AIR FORCE MATERIEL COMMAND: A SURVEY OF PERFORMANCE MEASURES

THESIS

Marcia Leonard, Capt, USAF

AFIT/GLM/ENS/04-10

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GLM/ENS/04-10

AIR FORCE MATERIEL COMMAND: A SURVEY OF PERFORMANCE MEASURES

THESIS

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

Marcia Leonard, BS

Capt, USAF

March 2004

AFIT/GLM/ENS/04-10

AIR FORCE MATERIEL COMMAND:
A SURVEY OF PERFORMANCE MEASURES

Marcia Leonard, BS
Capt, USAF

Approved:

//signed//	12 March 2004
Stanley E. Griffis, Maj, USAF (Chairman)	Date
//signed//	12 March 2004
Stephan P. Brady, Lt Col, USAF (Member)	Date

Abstract

Performance measurement has long been a matter of debate in logistics. However, in the recent past, there has been a renewed emphasis as AF leaders continue to seek funding for weapon system spares despite marginal improvements in mission capability. The Chief's Logistics Review, Logistics Transformation Program, AFMC Constraints Assessment Program, the Spares Requirement Review Board, the Spares Campaign, and the Depot Maintenance Reengineering and Transformation all represent efforts to find and implement effective answers (RAND, 2003:ix). And, while there appears to be a consensus that better performance measures are needed, there is little agreement on exactly what should be measured, and how.

Many performance management plans have been developed and recommended. In 1999, the Logistics Management Institute (LMI) published *Supply Chain Management: A Recommended Performance Measurement Scorecard* to guide senior DoD logistics managers. Then, in 2001, the AF Logistics Management Agency developed an set of aggregate or strategic level metrics, *Measuring the Health of USAF Supply*, at the request of AF/ILS. Most recently, in November of 2003, the Supply Management Division published the *AFMC Supply Chain Metrics Guide*. However, each of these performance measurement plans each is distinctly different.

This research seeks to determine how and why these performance measurements plans differ, and to examine what such differences might reveal about the nature of performance measurement in AF logistics systems.

Acknowledgements

It is good to have an end to journey towards;
but it is the journey that matters in the end.
~ Ursula K. LeGuin

To my advisor, Major Stanley Griffis, I sincerely appreciated your guidance and patience in this effort. Hindsight is 20/20, and I can only imagine how this would have turned out if I had just been a better listener.

To my class leader, Captain Steve Gray, your support, guidance and encouragement have been invaluable over the last 18 months. You took the role of surrogate supervisor to unprecedented heights. I can only hope to be as smart as you are someday, but I am sure there are not enough days left. You are truly an officer and a gentleman.

To my family, there are not enough words. Despite the abstract concepts and application, you continued to ask and listen with every call of support. Rachel, your unwavering confidence, despite your wavering interest, meant the most. Just so you know I'm not done whining, "are we there yet?" We have a few years left on this journey.

My sincerest gratitude,

Marcia E

Table of Contents

Page

Page

List of Figures

Figure Page

List of Tables

Table Page

AIR FORCE MATERIEL COMMAND:
A SURVEY OF PERFORMANCE MEASURES

I. Introduction

This chapter presents an overview and the background of this study of Air Force Materiel Command (AFMC) performance measures. It summarizes the problem statement, as well as the research and investigative questions. Finally, it outlines the methodology, scope and significance of this research focus.

Overview

Performance measurement has long been a matter of debate in logistics. However, in the recent past, there has been a renewed emphasis as Air Force (AF) leaders continue to seek funding for weapon system spares despite marginal improvements in mission capability. The Chief's Logistics Review, Logistics Transformation Program, AFMC Constraints Assessment Program, the Spares Requirement Review Board, the Spares Campaign, and the Depot Maintenance Reengineering and Transformation all represent efforts to find and implement effective answers (RAND, 2003:ix). And, while there appears to be a consensus that better performance measures are needed, there is little agreement on exactly what should be measured, and how.

Background

Within AFMC, the Materiel Support Division (MSD) is "responsible for AF managed depot-level reparable spare parts and the AF managed consumable spares" (SMMA, 2002:4). Reparable MSD assets typically represent a substantial inventory

investment. The Supply Management Division of AFMC was tracking three sets of metrics to measure the performance of the MSD. Each set of metrics was composed of those performance objectives that are most relevant to the respective end user, in this case, the Air Staff (HQ USAF/IL), the major commands (MAJCOM), and the Air Logistics Centers (ALCs). While each of the performances measure provided an indication of how the MSD is performing in any given aspect, many of the objective functions are competing for the same resources, or are in conflict. Managers in the Supply Division of AFMC explained the conflicting views as follows:

> From the MAJCOM perspective, there is an expectation that all kits remain full and backorders be driven to zero. From the Air Staff perspective, it would seemingly be that the Net Operating Result is realized and that metrics do not get any worse. From the AFMC perspective, the expectation should be that the logistics system achieves the level of performance that is consistent with its funding level. (AFMC, 2003)

In addition, it was realized that the existing measures were disconnected from the funding process, and Aircraft Availability (AA) targets used to drive the budget requirement. As such, managers sought to identify a standard set of metrics to measure performance of the MSD.

Problem Statement

There have been numerous studies and initiatives that have attempted to answer the plaguing question: 'is AFMC measuring the right things?' Various performance management plans have been developed and recommended. In 1999, the Logistics Management Institute (LMI) published *Supply Chain Management: A Recommended Performance Measurement Scorecard* to guide senior DoD logistics managers. Then, in 2001, the AF Logistics Management Agency developed a set of aggregate or strategic

level metrics, *Measuring the Health of USAF Supply*, at the request of AF/ILS. Most recently, in November of 2003, the Supply Management Division published the *AFMC Supply Chain Metrics Guide*. However, each of these performance measurement plans each is distinctly different.

While each performance plan recommends some new measures, there is also a repeated trend of continuing to use the same measures, with disclaimers as to their value and application. To date, however, there has been no consideration given to the differing content of each of the initiatives. Although three learned organizations have attempted to answer the same question about performance management, there are three distinct, yet seemingly compelling recommendations.

Research Questions

The focus of this research effort is to determine what a comparative analysis of three performance measurement plans may reveal about the nature of performance measurement in AF logistics systems.

Investigative Questions

As such, the following investigative questions will be used to guide the researcher's efforts:

1. How do the performance measurement recommendations of the LMI, the AFLMA and AFMC differ?
2. Why do the performance measures differ?

Methodology

This research effort applies a case study design to compare the performance measurement recommendations of the LMI, the AFLMA, and AFMC initiatives.

Utilizing a multiple-case method, the performance plans were analyzed individually and the results were compared to identify common themes and draw cross-case conclusions.

Scope

This thesis examines the underlying assumptions of three performance measurement initiatives in order to provide a better understanding of AF logistics systems. However, AFMC is a complex organization, composed of several inter-related functions and processes. As such, this study will focus on AFMC processes as defined by the performance plans.

Significance

As noted, there have been numerous initiatives to improve the performance and measurement of the MSD processes. It would be presumptuous to suggest that one set of metrics would provide a better assessment of AFMC performance, however, since the question persists, it is reasonable to assume that there are still differing views of how performance should be measured. Findings of this research may identify concepts that provide a foundation of consensus that would make the measures more relevant and meaningful to the all users.

Thesis Overview

This chapter presents the background, purpose, research questions, and assumptions under study. Chapter II provides a review of the literature pertaining to performance measurement. Chapter III explains the methodology used for this research effort, and Chapter IV summarizes the results of those efforts. Finally, Chapter V outlines the research limitations, and provides recommended future research.

II. Literature Review

This chapter begins with an explanation of the reporting requirements contained in the Government Performance and Results Act. Pursuant to those requirements, it discusses strategic planning, performance measurement and characteristics of measurement systems. Finally, it provides an overview of supply chain management as it pertains to subsequent research and discussion.

Government Performance and Results Act (GPRA)

As early as 1971, a DoD task force recommended "increased uniformity, standardization, and/or integration on an inter-functional or inter-Component basis," as a means to improve efficiency and responsiveness (1998:5-1). It was noted in the *Senate Committee on Government Affairs GPRA Report* (Report 103-58) that the GAO had "produced over 70 reports on performance measures" since 1973 (1993:5). With passage of the GPRA in 1993, performance measurement within federal agencies was mandated by public law. By requiring the submission of formalized strategic plans, federal agencies were now required to set goals, measure their performance, and self report. In accordance with issued guidance, and with an increased emphasis on accountability in government, strategic plans must include:

1. a comprehensive mission statement covering the major functions and operations of the agency;
2. general goals and objectives, including outcome-related goals and objectives, for the major functions and operations of the agency;
3. a description of how the goals and objectives are to be achieved, including a description of the operational processes, skills and technology, and the human, capital, information and other resources required to meet those goals and objectives;

4. a description of how the performance goals included in the plan…shall be related to the general goals and objectives in the strategic plan;

5. an identification of those key factors external to the agency and beyond its control that could significantly affect the achievement of the general goals and objectives; and

6. a description of the program evaluations used in establishing or revising general goals and objectives, with a schedule for future program evaluations. (Report 103-58, 1993:44)

Although the act was passed in 1993, submission of formal plans was not mandatory until 1997. Nonetheless, "in [fiscal year] 1994, the Deputy Assistant Secretary of Defense (Logistics) began an initiative to publish an annual DoD logistics strategic plan" (LMI, 1998:5-3). With that, each military service and the Defense Logistics Agency began publishing subordinate plans as well, and a formalized planning process took root. Although it has been nearly ten years since the first logistics strategic plan was published, many federal agencies continue to struggle with the strategic planning process.

Strategic Planning

The word 'strategy' literally means 'general of the army.' Greek *Strategoi* "were elected political leaders, who left battlefield tactics to troop leaders, but ruled on policy issues as a group" (Blackerby, 1994:21). Similarly, AF Doctrine Document 1 states that "strategy originates in policy and addresses broad objectives and the plans for achieving them" (1997:4). AF Policy Directive 20-1 adds that "long range strategic planning is a necessity… [that] demands a disciplined, yet flexible process capable of identifying crucial logistics goals and developing a road maps to achieve them" (1993:1). The common concept in all of these definitions is the presence of a goal, or objective, and the development of a plan to achieve it. Accordingly, Blackerby, a former GAO planner,

defined strategic planning as "a continuous and systematic process where people make decisions about intended future outcomes, how outcomes are to be accomplished, and how success is measured and evaluated" (1994:21).

