCMC	175 reviews	185 reviews
Increase conforming items (right item)	DCMC	TBD	99%
Increase cost savings and avoidances return on investment (right price)	DCMC	4.85 to 1	4.62 to 1
Increase on-time contractor delivery (right time)	DCMC	5%	TBD
Inventory value (active)	Supply (non-fuels)	TBD	$5.0 billion
Inventory value (inactive)	Supply (non-fuels)	TBD	$3.1 billion
Logistics response time (ICP delayed issues)	Supply (non-fuels)	TBD	91 days
Logistics response time (ICP immediate issues)	Supply (non-fuels)	1 day	1 day
Logistics response time (MRO processing—high-priority)	Distribution	≤1 day	0.72 days
Logistics response time (MRO processing—routine)	Distribution	≤4 days	2.17 days
Logistics response time (planned direct vendor deliveries)	Supply (non-fuels)	TBD	20 days
Product availability	Supply (fuels)	90%	100%
Product conformance	Supply (non-fuels)	95%	95%
Return on investment	DRMS	3%	3.6%
Reutilization, transfer, and donation ratio	DRMS	17.5%	17.9%
Right efficiency (measure under development)	DCMC	TBD	TBD
Sample inventory accuracy	Distribution	92%	66.2% to 97.13%
Space utilization	Distribution	85%	69%
Stock availability	Supply (non-fuels)	85%	85.7%
Unit cost	Supply (non-fuels)	$0.90	$0.98
Unit cost (covered storage)	Distribution	$7.17	$5.48
Unit cost (open storage)	Distribution	$0.75	$0.67
Unit cost (receiving and shipping)	Distribution	$18.48	$23.57
Unit cost per barrel	Supply (fuels)	$32.54	$30.36

Note: TBD = to be determined.

Table C-9. Metric Definitions

Indicator	Definition
Customer complaints	Percentage based on the number of valid reports of discrepancies received and the number of MROs shipped
Customer price change	Change in customer price expressed as a percentage; the difference in price (standard price) charged for an item from one year to the next (not applicable to fuels, subsistence sales to the Defense Commissary Agency, and items not having a standard price, e.g., local purchase items); the customer price change is a measure of DLA's supply management and financial performance to its external customers
Customer satisfaction	Customer satisfaction based on survey data (the percentage of customers satisfied with DLA services and products)
Customer satisfaction rating (right reception)	Average program manager and procuring contracting officer ratings based on a scale of 1 (totally dissatisfied) to 6 (completely satisfied); the survey questions generally relate to the quality and timeliness of support DCMC provides in product conformance, product delivery, product cost, advice, and overall support
Disposal release order processing time	Average number of calendar days for depots to process and ship disposal release orders; metric measures the time between when the depot receives the disposal release order and the time transportation ships the materiel
Disposal unit cost (hazardous item)	Cost per line to operate the environmental (hazardous) program; calculated by dividing the environmental operating cost by the line items of hazardous waste disposed by service contract
Disposal unit cost (nonhazardous)	Cost per dollar of proceeds realized from the reutilization, transfer, donations, and sales of nonhazardous materiel; metric calculated by dividing the cost of operating the program by the workload; workload is defined as a portion of the acquisition value of property that is disposed plus total sales proceeds
DLIS percent of real-time inquiries completed within 2 seconds	Time for customers to process their Federal Logistics Information Systems on-line transactions through the DLSC Logistics On-line Access System; expressed as the percent of the number of monthly transactions processed within 2 seconds; metric is inclusive of queries and updates and accounts for simple and complex transactions
DLIS processing time (batch inquiries)	Transaction response time for system inquires, expressed as a monthly average of the processing times; the types of transactions that enter the system through the batch process are routine maintenance of segment data or data elements; database queries, such as data retrieval and provisioning screening; and requests for NSN assignments for new items entering the supply system
DLIS publications on-time distribution	Percent of publications distributed on time; some products are produced monthly, bimonthly, semiannually, and annually; the metric measures DLIS's ability to distribute the publications according to schedule
DNSC sales revenue (less diamonds)	Estimated revenue expected to be generated by the sale of assets (other than diamonds) held in the DNSC inventory; measure is one factor to determine the success of the public offering of strategic assets
Increase acquisition planning and request for proposal review participation (right advice)	Measure of DCMC acquisition activity, including participation in acquisition strategy panels and other acquisition planning meetings as well as review of acquisition planning documents; metric tracks the quantity of requests received from customer buying activities to participate in acquisition planning or request for proposal
Increase conforming items (right item)	Measure of items that satisfy contract requirements; metric tracks items found usable following lab testing as a percentage of all items lab-tested
Increase cost savings and avoidances return on investment (right price)	Ratio of cost savings and avoidances to the DCMC budget

Table C-9. Metric Definitions (Continued)

Indicator	Definition
Increase on-time contractor delivery (right time)	Measure of items delivered on time; metric tracks line items delivered on-time as a percentage of line items due
Inventory value (active)	Value of DLA-owned consumable materiel in current-year dollars, based on latest acquisition cost, with unserviceable assets revalued to 50 percent and potential reutilization stocks revalued to salvage value (approximately 3 percent); active inventory is materiel expected to be consumed in the budget period (2 years) and materiel purchased to meet war reserve requirements; data for indicator reported to OSD by the SSIR
Inventory value (inactive)	Value of DLA-owned consumable materiel in current-year dollars, based on latest acquisition cost, with unserviceable assets revalued to 50 percent and potential reutilization stocks revalued to salvage value (approximately 3 percent); inactive inventory is materiel not expected to be consumed in the budget period but likely to be used in future years; data for indicator is reported to OSD by the SSIR
Logistics response time (ICP delayed issues)	Time (mean days) that elapses between the date a requisition is received at an ICP and the date the MRO is transmitted to a depot or storage site for stocked items that have no materiel on-hand and are backordered pending receipts
Logistics response time (ICP immediate issues)	Time (mean days) that elapses from the date a requisition is received at an ICP to the date the MRO is transmitted to a depot or storage site for orders that have materiel on-hand
Logistics response time (MRO processing—high priority)	Ability of performance to meet the performance target
Logistics response time (MRO processing—routine)	Ability of performance to meet the performance target
Logistics response time (planned direct vendor deliveries)	Time that elapses from the date an ICP receives a requisition for an item, managed under the planned direct vendor delivery concept, to the date the contractor ships the materiel directly to the requisitioner
Product availability (fuels)	A measure of the availability of fuel; on-hand inventory and a projection of future inventory status are compared to customer requirements for all products; the status is the percent of the requirement being met; metric indicates ability to meet the objective (100 percent means that if required product is on-hand, customer operational requirements are being met 100 percent of the time)
Product conformance	Number of NSNs that passed random testing for critical and major defects and characteristics divided by the total number of NSNs tested; the data are for materiel on contract for the current and previous 2 contract years; indicator applies to construction, electronics, industrial, and general supplies
Return on investment	Measure calculated by dividing the sum of all return on investment amounts saved and avoided during the period by the total operating costs expended during the period
Reutilization, transfer, and donation ratio	Aggregate acquisition value of reutilized, transferred, and donated property processes, expressed as a percent of acquisition value of all excess and surplus property received (total receipts); indicator applies to available assets that are economically reused, thus preventing concurrent procurement of new assets; indicator addresses disposal via reutilization by another defense customer, transfer to another federal agency, or donation to state and local governments or nonprofit organizations; using indicator as a percent of usable receipts indicates compliance with federal regulations that mandate reuse through cost avoidance programs
Right efficiency	New measure being developed