Although it would appear to be a straightforward process, there are pitfalls to strategic planning. Frost warns that organizational managers should "be wary of using lofty statements if they are just there for PR [public relations] purposes" (2000:28). Developed appropriately, well-defined goals can "compel [the] organization to develop a consensual vision of the future" (Blackerby, 1994:23). In fact, many planners agree that "the most valuable benefits of any strategic planning effort lie in the process, rather than the product,…[because it] unifies the entire organization behind a single set of marching orders" (1994:23). This view is shared by AFMC in command policy which states that "the strategic plan is the glue (not the metrics) which cements the command's long range vision together from command level to the worker level" (1995:5).

Porter warns of another potential difficulty that occurs when "rather than seeing the company as a whole, managers [turn] to 'core' competencies, 'critical' resources, and 'key' success factors" (1996:70). By failing to realize the interdependent relationship of discrete activities, managers overlook "one of the oldest ideas in strategy,…[which is] the importance of fit among functional policies" (1996:70). He explains that:

> "There are three types of fit, although they are not mutually exclusive. First-order fit is *simple consistency* between each activity (function) and the overall strategy…Second-order fit occurs when *activities are reinforcing*…Third-order fit goes beyond activity reinforcement…to *optimization of effort*" (1996:71-72)

This notion not only cautions again disjointed policy developments, but also highlights the potential synergy that can occur when strategy and policy are properly aligned.

Linking Strategy and Performance

In order to link strategy to performance, the strategy should include some form of goals, objectives, or mission statements—"all the key things [that the organization] is committed to accomplishing" (Frost, 2000:28). Kaplan and Norton refer to this as "translating the vision," and believe that it is a key element in "build[ing] a consensus around the organization's vision and strategy" (1996:75). And, since every organization is different, strategic performance measures should be "truly unique and relevant to…the organization," in that, they "should be closely focused around a line of sight" (Frigo, 2002:15).

Kaplan and Norton share Frost's view on lofty statement, saying they "don't translate easily into operational terms…[or] provide useful guides to action at the local level" (1996:76). In fact, in a survey conducted by the Institute of Management Accountants, over half of the participants believed that their company's performance measures failed to adequately communicate the company's strategy (Frigo, 2002:10). The suspected cause of this phenomenon is that very often the "strategy-development processes and performance measurement (strategy-execution) processes" are conducted independently (2002:10). Kaplan and Norton propose that organizations using a "Balanced Scorecard" (to be discussed later) can use it to initiate "four new management processes, that separately and in combination, contribute to linking long-term strategic objectives with short-term actions" (1996:75).

Strategic Management System

As noted above, Kaplan and Norton's model begins with *translating the vision*. The second process, as shown in the model below, is *communicating and linking*, which

"lets managers communicate their strategy up and down the organization and link it to departmental and individual objectives." (1996:76) (referred to later as vertical alignment). In *business planning*, organizations utilize their balanced scorecard to allocate resources, thereby establishing the organizational priorities. The priorities can then be used to "guide budget decisions later…and when an organization integrates its strategic planning process with its budgeting process, managers can focus more clearly on organizational outcomes and priorities" (Blackerby, 1994:23). The, fourth and final process, *feedback and learning*, is referred to as "strategic learning." It provides managers with an opportunity to validate, or challenge, the assumptions of cause-and-effect made during strategy development (Kaplan and Norton, 1996: 84).

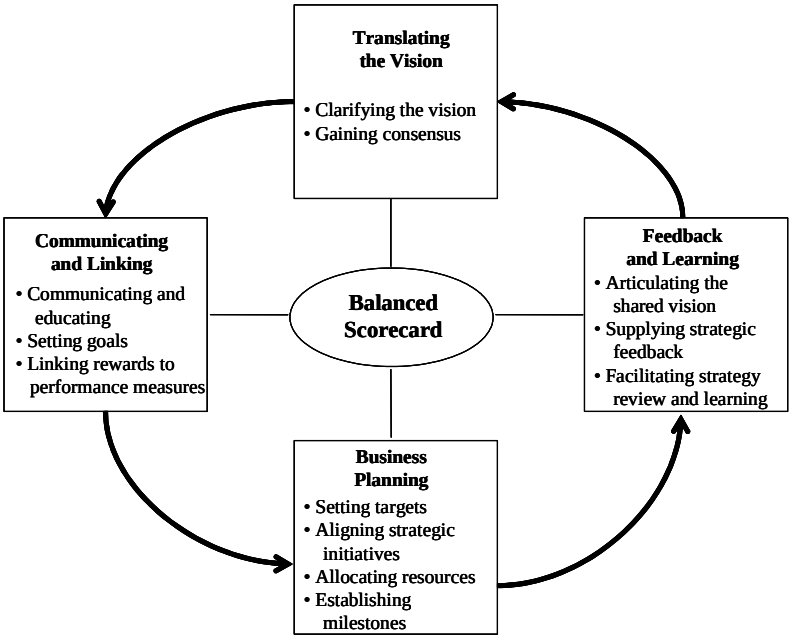


Figure 1. Managing Strategy: Four Processes

(Kaplan and Norton, 1996: 77)

Vertical Alignment

Due to the hierarchical nature of organizational management, the concept of vertical alignment recognizes that different levels of management within an organization require different kinds of information to make decisions or monitor internal processes. To ensure vertical alignment, Frost recommends translating strategy factors into "performance topics" (2000:29). As each area of responsibility identifies the activities that are necessary to support the broader "performance topic," objectives and measures will naturally 'cascade' from level to level and "get everyone pulling in the same direction" (2000:29). DoD's guidance on vertical alignment is vary similar to Frost's concept of 'cascading' measures.

DoD 4140.1-R, *DoD Supply Chain Materiel Management Regulation*, specifies that all DoD Components "develop and maintain metrics that address these [three] levels of supply chain operations:" enterprise level, functional level, and program or process level (2003:21). The regulation also provides the following definitions:

> Enterprise metrics are cross-functional measures that describe the overall effectiveness of the supply chain.
>
> Functional metrics support at least one enterprise metric and measure a major function's internal performance.
>
> Program or process metrics support functional metrics and are diagnostic and internal in nature. For weapon systems with established performance agreements, program managers and the Military Services, with system users, can review sustainment strategies by utilizing program level performance metrics to compare actual performance against expected performance. (2003:21-22)

Figure 2 provides an overview of each of these levels, their associated relationships, and the recurring nature of the measures.

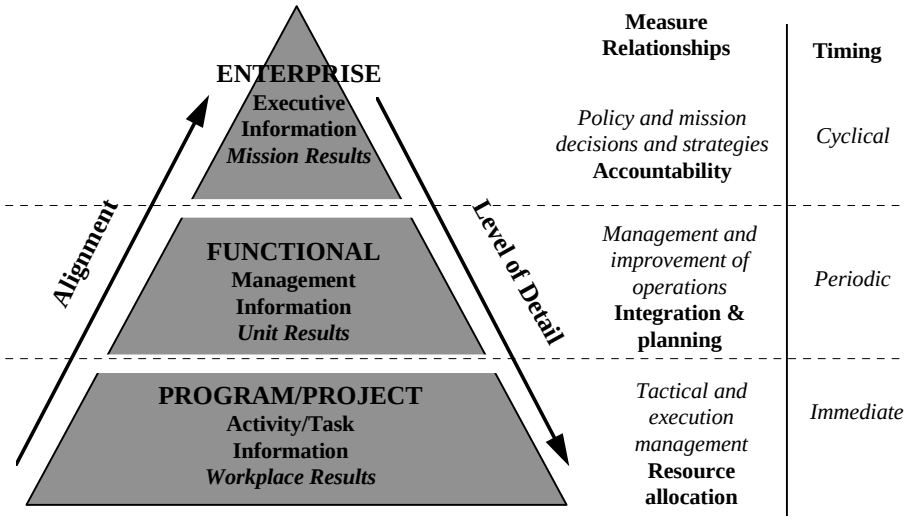


Figure 2. DoD Levels of Performance Measurement

(Vector Research, Inc., 1997:3-4)

LMI provides additional guidance to identify the appropriate users of information at the various levels. Executive information is used by senior DoD officials, departmental secretaries, and combatant commanders-in-chief to "report and justify the use of resources to Congress, Office of Management and Budget (OMB), GAO and other external entities" (2000:5-14). Functional level managers consist of the staff personnel that report to the departmental secretaries and defense agencies and they use management information to oversee several projects, programs, or acquisitions (2000:5-14). Tactical and execution managers lead "units, programs, projects and acquisitions sponsored by functional level managers" (2000:5-15). By aligning the measurement system in this manner, "management information provides an important linkage between management objectives and operating activities through…a hierarchy of success factors, performance objectives, and operational data" (2000:5-7). AFMC guidance also dictates that "each level translate the preceding level's objectives and the command guidance into a plan, objectives, and strategy which can be implemented at their level" (1995: 5). However, all

users should understand that “this generally means less detail for senior managers and greater detail for functional and operational managers” (LMI, 1998:5-22).

However, some would disagree that managers can so readily identify the associated measures. Eccles and Pyburn contend that “before a comprehensive system of performance measurement can be developed, senior management needs to agree on the business performance model of the firm—their understanding of the relationships between management actions and results, which are often implicit, that affect important decisions” (1992:42). Furthermore, Ittner and Larker, believe that

> “ although establishing a firm’s business model prior to selecting measures has the advantage of sharpening strategic focus and organizational priorities, it can be difficult to establish the reliability and predictive validity of the multiple measures in the business model without having done a great deal of measurement and analysis in the first place” (1998: 226).

Any differences abut an appropriate business model held by senior managers or management-planning teams need to be discovered and resolved “in order to develop an effective performance management system” (Eccles and Pyburn, 1992:44). In addition, they must develop a model that “works in terms of capturing the empirical relationships that exist while being credible to the people in the company” (1992:43). The desired end state is that when an organization develops a performance measurement system, the selected measures all contribute in some meaningful way to the overall strategy of the organization.

Developing Performance Measures

Prior to developing a performance measurement system, managers must be aware of the potential implications of their undertaking because “what you measure is what you

get" (Kaplan and Norton, 1992:71). In addition, "relatively few studies have examined the…measures' economic relevance, the implementation issues arising from their adoption, or the performance consequences from their use" (Ittner and Larcker, 1998:205). So, generally, "the choice of performance measures is one of the most critical challenges facing organizations" (1998:205). Generically, most would agree that selected "measures should be those that help… improve output—make [the] organization's deliverables better, faster, and cheaper" (Frost, 2000:22). However, as previously discussed, "the range of measures must be structured to provide a clear view of the causes of the results and the drivers of future performance" (McAdam and Bailie, 2002:975). Without such alignment, "it is possible that any performance consequences are simply due to a Hawthorne Effect, with the specific measure [chosen] having minimal importance" (Ittner and Larcker, 1998:234). In addition, "for metrics to be motivational…there must be a line of sight between the actions employees can take and the changes that occur in the measure." (Frost, 2000:43).

Due precaution is necessary because once a measurement system is in place, it can be extremely difficult to change. Very often, changing the measures used to evaluate a system requires that "traditional measures…be discarded, at great risk and under significant duress, in order to proceed with…change" (Sink, 1991:23). Not only are personnel resistant to change, but also many may feel challenged or uneasy about the prospect of how their work will be evaluated. In addition, "numerous counter-intuitive and counter-tradition actions [have] to be taken" to allow time for the new management emphasis to 'settle in' (Sink, 1991:23). So, while "some past practices may still be useful,…everything should be strenuously challenged" (Eccles, 1991:137).

"A good performance measurement system does not by itself produce good performance" which is why Mosso refers to it instead as "performance management" (1999:69). And, it is a responsibility of management to "translate performance measures into value-added" activities (1999:69). There are four critical elements of effective performance management:

> First, a comprehensive measurement system that integrates financial and nonfinancial measures of the costs and consequences of an entity's operations, and analyzes and reports results internally and externally.
>
> Second, a management process that focuses on maximizing value added and bases planning, budgeting and operating decision making on information provided by the measurement system.
>
> Third, an incentive structure that reinforces the measurement system and fosters innovation and prudent risk taking.
>
> Fourth, an independent audit facility that tests the credibility of the measurement system and critiques the effectiveness and efficiency of the operations. (1999:70)

Incorporating these elements into a performance management system helps managers elicit the desired performance.

However, performance measurement in the public sector presents some unique challenges. Eccles noted that "what is most effective for a given [organization] will depend on its history, culture, and management style" (1991:137). Federal agencies, and the military, in particular, are often characterized by their history and deeply ingrained cultures. This leads managers in government agencies to question "whether private sector notions of performance measurement and accountability are applicable in the public sector" (Ittner and Larcker, 1998:233). Boland and Fowler found that

> "performance management in the [public] sector is relatively more complicated due to the absence of the single overriding goal which ultimately dominates private sector companies. That is, the motivation to

> make profits and provide satisfactory financial returns to shareholder interests" (2000: 440)

In addition, the federal government, in particular, suffers from a reputation that Mosso refers to as "management by slogan" (1999:66). When a new performance measurement system is proposed, many are skeptical because "there is a long history of unsuccessful management control initiatives in the U.S. government, ranging from management-by-objective to zero-based budgeting" (Ittner and Larcker, 1998:233). Due to the bureaucratic nature of the federal government, many believe that "efforts to improve government efficiency and effectiveness through improved performance measurement will be unsuccessful without complimentary changes in other organizational practices" (1998:233). Even Blackerby, a noted proponent of the GPRA, admits that the "veterans have seen the good, the bad and the paperwork [of past initiatives]. They remain frustrated, ultimately, by the lack of decision making and follow-through" (1994:24).

Measurement Models

Performance measurement literature contains numerous models and application principles. However, in reality, none of them can specifically delineate which specific measures to use (Frost, 2000:22). Each industry and organization is unique, and the particular circumstances in a given organization can be even more distinctive. Still, the models provide a good reference on "where to look" for performance metrics, and how to group them once they have been selected (2000:22). Due to the limited scope of this research, discussion will be limited to those models deemed applicable to the measurement plans being studied.

Family of Measures

Although none of the recommended performance plans under study specifically refer to a 'family of measures,' this concept is common to all of the measurement models. Essentially, it suggests that most organizations require more than one measure of performance, and implies that to be effective measures should be interrelated. This concept is conveyed by comparing performance measurement with a trip to the emergency room (Provost and Leddick , 1993:477). Suppose upon admittance, the doctors chose to use temperature as the only indicator of a patient's well-being. They would take the patient's temperature often and from different areas of the body, meticulously recording every reading, but they take no other measures. Most would agree that the notion is ludicrous and insist upon other measures, such as blood pressure, heart rate and reflexes. However, many organizations do just this. Many organizations "often measure only one or two dimensions or aspects of their performance [and] by doing so…blind themselves to how the *entire* organization is functioning" (1993:477-478). It is important that managers view "the organization as a whole, as a single, complex, and dynamic system" to ensure that they are "optimizing the performance of the whole system, not just its parts taken individually and summed" (1993:478).

Another common analogy compares a family of measures to a vector. By definition, "a vector is composed of components that individually may not provide useful information, but, taken as a whole, the components provide information on both the magnitude and direction" (Provost and Leddick, 1993:478). As such, a family of measures should not only be an indication of current performance, *magnitude*, but also provide a realistic forecast of future performance, *direction* (1993: 479). Again, the

overarching premise is that managers must "develop a holistic view of the system, rather than an analysis of each component or each individual period's set of measures" (1993: 485).

Supply Chain Operational Reference (SCOR)

The SCOR Model (shown below), developed by the Supply-Chain Council, is "a business process reference model which provides a comprehensive toolset linking business process to metrics, best practices and technology" (Stephens, 2001:471). The SCC is an independent, not-for-profit corporation that joins together a broad range of industries to advance state-of-the-art supply-chain management systems and practices (Stephens, 2001:471). By defining the activities that make up an organization's 'plan,' 'source,' 'make,' and 'deliver' processes, this analytical tool "integrates the concepts of business process reengineering, benchmarking, and process measurement into a structured approach" (LMI, 2000: 108).

Figure 3. SCOR Model Supply Chain Thread

(Supply-Chain Council, Inc, 2000: 3)

Balanced Score Card

Kaplan and Norton introduced the 'balanced scorecard' as "a set of measures that gives top managers a fast but comprehensive view of the business" (1992:71). As company's looked for performance indicators beyond the traditional accounting measures, the model was designed to "complement the financial measures with operational measures on customer satisfaction, internal processes, and the organization's innovation and improvement activities—operational measures that are the drivers of future financial performance" (1992:71). The assumption is that improvements in the operational measures create excess capacity, and managers are encouraged to redirect this excess capacity to ensure that the improvements translate into financial savings, or profits (1992:78). However, the financial aspect of the model focuses on "how do we look to shareholders?" (1992:77). As shown below, the original scorecard of measures was designed for the 'for-profit' organization.

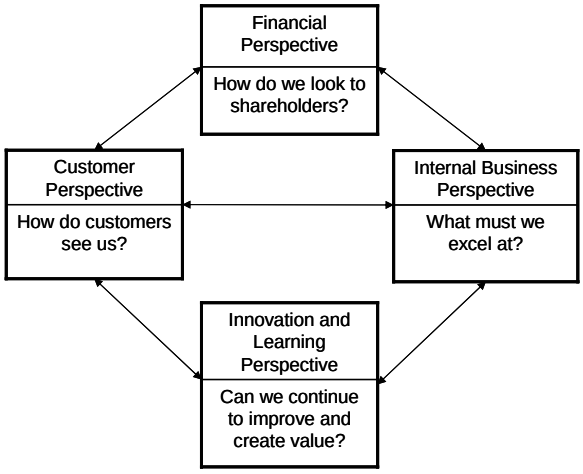


Figure 4. Balanced Scorecard Performance Measures
(Kaplan and Norton, 1992:72)

In 2001, Kaplan and Norton introduced modifications to the scorecard for use in non-profit and government agencies. In contrast to models that placed the financial or customer perspective on top, they recommended that "the agency's mission should be featured and measured at the highest level of the scorecard. Below is the resulting financial/customer service perspective for the public sector.

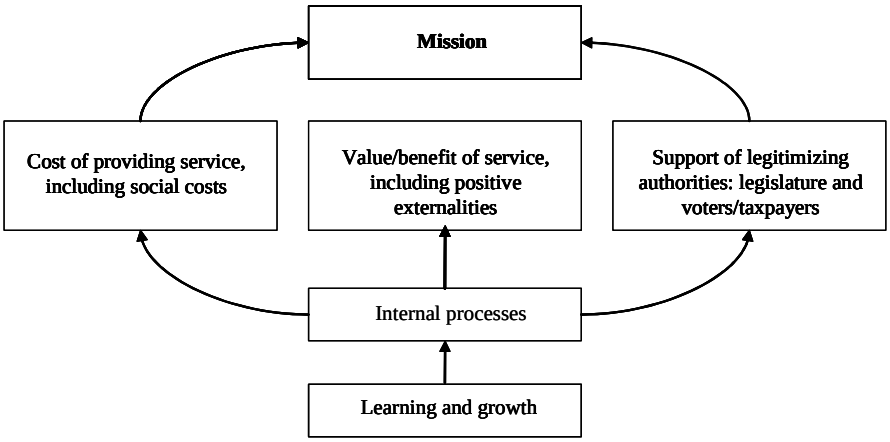


Figure 5. Financial/Customer Perspective for the Public Sector
(Kaplan and Norton, 2001:24)

This modified framework highlights the fact that "a government agency has three high-level perspectives: cost incurred, value created, and legitimizing support" (Kaplan and Norton, 2001:24). The cost perspective should "include both the expenses of the agency and the social cost it imposes on citizens and [private-sector] organizations through its operations" (2001:24). For example, a common social cost of many Air Force bases to the local community is the noise 'pollution' of base flight operation. Value created is certainly "most problematic and difficult to measure" (2001:24). In addition to being difficult to quantify financially, not all citizens may agree on what constitutes a 'social

good.' Nonetheless, "the citizens and their representatives—elected officials and legislators—will eventually make the judgments about the benefits from these outputs versus their costs" (2001:24). Finally, since most government agencies rely on appropriated funding, very often agency officials are compelled to legitimize such support. As indicated by the modified scorecard, when an organization focuses on the learning and growth that facilitate its internal processes, these support the three high-level objectives that can ultimately lead to mission accomplishment.

Categories of Performance Measures

Performance metrics are a way of "providing [managers with] the gauges, levers and handles to move [the] organization in the right direction" (Frost, 2000:14). Organizations often develop them in a hierarchal manner. "Primary metrics" measure the intended production results and the expected value output. These include financial measures, "customer service results, production achievements, and results on specific goals such as cost savings" (2000:24). These primary metrics facilitate early attempts to align efforts and manage accountability, while reporting improvements and results. "Advanced metrics" address the work processes or organizational capabilities (2000:24). These measures should facilitate activities that prevent inertia, manage waste, improve efficiency, and "prepare for the future." The assumption is that organizations generally need to understand and improve their primary measure before they can move on to advanced initiatives that would address processes and capabilities.