Table C-9. Metric Definitions (Continued)

Indicator	Definition
Sample inventory accuracy	Accuracy of inventory records based on a random sample; record accuracy is based on if the physical count matches the recorded balance; DoD is developing standard formulas that will be implemented in the Distribution Standard System
Space utilization	Total usable storage space occupied in DLA warehouses and storage facilities for all depots; the space utilization performance target of 85 percent reflects the desire to make optimum use of available covered storage space at distribution depots; the goal is 85 percent (rather than 100 percent) because unoccupied storage space is necessary to facilitate the movement to stow materiel in the inventory, pick materiel from the inventory, accomplish rewarehousing of materiel, and conduct periodic physical inventories
Stock availability	Percent of requisitions filled immediately from stock on hand; the calculation for stock availability is back orders established divided by net demands with the quotient subtracted from 100 percent; stock availability does not apply to subsistence or fuel
Unit cost	A cost accounting procedure that captures all costs to produce an output; the process is to identify the output, the cost of producing the output, and the workload for an output; costs are identified as direct, indirect, and general and administrative (overhead); the output for a depot is a line item received or issued; each DLA ICP has a unit cost goal; this indicator is derived by combining supply operations costs and materiel product costs, and dividing by the total amount of sales
Unit cost (covered storage)	Customers who store materiel at DLA depots are charged a storage price per square foot for storage based on the square footage occupied in a roofed facility; occupied space is based on a four-quarter average of the standard quarterly storage reports (DD Forms 805 and 1649); quarterly reports are provided to service ICPs; annual rate is developed using the total storage cost divided by the average annual occupied square feet
Unit cost (open storage)	Customers who store materiel at DLA depots are charged a storage price per square foot for storage based on the square feet occupied outdoors; occupied space is based on a four-quarter average of the standard storage reports (DD Forms 805 and DD 1649); quarterly reports are provided to service ICPs; annual rate is developed using the total storage costs divided by the average annual square footage occupied
Unit cost (receiving and shipping)	Costs associated with the receipt and issue of materiel into the DLA distribution system are charged to customers by discrete processing rates based on the handling characteristics of the materiel (bin, medium bulk, heavy bulk, hazardous) and type of processing requested (receipt, off-base issue, on-base issue, transshipment); DLA uses a cost accounting system that captures all costs to produce each category of receipt and issue
Unit cost per barrel	Cost per net barrel sold; the unit cost per barrel of fuel is equal to the projected costs (materiel, materiel related, and operations) divided by the number of barrels projected to be sold; credit barrels have a separate unit cost that is equal to the standard price

Table C-10 matches LMI's recommended enterprise metrics with the metrics DLA uses.

Table C-10. Metric Matching

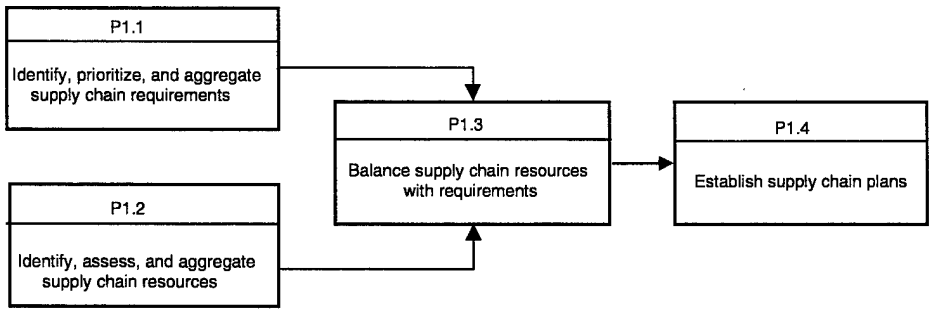
Recommended key supply-chain management metric	Perspective			Possible DLA metric equivalents
	Customer satisfaction	Cost	Readiness and sustainability	
Supply chain response time	X			Can be obtained from several measurements; LRT metrics in DLA performance report include LRT (ICP immediate issues), LRT (ICP delayed issue), LRT (planned DVD), LRT (MRO processing—high-priority), LRT (MRO processing); data can be obtained from DAAS; other sources include PLT and ALT from Standard Automated Materiel Management System
Perfect order fulfillment	X			Can be obtained from several measurements, including DCMC's customer satisfaction rating (DCMC's role in getting the right item, getting it at the right time, getting the right price, and providing the right advice), customer complaints (reports of discrepancies, although discrepancies less than $100 are not reported), and metrics on meeting required delivery dates
Weapon system NMCS rates			X	Weapon system supply availability rates, stock availability rates, and fill rates
Upside production flexibility			X	Metric needs to be developed; however, the ICIS model is a good candidate source for the data
Total supply chain management costs as a percent of sales		X		Unit cost equivalents include unit cost (receiving and shipping), unit cost (covered storage), and unit cost (open storage); some information on operations and materiel costs can be obtained from DLA overhead costs
War reserve ratio			X	Metric needs to be developed; ICIS model could be a source
Net asset (inventory) turns		X		Metric tracked by DLA

Appendix D
Process Performance Measures

PLAN

Process metrics provide another level of drilldown; each metric provides diagnostics for a functional metric. The SCOR model facilitates this drilldown by identifying many processes to perform the planning function. Figure D-1 captures the processes used in the plan function.

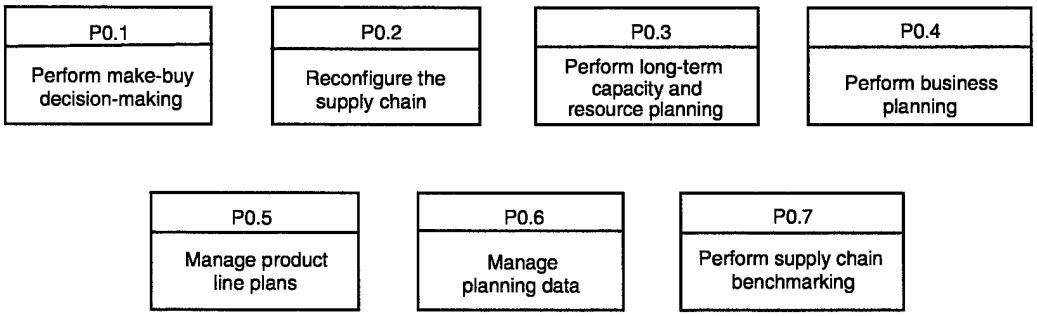
Figure D-1. SCOR Process Model: Plan Supply Chain



The first step is determining current requirements and estimating them for the near future. Pipeline assets, those already in the system and those planned, are aggregated and applied to the requirements. The assets typically are separated into the categories of on-hand inventory, in maintenance (or waiting to be inducted), or in procurement (a vendor contract has been signed or is being developed).