However, as strategy would dictate, there should be a consensus on the direction of the organization, and as the previous discussion of measurement models would suggest, the associated framework selected will imply the relative significance of the

strategic priorities in the organization. For example, the SCOR model emphasizes process metrics, highlighting customer interactions, product transactions, and market interactions (SCOR, 2002:3). The balanced scorecard, on the other hand, reinforces the importance of calculated trade-offs in attempt to minimize suboptimization (Kaplan and Norton, 1992:73). Again, performance measurement literature offers many varied ways to classify and categorize measures. And, in order to establish a robust family of measures, it is imperative that managers are aware of the type of measures they are employing to ensure they are not misinterpreted, or worse, misapplied.

However, there must be a consensus on the organizational business model that would produce such results. The Governmental Accounting Standards Board (GASB) suggests that there are three broad categories of indicators: those that measure efforts, those that measure accomplishments—outputs and outcomes, and those relate efforts to accomplishments. As a generic point of reference, Boland and Fowler developed the following model to demonstrate the most frequent applications of the "three Es." They believe that "it is common practice in public sector performance management literature to talk about the three Es of: (1) economy, (2) efficiency; and (3) effectiveness, based upon a simple input, process, and output model of organizations" (2000:419).

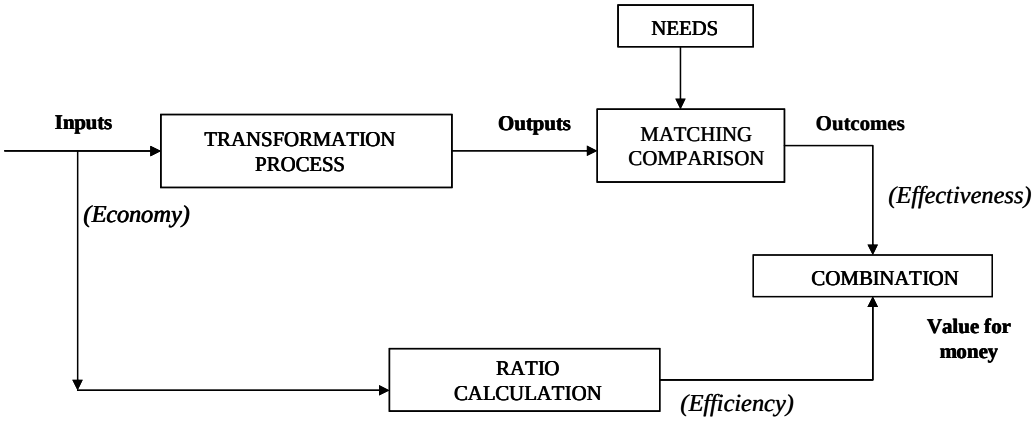


Figure 6. Relationship between Alternative Performance Measures

(Boland and Fowler, 2000:426)

Process Measures: Economy

Process management is an outgrowth of the 'work smarter, not harder' ideology. (Frost, 2000:48). Therefore, process measures should capture the essence of the work processes that occur in the "transformation process" block of the given model. The development of process measures begins with an "end-to-end view of work as a process—a sequence of stages and activities" (2000:48). In addition to reaching a consensus of the organization's business model, this approach requires that managers first agree on "what characteristics represent value on the receiving end…Usually, these are a mix of quantity, quality, time and cost factors" (2000:49). By tracing the workflow from end-to-end, managers are able to "reduce handoffs, eliminate waits, errors, bottlenecks, and lost productivity…eliminate[ing] non-value-added steps" along the way (2000:50).

While the end goal is effectiveness, this assessment process attempts to 'build in value' as inputs go through the transformation process. However, these measures can be

difficult to determine since "process metrics should conform to the line-of-sight principle wherever possible….[So], it [may be] necessary to balance this requirement against the fact that the ideal process metrics are broad measures tied directly to what the end user values" (Frost, 2000:50). Managers should regard economy measures as incomplete because "any change in these performance measures simply reflects the 'economy' with which the organization is using its resources and provides little information about the operational processes within the organization, apart from some crude benchmarking" (Boland and Fowler, 2000:419).

Productivity Measures: Efficiency

Brinkerhoff and Dressler suggest that "productivity reflects results as a function of effort. When productivity improves, it means that more results are being gained for a given amount of effort" (1990:16). Early measurement initiatives focused strictly on measures of productivity—input/output ratios, utilization, and performance ratios (A. T. Kearney , 1984:37). However, managers must use caution when applying ratio measures because they are susceptible to a phenomenon known as "denominator management" (Frost, 2000:76). That is, when productivity appears to have reached a peak in performance, there is a tendency to redefine the process in order to continue showing improvement in the measure. When observed, managers should seek new aspects of performance to improve upon (2000:76).

Effectiveness: Output versus Outcomes

The issue of defining "effectiveness" has long been a challenge in performance measurement literature. At times, it is important "to differentiate between performance measures and performance indicators…[because the] focus has switched…to using

quantifiable indicators of performance" (Boland and Fowler, 2000:420). In this context, indicators generally represent those quantifiable levels of activity, while measures describe the intended results or consequences of those indicators. This switch in focus:

> "represents an attempt to recognize the intangibility of outcomes while still providing useful data defining the extent to which public organizations are meeting their aims and making the best use of their resources. However, the distinction between the two is imprecise" (2000:420)

Furthermore, since "effectiveness is concerned with the extent to which outputs meet organizational needs and requirements, [it] is…much more difficult to assess, let alone measure" (2000:420). Since it appears "impossible" to manage results directly, organizations can only attempt to "manage the systems and processes that produce them" (Provost and Leddick, 1993:485). As such, "the resulting focus on quantifiable indicators of economy and efficiency may be not only misleading but dangerous" (Boland and Fowler, 2000:420).

Similarly, much of the debate in federal agencies centers on the ability to distinguish between 'output' and 'outcome,' and their appropriate use. The guidance issued in the GPRA provides the following definitions:

> An "outcome measure" assesses the actual results, effects or impact of a program activity compared to its intended purpose…An "output measure" records the actual level of activity or effort that was realized and can be expressed in a quantitative or qualitative manner. (Report 103-58, 1993: 30)

For the purpose of government reporting, however, the Senate Committee recognized that "outcome measurement cannot be done until a program or project reaches either a point of maturity…or at completion" (1993:30). Nonetheless, the guidance becomes rather vague obscure, noting

> "Performance goals may relate to either 'outputs' or 'outcomes,' the latter usually being the most important for policy purposes, but the former often being a useful management tool. A common weakness in program performance plans is an over-reliance on output measures, to the neglect of outcomes" (1993:15)…While recognizing that outcome measurement is often difficult, and is infeasible for some program activities, the Committee views outcome measures as the most important and desirable measures, because they gauge the ultimate success of government activities." (1993:30)

In fact, GASB direction concurs that "there is often not a clear cause-and-effect relationship between the service provided and the resulting outcome…Numerous explanatory factors, completely or partially beyond the control of the entity, that also have a significant effect on results" (1994, 16). Perhaps, then, "it is [the] value added—the excess of output value over input value—that should be the gauge of performance. The concept of value added is identical for business and government. The difference is that there are more intangible values in the government equation" (Mosso, 1999: 68). While it may be extremely difficult to quantify effectiveness, it is critically important to gaining support in the public sector.

Capability Measures

Capability measures are "advanced metrics" (Frost, 2000:24). In the balanced scorecard model, capability measures are similar to the organization's learning and growth measures. These measures attempt to measure and manage "organization-wide capabilities, or core competencies" (Frost, 2000:52). They should enable managers to "gauge and improve in broad areas like agility, scientific excellence, rapid product development, or any topic that represents either a competitive advantage or an ability to create better results in the future" (2000:52). Much like measures of effectiveness, measurement methods for these capabilities can be very challenging to develop due to the

intangible nature of the desired results. Nonetheless, using comparatives and best practices (discussed later) to judge the organization's performance can guide the organizational efforts (Frost, 2000:52).

Lagging versus Leading Indicators

Lagging indicators are performance measures that represent the consequences of actions previously taken. They frequently focus on results at the end of a time period and characterize historical performance, such as employee satisfaction (Niven, 2003:295). The most common criticism of lagging indicators is that they lack predictive power (2003:190). Conversely, leading indicators are "considered the 'drivers' of lagging indicators. The assumed relationship between the two…suggests that improved performance in the leading indicator will drive performance in the lagging indicator" (2003: 295). Leading indicators are often difficult to identify, and even more challenging to quantify (2003:190). For example, lowering absenteeism, a *leading indicator*, is hypothesized to drive improvements in employee satisfaction, a *lagging indicator* (2003:295). Measurement systems composed entirely of lagging indicators will provide very little indication of how the organization achieved a given level of performance. Conversely, a measurement system composed totally of leading indicators "will not reveal whether improvements are leading to improved process or customer results" (2003:190).

Characteristics of Measure Systems

There are many and varied views on the characteristics that make up the most comprehensive, or reliable measurement system. Generic characteristics of information quality that always emerge are things such as "timely, complete, accurate, and consistent

with management responsibility" (LMI, 1998: 5-7). This review will be limited to some theories for determining the number of measurements to use and the measurement frequency. It will also address the additional concerns of accountability, reliability, and validity. Finally, it will cover the use of comparatives.

How Many

An airplane cockpit is a common analogy used to describe performance measurement systems and the process for determining the appropriate number of measures in a given organization. While there are many 'dials and gauges' in a cockpit, only a few are important at any given time. The pilot will use different measurement instruments at cruising altitude than during take-off or landing, however, the full complement of gauges is required. (Frost, 2000:57). So, it is in a large organization. Due to the size and complexity of modern organizations, "managing with a keyhole view can lead to disaster" (2000:57). Much like the pilot, "not all of [the] metrics will demand focused attention all the time, but if a few key ones are missing," it could be detrimental to the organization (2000:57). However, there are purported "experts [who may] make compelling arguments for the critical few metrics" (2000:33). Organizations that are large and complex are usually quite unique as well, and performance measures are not like accounting standards in which 'one size fits all.' Developing a measurement system that "spotlights the critical few but includes the critical many" is a more balanced approach (2000: 33). Another common solution it to develop foreground and background metrics; "tiers of metrics available by drill-down links; and designs that distinguish between strategic metrics and monitored metrics" (2000:59).