In addition to balancing assets and requirements, the plan function has the responsibility for examining long-term supply chain requirements and configuration. Figure D-2 shows the processes used to create supply chain infrastructure.

Figure D-2. SCOR Process Model: Plan Infrastructure



For the deficit ratio, metrics can be divided along a time horizon (to identify the magnitude of a potential problem) and pipeline position (to identify the location of a potential problem). Table D-1 shows the deficit ratio process metrics.

Table D-1. Deficit Ratio Process Performance Measures

Process metric	Planning process	Process element
Deficit ratio	Plan supply chain	Balance supply chain resources with requirements
Under-induction into maintenance	Plan supply chain	Balance supply chain resources with requirements
Over-induction into maintenance	Plan supply chain	Balance supply chain resources with requirements
Deficit on contract	Plan supply chain	Balance supply chain resources with requirements
Deficit in commitment	Plan supply chain	Balance supply chain resources with requirements
Forecast accuracy	Plan supply chain	Aggregate supply chain requirements
Percent assets not counted	Plan supply chain	Identify supply chain resources

Components of inventory holding cost provide diagnostics for this important metric (Table D-2).

Table D-2. Holding Cost Process Performance Measures

Process metric	Planning process	Process element
Obsolete inventory	Plan supply chain	Balance supply chain resources with requirements
Inventory loss	Plan supply chain	Balance supply chain resources with requirements
Inventory storage costs	Plan supply chain	Balance supply chain resources with requirements

Overage diagnostics (Table D-3) identify the location of pipeline excesses. The functional metrics determine if the overage begins in the current year or in forecasted years. For current-year overages, process metrics determine the pipeline location of the excesses. Two metrics of inapplicable assets help to determine if excesses are being introduced unnecessarily into the pipeline during procurement.

Table D-3. Overage Process Performance Measures

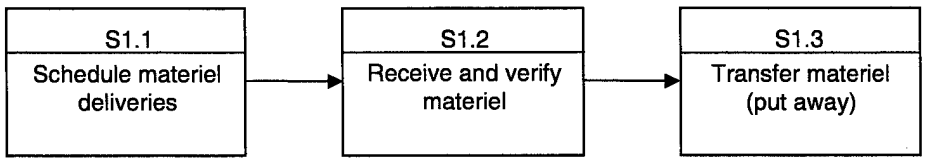
Process metric	Planning process	Process element
Overage	Plan supply chain	Balance supply chain resources with supply chain requirements
Inapplicable asset on contract	Plan supply chain	Balance supply chain resources with supply chain requirements
Inapplicable assets in commitment	Plan supply chain	Balance supply chain resources with supply chain requirements

SOURCE

Process Metrics

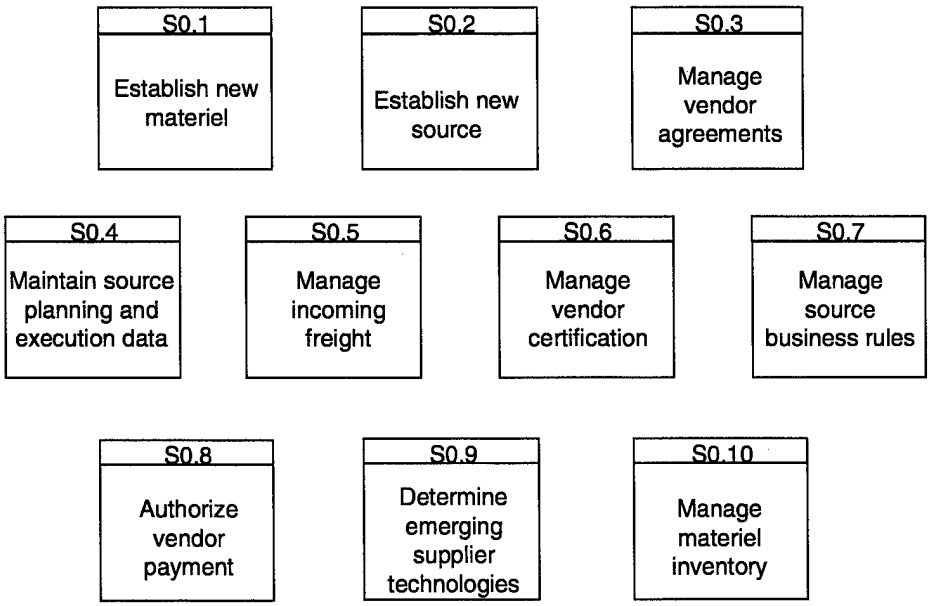
One of the primary responsibilities of source (materiel acquisition) may be viewed in terms of the kind of materiel that is sourced: stocked, make-to-order, and engineer-to-order materiel. Secondary items, the subject of this report, are stocked or make-to-order materiel (because stocked and make-to-order materiel have the same processes, this report refers to only stocked materiel in discussing secondary items in this section). SCOR represents these processes in Figure D-3.

Figure D-3. SCOR Process Model: Source Stocked Items



Before sourcing can occur, the infrastructure needs to be in place. SCOR represents the processes involved with managing the source infrastructure in Figure D-4. Metrics for source infrastructure and source stocked product are process metrics and provide diagnostic insight to the functional metrics. If the results of the functional metrics are not acceptable to the managers of the source function, they would examine the process metrics to determine the underlying causes for the unacceptable results. Process metrics may be diagnostic to more than one functional metric.

Figure D-4. SCOR Process Model: Source Infrastructure



The diagnostic process metrics for percent perfect order fulfillment (from suppliers) are listed in Table D-4.

Table D-4. Percent Perfect Order Fulfillment (from Suppliers) Process Metrics

Process metric	Source process	Process element
Percent on-time deliveries	Source stocked product	Receive and verify materiel
Percent correct quantity deliveries	Source stocked product	Receive and verify materiel
Percent defect-free deliveries	Source stocked product	Receive and verify materiel
Percent deliveries with correct documentation	Source stocked product	Receive and verify materiel

The process metrics, similar to the enterprise metric, use four requirements to determine if an order from a vendor is perfect. The order has to be delivered on time (to request date), in the correct quantity, in defect-free condition, and with the correct supporting documentation. If an order fails to meet any criterion, it is not perfect. Tracking the reasons for an imperfect order allows the source professional to take appropriate actions with the supplier to improve order fulfillment.

The diagnostic process metrics for percent change in materiel price as compared to inflation are listed in Table D-5.[1]

Table D-5. Percent Change in Materiel Price as Compared to Inflation Process Metrics

Process metric	Source process	Process element
Percent suppliers submitting electronic invoices	Source infrastructure	Authorize vendor payment
Percent suppliers accepting electronic payment	Source infrastructure	Authorize vendor payment
Percent suppliers with on-line catalogs	Source stocked products	Schedule materiel deliveries
Percent suppliers accepting electronic orders	Source stocked products	Schedule materiel deliveries
Percent suppliers accepting EDI orders	Source stocked products	Schedule materiel deliveries
Percent orders placed electronically	Source stocked products	Schedule materiel deliveries
Percent orders placed via EDI	Source stocked products	Schedule materiel deliveries

In addition to the materiel and overhead costs a supplier pays, the selling price is affected by the way that the supplier conducts business transactions with its customers. To the extent that a customer can conduct business in a way that is cost-effective for the supplier, it should manifest in a lower purchase price. The metrics in Table D-5 reflect best commercial practices because they are cost-effective. The degree that source professionals use the practices should be measured. As their adoption increases, pricing changes should not exceed the inflation rate.

[1] The metrics are subsets of the diagnostic metrics for materiel acquisition costs.

The diagnostic process metrics for materiel acquisition costs as a percent of sales are listed in Table D-6.

Table D-6. Materiel Acquisition Costs as a Percent of Sales Process Metrics

Process metric	Source process	Process element
Materiel process engineering costs as a percent of materiel acquisition costs	Source infrastructure	Establish new materiel
Materiel management and planning costs as a percent of materiel acquisition costs	Source infrastructure	Maintain source planning and execution data
• Ordering costs as a percent of materiel acquisition costs	Source stocked products	Schedule materiel deliveries
• Percent of suppliers in compliance with contracts	Source infrastructure	Manage vendor agreements
• Percent of long-term (greater than 3 years) contracts	Source infrastructure	Manage vendor agreements
• Percent of suppliers with on-line catalogs	Source stocked products	Schedule materiel deliveries
• Percent of suppliers accepting electronic orders	Source stocked products	Schedule materiel deliveries
• Percent of suppliers accepting EDI orders	Source stocked products	Schedule materiel deliveries
• Percent of orders placed electronically	Source stocked products	Schedule materiel deliveries
• Percent of orders placed via purchase card	Source stocked products	Schedule materiel deliveries
• Percent of orders placed via EDI	Source stocked products	Schedule materiel deliveries
Receiving costs as a percent of materiel acquisition costs	Source stocked products	Receive and verify materiel
Inspection costs as a percent of materiel acquisition costs	Source stocked products	Receive and verify materiel
Materiel storage costs as a percent of materiel acquisition costs	Source stocked products	Transfer materiel (put away)
• Total NSNs managed as a percent of materiel acquisition costs	Source infrastructure	Manage materiel inventory
• Value of inventory as a percent of materiel acquisition costs	Source infrastructure	Manage materiel inventory
• Percent of NSNs with ABC or weapons criticality classification	Source infrastructure	Manage materiel inventory
Percent of NSNs with accurate inventory storage data	Source infrastructure	Manage materiel inventory
Inbound freight charges as a percent of materiel acquisition costs	Source infrastructure	Manage incoming freight
• Percent of certified carriers	Source infrastructure	Manage incoming freight
• Number carriers used as a percent of target number of carriers	Source infrastructure	Manage incoming freight

Note: The indented metrics are diagnostic for the ones above them.

The SCOR model defines materiel acquisition costs as materiel management and planning, supplier quality and engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs. The metrics in Table D-6 assess the components of materiel acquisition costs. Measuring the components allows the source professional to identify causes and take corrective action if managers determine that materiel acquisition costs are unacceptable.

The diagnostic process metric for surge volume identified as a percent of total surge volume is presented in Table D-7. This metric is needed because most contracts contain a surge clause. The requirement to demonstrate a surge capability (e.g., drills) should also be included in the contracts.

Table D-7. Surge Volume Identified as a Percent of Total Surge Volume Process Metric

Process metric	Source process	Process element
Number of supplier contracts with surge clauses as a percent of total contracts	Source infrastructure	Manage vendor agreements

The diagnostic process metrics for upside production flexibility—source are presented in Table D-8. The metrics measure how effectively the source function can satisfy the need for new materiel or the increased demand for existing materiel. They measure how well the source function manages the existing and potential supplier networks. A well-managed supplier network usually includes a certification program for its suppliers. Requirements and methods are established for identifying and prequalifying backup suppliers for single-sourced materiel and materiel that meet certain criteria (e.g., criticality, dollar investment, technological requirements).

Table D-8. Upside Production Flexibility—Source Process Metrics

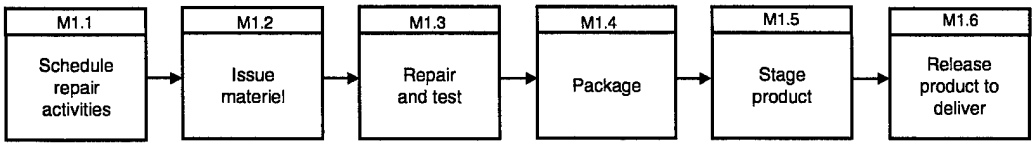
Process metric	Source process	Process element
Time (days) to identify a new supplier	Source infrastructure	Establish new source
Percent of prequalified suppliers	Source infrastructure	Establish new source
Percent of NSNs single-sourced	Source infrastructure	Manage materiel inventory
Percent of single-source suppliers having backup suppliers	Source infrastructure	Manage vendor agreements
Percent of certified suppliers	Source infrastructure	Manage vendor certification
Percent change in certified suppliers	Source infrastructure	Manage vendor certification

MAINTAIN

Process Metrics

The SCOR processes for maintenance are depicted in Figure D-5. The relevant maintenance metrics for the processes in Figure D-5 are diagnostic to the maintain functional metrics.

Figure D-5. SCOR Process Model: Maintain Stocked Product



The process metric for performance to customer-request date—maintain is presented in Table D-9. Schedule achievement compares the repair activity's performance to its schedule. When repair customers place orders for repair, maintenance depots schedule the workload to be accomplished. The inability to comply with the production schedule affects the depot's ability to deliver repaired materiel by the customer's required delivery date.

Table D-9. Performance to Customer-Request Date—Maintain Process Metric

Process metric	Maintain process	Process element
Schedule achievement	Maintain stocked product	Schedule repair activities

The process metrics for repair cycle time are listed in Table D-10. An important metric that affects repair cycle time is product and grade changeover time. As lot sizes are decreased, depots need to react quicker when orders are received. The timely availability of repair parts is measured by materiel requisition cycle time. One of the best supply chain practices is to position parts as close to the point of consumption as possible to reduce cycle time. The percent of parts delivered to point of use metric captures progress in implementing the strategy. Finally, the ratio of actual to theoretical cycle time measures how well the repair activity sets standards and executes the workload.