While Kaplan and Norton agree that "reliance on one instrument can be fatal," they contend that the "balanced scorecard minimizes information overload by limiting the number of measures used" (1992:72). They have found that managers gain two distinct benefits from such an approach. The scorecard consolidates many of the "seemingly disparate elements" of the organization's strategy, and "guards against suboptimization" (1992:73). However, others contend that in limiting the number of measures, organizations risk the implication that those measures that are not included are not important (Frost, 2000:33, and Provost and Leddick, 1993:484). In fact, "in contrast to the information overload hypothesis, an experiment by Lipe and Salterio (1998) found that performance evaluations were not affected by increasing the number of measures when these measures were organized into four balanced scorecard categories" (Ittner and Larcker, 1998: 226). By attempting to limit the number of measures, managers "may not include what is really important, [and] lose sight of [other] key processes in the organization" (Provost and Leddick, 1993:484).

Artificially limiting the number of measures may cause organizations to overlook "snoozing alligators" (Frost, 2000:33). These are measures that may be outside of the immediate realm of strategic focus, but that prudent management should not ignore. "Depending on the industry or circumstances, examples might include nearly anything" (2000: 33). In the military industrial complex, it could include things such as technological obsolescence, industry-wide production capability, or advancing technology. While these may not affect current operations, the potential to impact future operations is profound. Even when no current change may be anticipated, these are

issues that the organization would want to know about "even if gradual changes were occurring" (2000: 33).

Frequency

There are a number of practical suggestions for measurement frequency as well. Depending on the type of process under consideration, measurement frequency should be comparable to the expected rate of change in the results (Frost, 2000:60). In addition, the importance of the particular process in the overall organization would dictate frequency. As such, managers may decide to err on the side of caution when deviation of particular measure has the potential to significantly impact the organization's output. (Frost, 2000:60). Another consideration is the lead-time required to change course of action, once a process is set in motion. The longer it takes to implement corrective action, the more closely managers should monitor the measure. In contrast, if short-term variability is of little significance to the overall process, measuring too frequently could cause incidents of over-correction (2000:61). Finally, and perhaps, most applicably, administrative and political pressures may dictate that organizations "report results more frequently than [they] would otherwise feel the need to measure" (2000:61).

Accountability

Performance measures without accountability are merely operational statistics, however, in large organizations, it is often very difficult to establish such direct relationships. Distinguishing between authority, responsibility, and accountability can help to explain the expectations of performance (Frost, 2000:62). The following definitions provide such distinctions:

> "*Authority* is the right to act without prior approval from higher management and without challenge from peers. *Responsibility*…is an obligation to perform. *Accountability* is the liability one assumes for ensuring that an obligation to perform—a responsibility—is fulfilled. In this system, then: responsibility can be delegated; authority is assigned; and accountability cannot be delegated, but can be shared. (2000:62-63)

While organizational planners and senior management may find "purely informational measures (that is, metrics with no line of sight)" useful, it is important that they are identified as such, because those who may be held accountable for such "measures with no clear means to affect them is de-motivating at any level" (Frost, 2000:44). Due to the large bureaucratic nature of many federal organizations, it is often difficult to establish such lines of accountability. In fact,

> "a major difference between business and government is that most government entities are subjected to much more oversight and regulation by external bodies. Executive oversight bodies, such as the central budget and human resources offices, and legislative oversight bodies, such as appropriation committees, intrude so much into the workings of an entity that they are essentially a part of the entity's management process—they preempt many management decisions" (Mosso, 1999:71).

Under these circumstance, where the ability of the organization to manage its' own operations is 'legislated,' liability for the results is then questionable, at best.

Validity

The accuracy of a performance measure's 'line of sight,' discussed earlier, determines the measures validity. This means that "a measure tracks what it's supposed to and is not contaminated by other factors that render [the] conclusions uncertain or invalid" (Frost, 2000:64). Under certain circumstances, manager must use caution to ensure that measures are not subject to external influences, like inflation. (2000:64). GASB refers to this characteristic as 'reliability' (see definition of consistency below, as

related to reliability), explaining that "information should be verifiable and free from bias and should faithfully represent what it purports to represent…derived from systems that produce controlled and verifiable data" (1994:16).

Reliability

Briefly, reliability of an indicator ensures that it "produces the same result every time, given the same circumstances" (Frost, 2000:66). GASB refers to this as 'consistency,' adding that "performance information should [also] be reported consistently from period to period to allow users to have a basis for comparing performance over time" (1994:15).

Comparatives

Comparatives are the "benchmarks and anchors as standards by which to judge" what the performance indicators reveal (Frost, 2000:70). Generically, there are three types of such comparatives: internal, external and theoretical. Internal comparatives, the most commonly used, generally compare current performance to some other standard inside the organization (2000:71). A common internal method used to set performance targets is "baselining." As its' name implies, baselining utilizes current performance as the initial standard, and then "incremental improvement goals are established based on improved operational performance or cost reduction" (LMI, 1998:5-21). It is also common for organizations to 'benchmark' internally, between operating locations or business units (Neely, 1995: 96). External comparatives "might include the performance of competitors, or vendors who perform similar services" (Frost, 2000: 71). Although external benchmarking may not always result in "fully comparable" measures, they "are of great value in a business sense," particularly when they are selected from "similar

world-class organizations" (Frost, 2000:71; LMI, 1998:5-22). Theoretical comparisons are useful in measuring work processes, and can be derived two ways. Managers can study each work activity in the process, total the individual work times, and "this becomes the minimum possible time for the process—a theoretical standard" (Frost, 2000:71). Another method of establishing this type of comparative is to find a functional comparison, however, this only applies to "truly generic business processes, like order entry" (Neely, 1995:96).

GASB also endorses the use of comparatives. They suggest that "when presented alone, [performance measures] do not provide a basis for assessing or understanding the level of performance" (1994:14). In addition to the comparatives previously discussed, GASB recommends a fourth type of comparative: targets established as part of the budgetary process. Although fiscal targets are not unique to the governmental agencies, there are additional concerns regarding fiscal restraint in light of antideficiency laws.

Just as there are implications of selecting certain performance measures, managers should take precautions when selecting comparatives. First, the comparatives selected can "have an immense impact on the accuracy and fairness" of subsequent judgments about an organizations performance (Frost, 2000: 72). When performance exceeds or fails to meet an expected target, managers may take unnecessary action, or inappropriate actions, if all things are 'assumed equal' in the compared operations when indeed they are not. A second concern regarding comparative is the range and diversity of measures considered. It is possible that "better comparatives might lead to better understanding of performance" (2000: 72). Finally, when presenting performance measures, the use of multiple comparatives, such as a current trend line, an internal

target, and an external benchmark, can "paint a richer picture of performance," by facilitating the visual comparison of all three comparatives simultaneously (2000: 72). In fact, "it is the interaction among the metrics and goals that results in excellent performance. Evaluation of their 'individual' merits is a meaningless endeavor because it negates the integrated effect they have" (Perez, 1997: 291). When carefully selected and properly used, comparatives can lead to "dramatic quantitative improvements in performance" (LMI, 1998: 5-21).

Supply Chain Management (SCM)

There are many definitions of SCM. The Council of Logistics Management suggests the following definition:

> The process of planning, implementing, and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements. (Simchi-Levi et al, 2003:2)

More simply, the SCC defines SCM as "the management of internal logistics functions and the relationships between [the] enterprise and its customers and suppliers" (LMI, 2000:13). However, this definition does little to illustrate the true complexity of the concept. In fact, SCM "continues to be a poorly understood, badly explained and wretchedly implemented concept" (Monczka and Morgan, 1997:69). The difficulty generally lies in one, or both, of the two underlying principles. First, effective SCM requires that managers consider the entire system when attempting to minimize costs, a concept known as *global optimization* (Simchi-Levi et al, 2003:2). Second, supply chains must be devised "to eliminate as much uncertainty as possible and to deal effectively with the uncertainly that remains" (2003:3). Despite these challenges, DoD

logistics vision, as stated in the 2000 DoD Logistics Strategic Plan, is to develop "an efficient, integrated supply chain of private sector and organic providers that ensures full customer-oriented support to personnel and weapon systems" (LMI, 2000:12).

In 1998, the *Logistics Functional Requirements Guide* likened the SCM concept to "logistics pipeline management" for DoD (LMI, 1998:7-1). Regardless of its title, "the fundamental premise of SCM remains the operation of a continuous, unbroken, comprehensive, and all-inclusive logistics process" (LMI, 2000:13). However, in 2000, LMI recognized that there were "several influencing elements" that differentiated the concept for DoD. These added considerations included: "mission responsibilities, legal requirements imposed by statue, acquisitions regulations, organizational arrangements, [and] management policies" (2000:14). Nonetheless, acknowledgement of the 'systems approach' is a prerequisite for implementing needed changes.

Systems Approach

In contrast to models that depict the supply chain as a simple linear model, "systems thinking" reinforces the notion that the sum of the parts is, indeed, greater than the whole. Managers must realize that "in organizations, interactions are highly nonlinear—which accounts for the complexity inherent in trying to manage them" (Perez, 1997:290). However, systems management in the public sector is complicated even further because it involves "several nominally independent stakeholders, coupled with informational and resource material flows and behavior that is characterized by inertia and multiple feedback loops" (Boland and Fowler, 2000:424). Under these circumstances, "unexpected behavioral outcomes" result from "a structure which, at face

value may look deceptively simple" (2000:424). This is due to three characteristics of the system:

1. When there are several closed-loop subsystems (output from one system become input in a subsequent system), "the issue of causality becomes problematic…It is not possible to define a finite chain of cause and effect."

2. "Because of all the transformation processes associated with each successive subsystem take time to perform, the system possesses dynamic characteristics."

3. Due to the first two characteristics, "it is not possible meaningfully to understand behavior in one part of the system without also understanding all the other parts since they all interact dynamically" (2000:425)

Trade-Offs

There are many situations "in which the implicit belief was that quality, customer service, profitability, and so forth can be increased simultaneously in each period" (Eccles and Pyburn, 1992:43). Under the systems management approach, managers must recognize that, "simply put, a trade-off means that more of one thing necessitates less of another" (Porter, 1996:68). However, managers often approach trade-offs with trepidation, and find that "making no choice is sometimes preferred to risking blame for a bad choice" (1996:75). Nonetheless,

> "it is important to understand that the relationships and trade-offs among the different measures in the family are fixed by the present organization (system). Any procedure that breaks up the family of measures into independent measurements, without understanding how…the processes in the system that produced them are related, will lead to sub-optimization" (Provost and Leddick, 1993:484).

And, very often, it is viewed as the "rob-Peter-to-pay-Paul" problem, "anything not measured is subject to being sacrificed for the things that are measured" (Frost, 2000:58). Unfortunately, due to the outcomes expected of government agencies, sometimes "the

implication is that it is more important to achieve the outcomes that people want, rather than becoming optimally efficient in delivery" (Boland and Fowler, 2000:427).