Table D-10. Repair Cycle Time Process Metrics

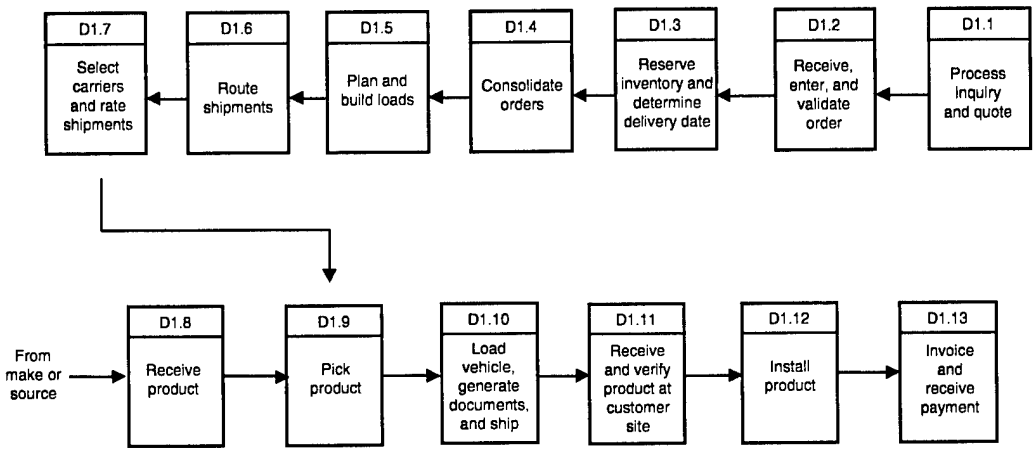
Process metric	Maintain process	Process element
Product and grade changeover time	Maintain stocked product	Schedule repair activities
Materiel requisition cycle time	Maintain stocked product	Issue materiel
Percent of parts delivered to point of use	Maintain stocked product	Issue materiel
Ratio of actual to theoretical cycle time	Maintain stocked product	Repair and test

DELIVER

Process Metrics

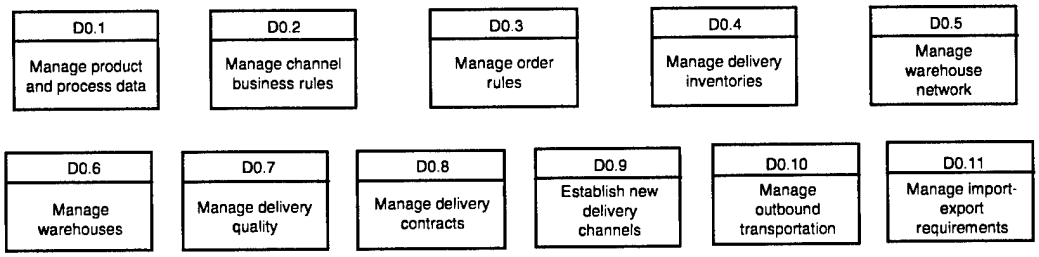
At the functional and process levels, the metrics for deliver evaluate the delivery of a stocked product. For the purpose of this report, we also use this view because our analysis focuses on the delivery of secondary items, although we note that two other delivery processes—deliver make-to-order products and deliver engineer-to-order products—also exist. Figure D-6 depicts the deliver stocked product process.

Figure D-6. SCOR Process Model: Deliver Stocked Product



However, before the deliver process can occur, the deliver infrastructure needs to be in place. This deliver infrastructure is depicted in Figure D-7.

Figure D-7. SCOR Process Model: Deliver Infrastructure



The metrics for deliver infrastructure and deliver stocked product are the process metrics in the SCOR model and provide a diagnostic insight and link to the deliver functional metrics. The ability to drill down from the functional level into the processes enables delivery managers to diagnose results internally across the deliver function as well as externally in terms of customer satisfaction, readiness, and cost.

Table D-11 presents the process performance measures for percent of on-time delivery, percent of correct quantity delivered, percent of defect-free delivery, percent of deliveries with correct documentation, and fill rate.

Table D-11. Percent of On-Time Delivery, Percent of Correct Quantity Delivered, Percent of Defect-Free Delivery, and Percent of Deliveries with Correct Documentation Metrics

Process metric	Deliver process	Process element
Inventory accuracy	Deliver infrastructure	Manage deliver inventories
Picking accuracy	Deliver stocked product	Pick product
Packing accuracy	Deliver infrastructure	Manage deliver quality
Shipping accuracy	Deliver infrastructure	Manage outbound transportation
Order entry accuracy	Deliver infrastructure	Manage product and process data

Inventory, picking, packing, and shipping accuracy are diagnostic because they directly affect percent of on-time delivery, percent of correct quantity delivered, and percent of deliveries with correct documentation. If the inventory is inaccurate, the product is picked incorrectly, or the product picked is obsolescent or shipped at the wrong time, cascading negative effects on perfect order fulfillment will occur—orders will be delivered late, the incorrect quantity will be delivered, and the documentation will be incorrect. Also, order entry accuracy can affect percent of on-time delivery, percent of correct quantity delivered, and percent of deliveries with correct documentation. If the order is entered incorrectly, the documentation will be wrong, on-time delivery will not occur, and the incorrect quantity will be delivered.

Table D-12 shows the process performance measures for order management costs. With the exception of capacity utilization, the order management costs process metrics are diagnostic because they aggregate of the costs of the order management function. Capacity utilization (distribution) is indicative of the effective use of resources at distribution depots. Capacity utilization affects the storage space to facilitate physical movement to stow materiel, pick materiel from inventory, rewarehouse materiel, and conduct physical inventories; all metrics are diagnostic to distribution costs that are part of the order management costs.

Table D-13 presents the process metrics associated with order fulfillment lead-time. The process metrics are diagnostic because each metric is a component of order fulfillment lead-time (deliver lead-time).

Table D-12. Order Management Costs Process Metrics

Process metric	Deliver process	Process element
Order entry and maintenance costs	Deliver stocked product	Receive, enter, and validate order
Create customer order costs	Deliver stocked product	Receive, enter, and validate order
Order fulfillment costs	Deliver stocked product	Reserve inventory and determine delivery date
Transportation, outbound freight, and duties cost	Deliver stocked product	Consolidate orders, plan and build loads, route shipments, select carriers and rate shipments
Distribution costs	Deliver stocked product	Receive and pick product
Incoming materiel costs	Deliver stocked product	Receive product
Customer invoicing and accounting costs	Deliver stocked product	Invoice and receive payment
Capacity utilization	Deliver infrastructure	Manage warehouse network; manage warehouses

Table D-13. Order Fulfillment Lead-Time (Deliver Lead-Time) Process Metrics

Process metric	Deliver process	Process element
Customer signature and authorization to order receipt time	Deliver stocked product	Receive, enter, and validate order
Order receipt to order entry complete time	Deliver stocked product	Receive, enter, and validate order; reserve inventory and determine delivery date
Order entry complete to order ready for shipment time	Deliver stocked product	Consolidate order, plan and build loads, route shipments, select carriers and rate shipments, pick product, load vehicle generate shipment documents and ship product
Order ready for shipment to customer receipt of order time	Deliver stocked product	Receive and verify product at customer site

Appendix E
Performance Measure Definitions

This appendix presents definitions of enterprise performance measures as well as definitions of the following SCOR functions:

- Plan
- Source
- Maintain
- Deliver.

ENTERPRISE

Inventory turns. Inventory turns are computed by dividing the total revenue (at latest acquisition cost) by the value of inventory at latest acquisition cost.

Percent change in customer price compared to inflation. Price is represented by a market basket of technology, similar to the basket of goods used in the CPI. The market basket of technology reflects the DoD practice of replacing many secondary items (e.g., radar systems) with the most recent technological version rather than the original version.

Perfect order fulfillment rate. The ratio of perfectly satisfied orders to total orders. A perfect order is an order that meets the following standards:

- Delivered complete; all items delivered in the quantities requested
- Delivered on time, using the customer's definition of on-time delivery
- Complete and accurate documentation (including packing slips, bills of lading, and invoices) to support the order
- Delivered in perfect condition and in the correct configuration ready to be used by the customer; no damage; faultlessly installed (as applicable).

Supply chain management costs as a percent of sales (at standard price). Supply chain management costs (i.e., supply chain-related MIS, supply chain planning, inventory carrying, materiel acquisition, and order management costs) expressed as a percent of sales at standard price.

Supply chain response time. The total average length (measured in days) of the supply chain. The time is derived from the average plan, source, maintain, and deliver cycle times. For DoD, the time is the sum of the average source and order cycle times. A reparable item has two components—serviceables obtained from procurement (administrative and production lead-times) and serviceables obtained from repair (retrograde and repair cycle time)—considered in the source cycle time. The source cycle time for a reparable is a quantity-weighted average of the two.

Upside production flexibility. The average number of days to achieve a sustainable posture for executing the national military strategy of fighting two MTWs.

War reserve ratio. The ratio of war reserve on-hand assets to the war reserve requirements.

Weapon system NMC rates. The average percent of time that a fleet of weapon systems is not fully mission-capable. This metric has two components: NMCS (lack of parts) and NMCM (lack of maintenance resources).

Weapon system supply chain costs as a percent of the acquisition cost. This indicator represents the cost of ownership of a weapon system as a function of its replacement cost.

SOURCE

Change in materiel price (of a market basket of technology) as a percent of inflation. The price of technology basket of the current period minus the price of technology basket of the prior period divided by inflation over the current period.

Dollar value of inventory as a percent of materiel acquisition costs. The dollar value of the inventory divided by the costs incurred for production materiel (i.e., sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Handling lead-time. The time from when an item is received and available for putaway until the item is stored in its initial storage location.

Inbound freight costs as a percent of materiel acquisition costs. Costs of inbound freight divided by the costs incurred for production materiel (i.e., the sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Inspection costs as a percent of materiel acquisition costs. All costs associated with inspecting and testing incoming materiel divided by the costs incurred for

production materiel (i.e., the sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Materiel acquisition costs as a percent of revenue. The costs incurred for production materiel (e.g., materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs) divided by sales at the latest acquisition cost.

Materiel management and planning costs as a percent of materiel acquisition costs. All costs associated with supplier source; contract negotiation and qualification; and the preparation, placement, and tracking of a purchase order divided by the costs incurred for production materiel (i.e., sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Materiel process engineering as a percent of materiel acquisition costs. Costs associated with tasks to document and communicate materiel specifications as well as reviews to improve the manufacturability of a purchased item divided by the costs incurred for production materiel (i.e., the sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Materiel storage costs as a percent of materiel acquisition costs. All costs associated with storing materiel (including warehouse space and management, materiel stocking, processing work orders, pricing, and internal materiel movement) divided by the costs incurred for production materiel (i.e., sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Number of carriers used as a percent of target number of carriers. The number of carriers used divided by the target number of carriers.

Number of supplier contracts with surge clauses as a percent of total contracts. The number of contracts with surge clauses divided by the total number of contracts.

Order lead-time. The time between requisition acknowledgement and supplier confirmation of the order.

Ordering costs as a percent of materiel acquisition costs. All costs associated with the preparation, placement, and tracking of a purchase order divided by the

costs incurred for production materiel (i.e., sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Percent of certified carriers. The number of certified carriers divided by the total number of carriers.

Percent of certified suppliers. The number of certified suppliers divided by the total number of suppliers.

Percent of change in certified suppliers. The number of certified suppliers in the current period minus the number of certified suppliers in previous period divided by the number of certified suppliers in the previous period.

Percent of correct quantity deliveries. The number of deliveries (from suppliers) with ordered quantity divided by the total number of deliveries.

Percent of defect-free deliveries. The number of deliveries (from suppliers) without damage divided by the total number of deliveries.

Percent of deliveries with correct documentation. The number of deliveries (from suppliers) with correct documentation divided by the total number of deliveries.

Percent of long-term contracts. The number of long-term (greater than 3 years) contracts divided by the total number of contracts.

Percent of NSNs single-sourced. The number of NSNs having single-source suppliers divided by the total number of NSNs.

Percent of NSNs with ABC and weapons criticality classification. The number of NSNs having ABC and weapons criticality classification divided by the total number of NSNs.

Percent of NSNs with accurate inventory storage data. The number of NSNs having accurate inventory storage data divided by the total number of NSNs.

Percent of on-time deliveries. The number of deliveries (from suppliers) on-time (relative to the request date) divided by the total number of deliveries.

Percent of orders placed electronically. The number of orders placed electronically divided by the total number of orders.

Percent of orders placed via EDI. The number of orders placed by EDI divided by the total number of orders.

Percent of perfect order fulfillment. The number of orders received on time, in the correct quantity, defect-free, and with correct documentation divided by the total number of orders.

Percent of prequalified suppliers. The number of suppliers prequalified for a subset of general supplier requirements divided by the total number of suppliers.

Percent of purchases made via purchase card. The number of purchases made with purchase cards divided by the total number of purchases.

Percent of single-source suppliers having backup suppliers. The number of single-source suppliers for which a contingency plan exists to use another (prequalified) supplier divided by the number of single-source suppliers.

Percent of suppliers with on-line catalogs. The number of suppliers having on-line catalogs divided by the total number of suppliers.

Percent of suppliers accepting EDI orders. The number of suppliers accepting EDI orders divided by the total number of suppliers.

Percent of suppliers accepting electronic funds transfer payment. The number of suppliers accepting electronic funds transfer payments divided by the total number of suppliers.

Percent of suppliers accepting electronic orders. The number of suppliers accepting electronic orders divided by the total number of suppliers.

Percent of suppliers in compliance with contracts. The number of suppliers in contract compliance divided by the total number of suppliers.

Percent of suppliers submitting electronic invoices. The number of suppliers submitting electronic invoices divided by the total number of suppliers.

Receiving costs as a percent of materiel acquisition costs. All costs associated with taking possession of materiel (excluding inspection) divided by the costs incurred for production materiel (i.e., the sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Receiving lead-time. The time between dock delivery and release for putaway into storage.