Funding Differences

As DoD logistics managers attempt to implement SCM initiatives, the reality is that "the planning staff and the budget staff tend to give mixed messages," encouraging ambitious planning pitted against limited budgets (Blackerby, 1994:26). As managers attempt to establish integrated supply chains and their associated performance measures, "specific goals should be set based on knowledge of the means that will be used to achieve them. Yet the means are rarely known at the time goals are set" (Schneiderman, 1999:8). In addition, "the appropriation process is stacked with negative incentives. Appropriations tend to focus on inputs rather than outputs, so operating performance is obscured and good or bad performance often has little to do with the amount appropriated" (Mosso, 1999:72). The assessment system in place reinforces the notion that "those organizations 'measured' as performing 'well' will be rewarded through additional resource allocation, whilst 'bad' organizations will have to demonstrate improvement in order to gain any additional resources" (Boland and Fowler, 2000:421). The implication is that "under-performance is the result of mismanagement of resources leading to inefficiency" (2000:422). Nonetheless, this often leads to a 'death spiral,' as the lack of additional resources only causes the 'performance gap' to widen (2000:430).

Chapter Review

Pursuant to the reporting requirements contained in the GPRA, the concepts of strategic planning and performance measurement discussed in this chapter provide the foundation for the case study protocol developed in Chapter III.

III. Methodology

This chapter provides the rationale for selecting the qualitative research method employed in this research, and the attributes that lend the study to case study design. It explains the data collection and analysis procedures. Finally, it introduces the case study protocol used to guide the researcher's effort.

Qualitative Research

Traditionally, quantitative research involves measurable variables, while qualitative research is comprised of descriptive or verbal data. According to Leedy, qualitative research is "typically used to answer questions about the nature of phenomena, often with the purpose of describing and understanding the phenomena from the participants' point of view" (2001:101). To that end, Yin suggests that "the first and most important condition for differentiating among the various research strategies is to identify the type of research question being asked" (1994:7). In an iterative process, the type of question will reveal the "nature of the data that will be collected in the resolution of the problem," and to that end, "the data [will] dictate the research method" (Leedy and Ormond, 2001:100). Since this research will compare the performance measures recommended for AFMC, asking 'how' and 'why' questions, a qualitative research design is appropriate for this study. Further, while there are many approaches to qualitative research, a case study strategy, explained below, will be used for this research.

Case Study Strategy

Selecting the appropriate research strategy is generally dependent on three conditions: "the type of research question posed, the extent of control [the researcher] has

over actual behavioral events, and the degree of focus on contemporary as opposed to historical events" (Yin, 2003:5). The following table offers a comparison of the five major research strategies that address these issues.

Table 1. Comparison of Research Strategies

Strategy	Form of the research question	Control over behavioral events?	Focus on current events?
Experiment	how, why	Yes	Yes
Survey	who, what, where, how many, how much	No	Yes
Archival Analysis	who, what, where, how many, how much	No	Yes/No
History	how, why	No	No
Case Study	how, why	No	Yes

(Yin, 2003:5)

The primary matter of interest is 'how' and 'why' the recommended performance measures are different. The main sources of evidence are previously published primary and secondary documents, all obtained unobtrusively. Unlike the experimental method, the researcher had no control over the behavioral events, or outcomes in this research. That is, as Silverman suggested, "text…consisting of words and images which have become recorded without the intervention of a researcher" (2000:40) And, although these sources of evidence consist of dated material, performance measurement is, indeed, a contemporary issue that continues to be examined by HQ USAF/ILI and HQ AFMC. Therefore, the historical method is not suitable for this research. Given the above criteria, a case study strategy is most appropriate for this study.

Attempting to arrange these research strategies in a hierarchical manner may artificially impose limitations on their utility. Instead, it is more productive to regard the case study as both inclusive and pluralistic in order to maximize its utility (Yin, 2003:3). The GAO maintains a dualistic view, suggesting that an exploratory case study is also

descriptive in nature, "aimed at generating hypotheses for later investigation rather than illustrating" (1991:9) However, Lee (1999) shares Yin's view that case study can be exploratory, explanatory, and descriptive, as defined by the nature of the study's questions. Table 2 provides an overview of the complementary nature of these objectives and further supports the use of the case study method.

Table 2. Matching Objectives to Strategy

Study's Purpose	Nature of the Study	Recommended Methods
Exploratory	- investigate poorly understood phenomena - generate preliminary hypothesis	- case study - field study
Explanatory	- clarify causal forces - identify operative networks	- multiple case studies - historical reporting - field surveys - ethnography
Descriptive	- define and illustrate, as thoroughly and objectively as possible	- field surveys - case study - ethnography

(Lee, 1999: 41)

Case Study Design

Yin suggests that there are five components of a research design: "a study's questions, its propositions, if any, its unit(s) of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings" (2003:21).

The *study questions* clarify the nature of the study. As previously noted, the nature of this study is to identify 'how' and 'why' the recommended performance measures are different.

Since the study questions do not indicate exactly what the research should examine, the *propositions* direct the researcher's attention to the relevant evidence within the scope of the study. Yin suggests that researchers use the literature review as a means "to develop sharper and more insightful questions about the topic" (2000:9). This research utilized the concepts discussed in Chapter II to develop the theoretical framework applied in this study. The case study protocol will provide a thorough discussion of the propositions.

The *units of analysis* define exactly what a "case" is (Yin, 2003:22). For this research, the units of analysis are the individual measurement plans. This approach, referred to as a multiple or collective case study, is often used "to make comparisons, build theory, or propose generalizations" (Leedy and Ormond, 2001:149). In addition, when, "within a single case, attention is given also given to a subunit, or subunits," it is referred as an embedded case study design (Yin, 2003:42). Within each case, or measurement plan under study in this research, there are several individual measures, or subunits.

Linking data to propositions and *criteria for interpreting the findings* are "the least well developed [components] in case studies" (Yin, 2003:26). While there are many possible approaches for linking data to the propositions, the "most preferred strategy is to follow the theoretical propositions that led to [the] case study" (Yin, 2003:111). The following discussion of the multiple-case method, in conjunction with the case study protocol, maps this strategy. Finally, although this research effort applies many of the recommended case study tactics, "there is no precise way of setting the criteria for

interpreting these types of findings" (Yin, 2003:27). Therefore, the remainder of this chapter is dedicated to establishing the criteria employed in this empirical research effort.

Multiple-Case Method

This research is a comparison of three recommended performance measurement plans. The nature of the research questions suggests that the following multiple case study method is most appropriate.

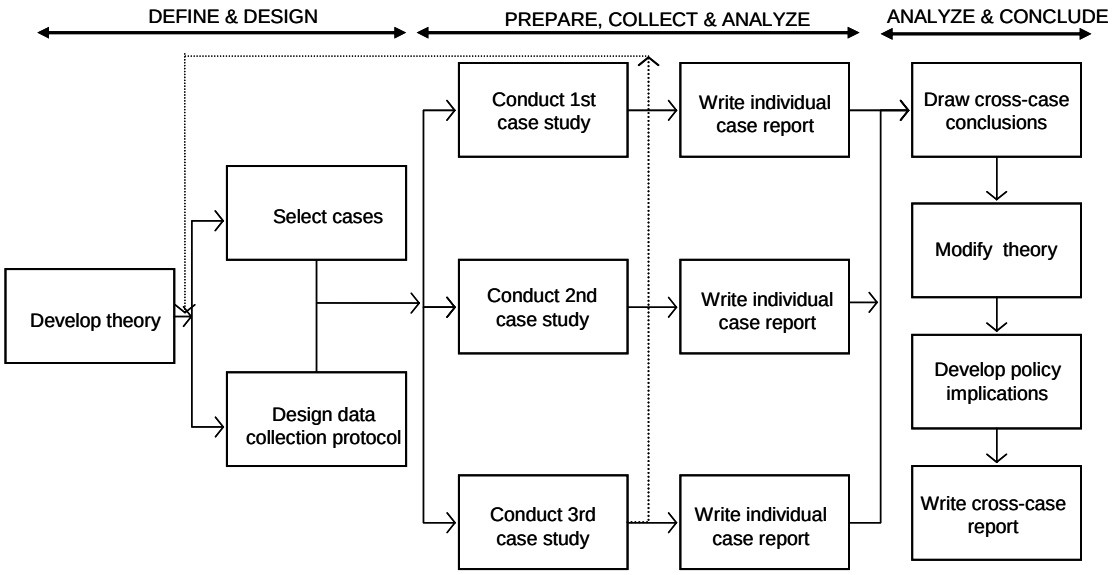


Figure 7. Multiple Case Study Method

(Yin, 2003:50)

As Yin suggests, theory development is the first step. The researcher used the information provided in the literature review to form the underlying propositions of this study, and to develop the related questions found in the case study protocol. The Data Collection section identifies the data sources, and contains the justification for the cases selected, as well as the secondary data used in subsequent analysis. In analyzing each case using the established protocol, the researcher recorded the results in tabular form in lieu of narrative case reports. This approach ensured each protocol requirement was

addressed and facilitated cross-case analysis. As previously noted, the researcher has no control over actual behavioral events in the current research. In addition, she has no authority or participatory role in subsequent policy development. The goal of this research is that discoveries made during the data analysis will provide insight to assist decision-makers in future performance measurement efforts.

Four Design Tests

Case study research and qualitative research, in general, is often criticized for a lack of rigor. Therefore, Yin suggests a number of methods to reinforce the quality of research design (2003:10). Four tests common to all social science research are relevant to case study research as well. The table below summarizes the four tests and the associated research tactics, followed by a discussion of each test.

Table 3. Case Study Tactics for Four Design Tests

TESTS	CASE STUDY TACTIC	APPLICABLE PHASE OF RESEARCH
Construct validity	- Use multiple sources of evidence	data collection
	- Establish chain of evidence	data collection
	- Have key informants review draft case study report	Composition
Internal validity	- Do pattern-matching	data collection
	- Do explanation-building	data collection
	- Address rival explanations	data collection
	- Use logic models	data collection
External validity	- Use theory in single-case studies	research design
	- Use replication logic in multiple-case studies	research design
Reliability	- Use case study protocol	data collection
	- Develop case study database	data collection

(Yin, 2003:34)

Construct validity is "the extent to which an instrument measures a characteristic that cannot be directly observed but must instead be inferred" (Leedy and Ormrod, 2001:98). If there is no universal agreement on the measurement instrument, such as the consensus that a scale measures weight, the researcher must demonstrate that the instrument being used is valid for its purpose. The onus is on the researcher to provide "evidence" that the criteria used during data collection was more than a succession of subjective judgments (Yin, 2003:35). In this research, multiple sources of evidence from the literature review were used to develop the propositions that guided data collection.