Supplier lead-time. The time between order confirmation and dock delivery.

Time to identify a new supplier. The time (in days) from the recognition of the need to locate a new supplier for a product to the date an agreement (contract) is signed with the supplier.

Time to identify new product specifications. The time (in days) from the recognition of the need to develop new product specifications to the agreement on specifications by all necessary parties.

Total NSNs managed as a percent of materiel acquisition costs. Total number of NSNs managed divided by all costs associated with storing materiel (including warehouse space and management, materiel stocking, processing work orders, pricing, and internal materiel movement) and the costs incurred for production materiel (i.e., sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Total source lead-time. Cumulative lead-time (inside-plant planning, supplier [internal or external] lead-time, receiving, and handling from demand identification until the materiel is available for use) to source 95 percent of the value of materiel from internal and external suppliers.

Upside production flexibility—source (existing supplier network). Time (in days) to increase supply from existing suppliers to support a two-MTW scenario.

Upside production flexibility—source (new suppliers). Time (in days) to identify and begin to obtain materiel from a new supplier to support a two-MTW scenario.

MAINTAIN

Materiel requisition cycle time. The average time for maintenance personnel to receive repair parts from the time they order the materiel to the time they receive it.

Percent of parts delivered to point of use. The percent of materiel receipts delivered directly to production, a consolidation point, or point of use on the production floor with no inspection or only a minor visual or paperwork inspection.

Performance to customer-request date—maintain. The percent of repair orders fulfilled on or before the ICP's requested date.

Product and grade changeover time. The average time (in hours) to change a repair line to repair a different item.

Ratio of actual to theoretical cycle time. The percent of time that the actual repair cycle time deviates from the standard (or theoretical) cycle time.

Repair cycle time. The sum of retrograde time (i.e., base processing and intransit time) to the repair depot, supply to maintenance movement time, shop flow time, and maintenance to supply movement time.

Schedule achievement. The percent of time that a plant achieves its production schedule.

Upside production flexibility—maintain. Time (in days) to increase repair from existing repair rate to support a two-MTW scenario surge requirement.

DELIVER

Capacity utilization. A measure of the use of a resource to produce a good or service. Factors that should be considered include internal manufacturing capacity, constraining processes, direct labor availability, and materiel availability of key components.

Create customer order costs. Costs for creating and pricing configurations to order and preparing order documents.

Customer invoicing and accounting costs. Costs for invoicing, processing customer payments, and verifying customer satisfaction.

Customer signature and authorization to order receipt time. Time from when the customer authorizes an order to the time that the order is received (in calendar days).

Days of sales outstanding. The gross accounts receivable divided by the total gross annual sales that has been divided by 365.

Delivery performance to customer-request date. The percent of orders that are fulfilled on or before a customer's requested date.

Delivery performance to scheduled commit date. The percent of orders that are fulfilled on or before the original scheduled or committed date.

Distribution and warehousing costs. Costs for warehouse space and management, finished goods receiving and stocking, processing shipments, picking and consolidating, selecting carrier, and staging products and systems.

End-of-life inventory. Inventory on-hand that will satisfy future demand for products no longer in production.

Faultless invoices. The number of invoices issued without error. Examples of potential invoice defects are a change from customer purchase order without proper customer involvement; wrong customer information (e.g., name, address, telephone number); wrong product information (e.g., part number, product

description); wrong price (e.g., discounts not applied); and wrong quantity, terms, or date.

Fill rates. The percent of ship-from-stock orders shipped within 24 hours of order receipt.

Finished goods inventory days of supply. Gross finished goods inventory divided by the value of transfers that has been divided by 365.

Incoming materiel costs. The costs of materiel entering the distribution center or depot.

Incoming materiel quality. The number of received parts that fail inspection divided by the total number of parts received.

Inventory accuracy. The percent of total items with no inventory discrepancies.

Inventory obsolescence as a percent of total inventory. The annual obsolete and scrap reserves taken for inventory obsolescence expressed as a percent of the annual average gross inventory value.

Materiel acquisition costs. Costs incurred for production materiel (i.e., sum of materiel management and planning, supplier quality engineering, inbound freight and duties, receiving and materiel storage, incoming inspection, materiel process engineering, and tooling costs).

Number of orders not delivered complete. The number of orders for which all items on order are not delivered in the quantities requested.

Number of orders with complete and accurate documentation. The number of orders with correct documentation supporting the order, including packing slips, bills of lading, and invoices.

Order entry accuracy. The percent of orders entered correctly into the system.

Order entry and maintenance costs. Costs for maintaining the customer database, checking credit, accepting new orders, and adding them to the order system as well as order modifications.

Order entry complete to order ready for shipment time. Time for release to manufacturing, order configuration verification, production scheduling, build, pick-pack, and prepare for shipment (in calendar days).

Order fulfillment costs. Costs for processing the order, allocating inventory, ordering from the internal or external supplier, scheduling the shipment, reporting order status, and initiating shipment.

Order fulfillment lead-times. The average lead-times achieved from customer signature and authorization to order receipt, order receipt to order entry complete, order entry complete to start build, start build to order ready for shipment, order ready for shipment to customer receipt of order, and customer receipt of order to installation complete.

Order management costs as a percent of sales. The aggregation of the following cost elements:

- Create customer order costs
- Order entry and maintenance costs
- Contract, program, and channel management costs
- Installation planning costs
- Order fulfillment costs
- Distribution costs
- Transportation costs
- Installation costs
- Customer invoicing and accounting costs.

Order ready for shipment to customer receipt of order time. Time that consists of the total transit time (all components to consolidation point), consolidation, queue time, and additional transit time to customer receipt of order (in calendar days).

Order receipt to order entry complete time. Time for order revalidation, configuration check, credit check, and scheduling of received orders (in calendar days).

Packing accuracy. The percent of items packed without damage or proper packing lists and documentation.

Percent of faultless installations. The number of faultless installations divided by total number of units installed.

Performance to customer commit date. The percent of orders fulfilled on or before the customer committal date.

Picking accuracy. The percent of lines picked with no errors.

Published delivery lead-times. The standard lead-time (after receipt of order) currently published to customers by the sales organization for typical orders only (not standing and resupply orders).

Shipping accuracy. The percent of items shipped when transportation is scheduled.

Transportation, outbound freight, and duties costs. All company-paid transportation, freight, and duties costs from point of manufacture to end customer or channel.

Upside production flexibility—deliver. Time to increase deliver from existing issue rate to support a two-MTW scenario surge requirement (in calendar days).

PLAN

DWCF net operating result. The annual budget variance of the DWCF as a percent of budget.

Deficit ratio. Requirements minus assets divided by requirements. For items in short supply, this metric measures the degree of shortfall. The functional metric should apply to the entire supply chain, while process metrics focus on portions (e.g., retail level, wholesale on-hand, wholesale pipeline) of the supply chain. In the wholesale pipeline, further subdivision can be achieved by isolating the deficit on contract and the deficit in commitment to measure how effectively items are brought into the supply system.