Internal validity is particularly important in explanatory and causal studies. It is "the extent to which [a study's] design and the data it yields allow the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data"

(Leedy and Ormrod, 2003:103-104). Generically, this gives credence to the researcher's conclusion that "x *causes* y." The literature review provided the foundation for explanation building during the data collection, and pattern matching was conducted during the cross-case analysis where applicable.

External validity is the "extent to which [the study's] results apply to situations beyond the study itself—in other words…*generalized* to other contexts" (Leedy and Ormrod, 2001:105). Although qualitative research is often criticized for its "limited generalizability," it is not usually understood that "the intent of qualitative research is not to generalize findings, but to form a unique interpretation of events" (Creswell, 1994:159). The GAO concurs that "generalizability depends less on the number of sites and more on the right match between the purpose of the study and how the instances were selected" (1991:76). Indeed, case study research should not be compared to survey research because in the former, the goal is "to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalizations)" (Yin, 2003:10). Alasuutari suggests that "what can be analyzed instead is how the researcher demonstrates that the analysis relates to things beyond the material at hand, [therefore]… *extrapolation* better captures the typical procedure in qualitative research" (1995:156-157).

Reliability is "extent to which [a measurement instrument] yields consistent results when the characteristic being measured has not changed" (Leedy and Ormrod, 2001:99). However, Yin cautions that in case study research "the emphasis is on doing the *same* case over again, not on 'replicating' the results of one case by doing another case study" (2003:37). He compares reliability to the question of generalizability, in that,

"the uniqueness of a study within a specific context mitigates against replicating it exactly in another context" (Yin, 1994:159). This research will employ both of the recommended tactics—a case study protocol and a case study database.

Data Collection

Yin identifies six commonly used sources of evidence for case study research. They are documentation, archival records, interviews, direct observation, participant observation, and physical artifacts (2003:86). This research will focus exclusively on the use of official program documentation and archival records as primary and secondary data sources. The table below provides an overview of the relative strengths and weaknesses of the chosen data types.

Table 4. Sources of Evidence

Source of Evidence	Strengths	Weaknesses
Documentation	- stable—can be reviewed repeatedly - unobtrusive—not created as a result of the case study - exact—contain exact names, references and details - broad coverage—long span of time, many events/settings	- retrievability—can be low - bias selectivity, if collection is incomplete - reporting bias—reflects (unknown) bias of author - access—may be deliberately blocked
Archival Records	[*same as above*] - precise and quantitative	[*same as above*] - accessibility due to privacy reasons

(*Adopted from* Yin, 2003:86)

Although Yin recommends the use of multiple sources of evidence, the researcher deliberately chose to adhere to printed references, as the subject matter is highly debatable and often contentious. While the researcher obtained all the data presented in

this case study from printed resources, the researcher made every attempt to seek the independent assessments from multiple institutional sources, as noted below.

There are three principles of data collection that can enhance the construct validity and reliability of case study evidence: use of multiple sources of evidence, creation of a case study database, and maintenance of a chain of evidence (Yin, 2003:97). Multiple data sources help to ensure that "a full picture will be obtained and that bias associated with self-protection or self-interests will be reduced" (GAO, 1991:24). In addition, multiple sources facilitate triangulation, that is, "the development of converging lines of inquiry" (Yin, 2003:98). This approach, discussed further in Data Analysis, is not limited to the use of multiple data gathering techniques, but can be a means of validating findings by brining together varieties of data, a range of investigators, multiple perspectives, or a combination of methodologies (Berg, 1998:5). A case study database requires that the researcher maintain "two separate collections," a catalogue of evidentiary records and an independent narrative report. The database of case study records in this study are contained in Appendices A through C. Finally, maintaining a chain of evidence enables a critical reader "to follow the derivation of any evidence, ranging from initial research questions to ultimate case study conclusions" (Yin, 2003:105). The protocol questions were used to develop to findings from each performance plan in order to maintain the chain of evidence.

Case and Data Selection Criteria

The selection of cases for this study was straightforward as there were unique cases that the researcher immediately discovered at the outset of the inquiry (Yin, 2003:78). While performance measurement has long been a matter of debate in logistics,

there are few published plans. In the recent past, various improvement teams, such as the Spares Campaign and Depot Maintenance and Reengineering Teams, had initiated several efforts, however, none resulted in published efforts. And, while there appeared to be a consensus that better performance measures were needed, there was little agreement on exactly what should be measured, and how. In August of 2003, the researcher discovered that the Materiel Support Division was preparing to publish a new *AFMC Supply Chain Metrics Guide*. However, the measures contained in the guide were the same measures already in use. On further investigation, the researcher discovered that LMI and AFLMA had recommended alternative measurement plans in 1999 and 2001. A comparison revealed that each plan was distinctly different, and led the researcher to this effort. The data sources are cited below, with a brief overview of the organizational authors.

Headquarters Air Force Materiel Command. *AFMC Supply Chain Metrics Guide*. Wright-Patterson AFB: HQ AFMC, 25 November 2003.

The Materiel Support Division of the Supply Management Mission Area is responsible for a wide range of logistics services to include requirements determination, acquisition, provisioning, cataloguing, data management, disposal and supply chain management (SMMA, 2002:2). As the supply chain focal point for the air logistics centers and worldwide AF customers, the division's mission is to provide their customers with the policy and responsive assistance necessary to achieve readiness through effective materiel support.

Logistics Management Institute. *Supply Chain Management: A Recommended Performance Measurement Scorecard*. McLean, VA: LMI, June 1999.

LMI is a private, non-profit organization dedicated to improving management of the nation's public sector through research, analysis, education, and counsel. Under contract through the General Services Administration (GSA), LMI's Logistics Management operating unit provides innovative logistics and supply chain solutions that promote efficient processes, industry best practices, and well-placed technology investments. The performance report cited above was derived from an earlier publication sponsored by the Supply Chain Integration Office, Assistant Deputy Under Secretary of Defense, *DoD Supply Chain Management Implementation Guide* (2000).

Air Force Logistics Management Agency. *Measuring the Health of USAF Supply*. Report LS199929101. Maxwell AFB: AFLMA, January 2001.

AFLMA is a field operating agency of the Air Staff—HQ USAF/IL. Their stated mission is "to increase AF readiness and combat capability by developing, analyzing, testing, evaluating, and recommending new or improved concepts, methods, systems, policies, and procedures to enhance logistics efficiency and effectiveness" (AFMAN 23-110:1-7). In 1999, the Director of Supply (AF/ILS) tasked AFLMA "to develop a set of performance measures or metrics that represent the health of supply at an aggregate level" (AFLMA, 1999:i). The result was the above referenced report.

In addition to the sources above, the researcher used reports and secondary data from the following sources: DoD, AFMC and Air Force regulations, GAO reports, and RAND studies. Often referred to as the "investigative arm of Congress," the GAO provides auditing and reporting services to help improve performance and ensure the accountability of the federal government for the American people. And, the RAND Corporation is a non-profit organization that helps improve policy and decision-making

through research and analysis. Established in 1946, Project AIR FORCE (PAF) includes a resource management research agenda that analyzes policies and practices in the areas of logistics and readiness.

Case Study Protocol

As noted, a case study protocol is a research tactic to enhance the reliability of case study research. It should contain a project overview, field procedures, case study questions and a guide for the case study report (Yin, 2003:69). In addition to increasing the reliability of case study research, it is "intended to guide the investigator in carrying out the data collection" (Yin, 2003:67). Chapters I and II of this thesis provide the project overview, covering the background information, the issues under investigation and the relevant literature. Chapter III contains the 'field procedures' that will be used to collect the case study data. The AFIT Style Guide contains the applicable format for completing the case study report. Therefore, the "protocol," as utilized in this thesis, will emphasize the case study questions.

Referred to the "heart of the protocol," the case study questions are "a set of substantive questions reflecting [the] actual line of inquiry" (Yin, 2003:73). The researcher will use the case study questions to link the literature review, the propositions, and the data. Developed in this manner with appropriate cross-references, the researcher will use table shells "to identify exactly what data are being sought…[and] ensure that parallel information will be collected…where a multiple-case design is being used" (Yin, 2003:75). Table 5 contains the study propositions and the associated questions used in the conduct of this research.

Table 5. Case Study Protocol

INDEX	PROPOSITION/QUESTION(S)
P1	Performance measurement begins with strategic planning.
Q1	What is the stated goal or objective?
P2	Performance should be directly linked to achievement of the stated strategy, i.e. there should be strategic management.
Q2a	Is there a business process model identified?
Q2b	Is there vertical alignment?
P3	Measures should be effectively grouped to provide a holistic view of the system.
Q3	Is a 'family of measures' identified, or is a measurement model employed?
P4[1]	Performance measures should provide a clear 'line of sight' between the business processes and the causes of results.
Q4a	Do measures reflect the output of the identified business processes?
Q4b	Do the associated measures encompass all operations included in the business process model?
P5	The business model should include categorical measures of economy, efficiency, and effectiveness.
Q5	Does the measurement plan include such categorical measures?
P6[2]	Performance measurement systems commonly identify the inherent characteristics of identified measures that qualify such as a plan as comprehensive, or reliable. When other measures are employed, managers should be aware of their limitations, i.e. capacity measures and leading/lagging indicators should be properly applied.
Q6a	Are the measures properly identified, defined, and/or employed?
Q6b	Does the measurement plan identify individual measurement characteristics?
P7	The systems approach to supply chain management often requires trade-offs among the various system measures.
Q7	Does the measurement plan identify any system trade-offs?

Note 1: Individual measures and their associated alignment are outlined in the Appendices A and B, for AFMC and AFLMA respectively. However, due to the number of measures identified by LMI, only the enterprise measures are summarized, with other measures included by exception when applicable.

Note 2: As noted above, due to the number of measures included in all the measurement plans, definitions and applications are summarized by exception when identified by the plan's author as notable.

Data Analysis Procedures

Analyzing case study evidence "consists of examining, categorizing, tabulating, testing, or otherwise recombining…evidence to address the initial propositions of a

study" (Yin, 2003:109). In the initial phase of this case study, the literature review was "aimed at surfacing salient concepts or themes" (Yin, 2003:110). These served as the foundation for developing the study's propositions and subsequently, the protocol questions. As previously noted, triangulation was used to reinforce this research by providing "assurance that reasons given for events properly reflect influences from many different sources" (GAO, 1991:24). However, the researcher employed addition analytic techniques to develop internal and external validity in this case. These included pattern matching, explanation building, and logic models (Yin, 2003:139). In addition, this study employed cross-case analysis to determine if the performance plans share common thematic characteristics and what insight those characteristics could possibly provide for future decision makers.