Forecast accuracy. Forecast accuracy is measured for each item, in dollars and units, and calculated by subtracting the sum of the variances from the forecast sum and dividing by the forecast sum. The forecast sum is the sum of the units or dollars forecasted to be shipped in each month based upon the forecast generated 3 months before. The sum of the variances is the sum of the absolute values, at the forecasted line-item level, of the differences between each month's forecast and actual demand for the month.

Inapplicable assets in commitment. The percent of materiel on purchase request (i.e., a purchase request has been forwarded from the item manager to purchasing) that does not fill current requirements.

Inapplicable assets on contract. The percent of materiel on contract that does not fill current requirements.

Inventory carrying costs. The sum of opportunity cost, shrinkage, insurance and taxes, and total obsolescence for inventory (for serviceables and unserviceables).

Inventory losses. The amount of inventory lost because of causes other than obsolescence as a percent of the total inventory value.

Inventory storage costs. The costs to store assets in distribution warehouses as a percent of the total inventory value.

Obsolete inventory. The amount of inventory lost because of obsolescence as a percent of the total inventory value.

Overage. The number of assets minus requirements divided by requirements.

Overinduction. The number of assets inducted prematurely divided by the number of assets inducted.

Percent of assets not counted. The percent of known assets not considered in the forecast.

Percent of NSNs with 2-MTW planning factors. The number of NSNs with two-MTW planning factors divided by the total number of NSNs. This metric is a simple ratio that measures planning comprehensiveness for mobilization.

Percent of NSNs with war reserve requirements developed. The number of NSNs with war reserve requirements divided by the total number of NSNs. This metric is a simple ratio that measures the comprehensiveness of war reserve planning.

Ratio of funded war reserves to war reserve requirements. This metric measures congressional authorization limits to total mobilization requirements. It is useful for separating congressionally imposed limitations from DoD efforts for managing war reserves.

Ratio of on-hand war reserves to funded war reserves. This metric measures DoD management of war reserves within congressional authorization limits.

Supply chain planning costs. The costs associated with forecasting, developing finished goods or end item inventory plans, and coordinating the demand and supply process throughout the supply chain, including all channels. For items in a long-supply position, this metric measures the degree of long supply. Requirements are measured for current year, budget horizon, and usage at any horizon.

Underinduction. The number of assets inducted by the number of assets requiring induction. A measure of how well unserviceable assets are inducted into maintenance to provide adequate supplies.

Appendix F
Abbreviations

ABC	activity-based costing
ADP	automated data processing
ADUSD(L)MDM	Assistant Deputy Under Secretary of Defense (Logistics) for Materiel and Distribution Management
AF	Air Force
AFB	Air Force Base
ALC	Air Logistics Center
ALT	administrative lead-time
AMARC	Aerospace Maintenance and Regeneration Center
AMC	Air Mobility Command
AMCOM	U.S. Army Aviation Missile Command
BOM	bill of materiel
CASREP	casualty report
CECOM	U.S. Army Communications-Electronics Command
CONUS	Continental United States
CPI	Consumer Price Index
DAAS	Defense Automated Addressing System
DCMC	Defense Contract Management Command
DCSLOG	Deputy Chief of Staff for Logistics
DESC	Defense Energy Support Center
DLA	Defense Logistics Agency
DLIS	Defense Logistics Information Service

DLMSO	Defense Logistics Management Standards Office
DLSC	Defense Logistics Support Command
DNSC	Defense National Stockpile Center
DoD	Department of Defense
DoDAAC	DoD Activity Address Code
DOS	days of supply
DRMS	Defense Reutilization and Marketing Service
DSCC	Defense Supply Center, Columbus
DSCP	Defense Supply Center, Philadelphia
DSCR	Defense Supply Center, Richmond
DSS	Distribution Standard System
DUSD(L)	Deputy Under Secretary of Defense (Logistics)
DVD	direct vendor delivery
DWCF	Defense Working Capital Fund
ECO	engineering change order
EDI	electronic data interchange
FMC	fully mission-capable
FY	fiscal year
GPRA	Government Performance and Results Act
ICIS	Integrated Consumable Item Support
ICP	inventory control point
LMARS	Logistics Metrics Analysis Reporting System
LMI	Logistics Management Institute
LRT	logistics response time
L1	level 1

L2	level 2
L3	level 3
MC	mission-capable
MCLB	Marine Corps Logistics Base
MDM	Materiel and Distribution Management
MILSTEP	Military Supply and Transportation Evaluation Procedures
MIS	management information system
MRO	materiel release order
MTMC	Military Traffic Management Command
MTW	major theater war
NADEP	naval aviation depot
NAVICP	Navy Inventory Control Point
NAVSUP	Naval Supply Systems Command
NMC	not mission-capable
NMCM	not mission-capable—maintenance
NMCS	not mission-capable—supply
NSN	national stock number
NSY	naval shipyard
NUWC	Naval Undersea Warfare Center
NWCF	Navy Working Capital Fund
OC-ALC	Oklahoma City Air Logistics Center
OCONUS	outside the continental United States
OO-ALC	Ogden Air Logistics Center
OSD	Office of the Secretary of Defense
PLT	production lead-time

PMC	partially mission-capable
PMCM	partially mission-capable—maintenance
PMCS	partially mission-capable—supply
PTAMS	Pipeline Tracking Analysis and Metrics System
RCT	repair cycle time
SA-ALC	San Antonio Air Logistics Center
SCIR	Subsystem Capability Impact Reporting
SCOR	Supply Chain Operations Reference
SM-ALC	Sacramento Air Logistics Center
SSIR	Supply System Inventory Report
TACOM	U.S. Army Tank-Automotive and Armaments Command
TAV	total asset visibility
TBD	to be determined
USMC	United States Marine Corps
WIP	work in process
WR-ALC	Warner-Robins Air Logistics Center

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Larry S. Klapper, Neil Hamblin, Linda Hutchison, Linda Novak, Jonathon Vivar

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Supply chain management is the management of all processes or functions to satisfy a customer's order (from raw materials through conversion and manufacture through shipment). Performance measures, or metrics, are used to monitor the progress of supply chain initiatives. However, a consensus in DoD considers the metrics available to senior DoD managers to be inadequate or lacking the depth to measure the effectiveness of the DoD supply chain. The metrics are not balanced across customer service, cost, readiness, and sustainability performance objectives.

Because of the lack of adequate measures, the Deputy Under Secretary of Defense (Logistics) tasked Logistics Management Institute (LMI) to propose a set of balanced performance measures that senior decision-makers can use to monitor supply chain effectiveness. This report addresses the recommended top-level, or enterprise-level, performance measures. Enterprise metrics measure the overall performance of the supply chain and are cross-functional. In addition, the report presents functional and process performance measures for the Assistant Deputy Under Secretary for Materiel and Distribution Management that can be used to diagnose performance at the enterprise level that might be substandard or below expectations.

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