Chapter Review

This chapter provided the justification for a case study research design and explained the use of a multiple-case method. In addition, it explained the techniques used in data collection and analysis. Finally, it provided the case study protocol used for data collection.

IV. Analysis

Chapter Overview

This chapter summarizes the research findings based on the literature review and the results of the case study protocol through a comparative analysis of the three performance measurement plans. Since the individually referenced findings from each plan are cited in the attached appendices, this section is intended to provide only an overview of the most distinguishing characteristics noted. It then addresses the investigative questions, in addition to the associated managerial implications.

Research Findings

This research posed the following questions: *how do the performance measurement recommendations of the LMI, the AFLMA and AFMC differ*, and *why do the performance measurement recommendations differ*. In the course of exercising the case study protocol, the researcher discovered that these questions were very symbiotic in nature. At times, it was difficult to distinguish whether the content was driving the cause, or the cause was driving the content. Nonetheless, the following provides an overview of the performance plans' distinguishing characteristics.

Strategic Planning and Vertical Alignment

As defined in the literature review, strategic planning is "a continuous and system process where people make decisions about intended future outcomes, how outcomes are to be accomplished and how success is measured and evaluated" (Blackerby, 1994:21). However, in initial comparison of the performance plans, it was noted that the intended level of enterprise reporting differed, and as a result, the scope of the measurement

objectives differed as well. The LMI plan took a DoD perspective stating the overriding objective is "to provide responsive and cost-effective support to ensure readiness and sustainability for the total force in peacetime and war" (1999:3-2), while the AFLMA and AFMC took more parochial view. Both of these plans used "aircraft availability" as their ultimate measure of success. While the LMI does include a measure of "Weapon System Not Mission Capable Rates" (essentially the inverse of aircraft availability), this is only one of nine measures assessed at the enterprise level. However, since the aim of this research is not to make a qualitative judgment regarding the suitability of such objectives, it is more useful but to identify the implications of such differences.

The significance of the relative differences in identified strategic outcomes is best illustrated by reviewing the DoD guidance regarding vertical alignment, as discussed in Chapter II.

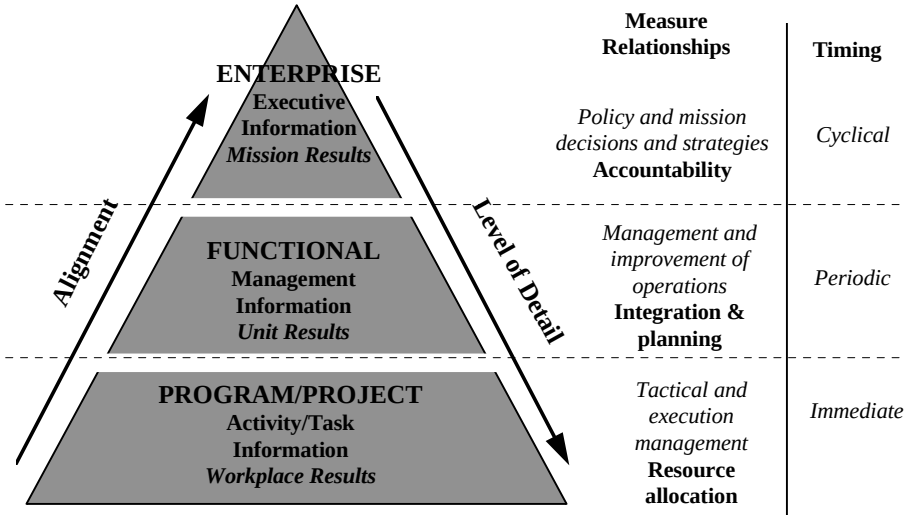


Figure 8. DoD Levels of Performance Measurement

(Vector Research, Inc., 1997: 3-4)

Although enterprise metrics are intended to assess the overall performance of the supply chain, the scope of overall performance, in itself, is contingent upon where in the supply

chain the inquiring *enterprise* resides. In addition, there are few relationships in the AF supply chain that are as directly related as the diagram would suggest, and attempts to align those relationships results in problematic issues of accountability and responsibility. For example, using the "enterprise, function, program" configuration, as defined above, would suggest alignments such as those shown in the following table:

Table 6. DoD Configured Alignment

Enterprise	AF/IL	AFMC	MAJCOM
Function	WSSCM	WSSCM	WSSCM
Program	SCM/IM	SCM/IM	SCM/IM

The Air Staff, AFMC, and MAJCOMs all have a vested interest at the executive level. However, for functional alignment, the DoD configuration would suggest that the WSSCM is the next appropriate level to provide management information. As shown in the table above, this would also present some challenging relationships in terms of implied authority. These implied relationships also assume that the WSSCM does indeed have control over all the processes in his supply chain, or that the IM has the authority to allocate resources as needed, which is rarely the case.

More common, however, the attempt to maintain accountability and 'roll up' performance measures results in implied alignments that are dysfunctional, such as:

Table 7. Implied Measurement Alignment

Enterprise	AFMC	AF/IL	DOD
Function	ALC	AFMC	AFMC
Process	SCM/IM	SCM/IM	WSSCM

Although these alignments would appear reasonable, there are gaps in the chain of command, and aggregation of measures occurs at an inappropriate level. As implied above, the intended level of enterprise reporting for each of the measurement plans is different. It would be convenient if the performance measurement plans could be neatly indentured, such that AFMC measures fit into AF/IL measure, that fit into DoD measures; however, not only does this violate the intention of the DoD configuration, it also fails to include one of the primary end customers—MAJCOMs. In addition, it becomes a matter of perception that begs the question of authority between AF/IL, AFMC and the supported MAJCOMs (RAND, 2003:63). While the intended strategic outcomes may be comparable for all of the enterprise functions, the nature of the enterprise determines the scope of functions and processes to be included in their diagnostic measures.

Business Process Models

As defined in the literature, the business model should represent the corporate consensus of exactly how the processes of the organization contribute to the accomplishment of the organizational goals. While each performance plan implies that similar processes are in place, each plan proposed a distinct model. AFMC used the following model to represent the "process linkage."

Figure 9. Aircraft Availability Metrics Cycle

ALMA developed a unique model as well, shown below, in addition to providing the summary outline of tasks contained in Appendix B.

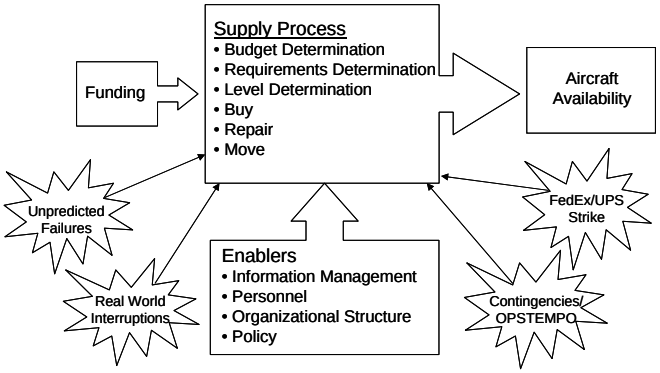


Figure 10. Supply Model Outline (AFLMA, 2001)

Finally, LMI adopted the SCOR Model, as shown in Chapter II. All of these models are summarized in the following table to demonstrate their similarities:

Table 8 Business Process Model Summary

AFMC AA METRIC CYCLE	AFLMA CORE PROCESSES	LMI SCOR FUNCTIONS
Aircraft Availability	Repair	Plan
Requirements Computation	Buy	Source
Asset Allocation & Funding	Stockage & Distribution	Make
Real World Performance	Funding	Deliver

While all of the models include the critical functions of the AF supply chain, perhaps the most striking similarity is their simplicity. The AF supply chain is extremely complex, consisting of multiple customers with varying demands that support many different major end items (MEI) and receive multiple services (supply, maintenance, transportation, and planning) at many locations (RAND, 2003:xi). While it is indeed important to define processes unambiguously, it is also important that definitions be "all encompassing" (Manship, 2001:51). Although a complete depiction of the process may not be practical or realistic, it is critical that those managers utilizing the performance measures derived from simplified models understand their limitations. Indeed, these limitations encourage the movement toward the supply chain management principles of systems approach and global optimization discussed in Chapter II, and at the conclusion of this section.

Measurement Models and "Line of Sight"

Measurement models provide a convenient way to group measures into 'families' that together provide a holistic view of the system. Although both LMI and AFLMA utilized the Balanced Scorecard as the basis for organizing their metrics, each adapted the model to best fit the priorities and the processes of the organization as they had each defined them. LMI modified to the model configuration to illustrate the 'balanced'

priorities of customer service, cost, and readiness and sustainability performance objectives (1999, iii), as shown below:

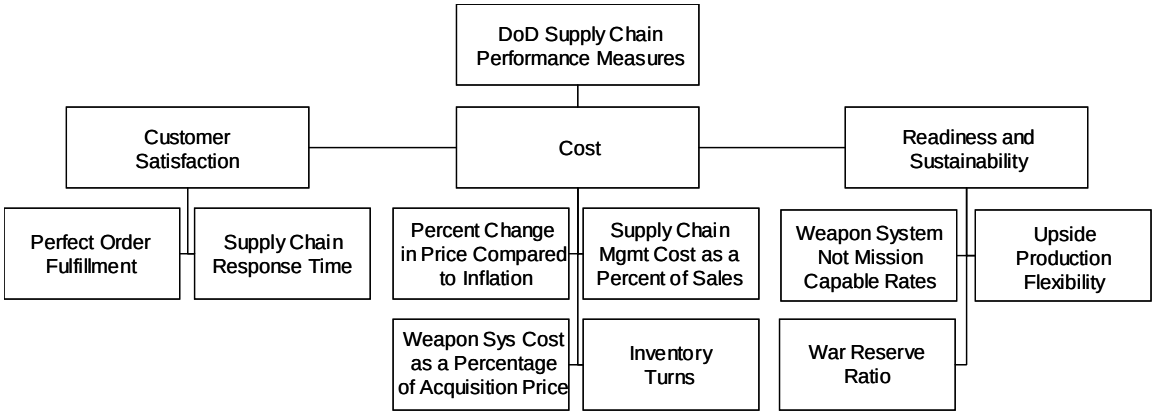


Figure 11. DoD Supply Chain Performance Metrics

Due to the broad scope of the LMI's Balanced Scorecard, it is difficult to see the 'line of sight' between the business processes and the causes of the desired results, as indicated by the measures above. This performance plan includes a total of 110 metrics: 9 enterprise level, 27 functional level, and 74 process level. LMI offers the following explanation to describe the thread of collective measures:

> 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 (1999, 3-5)

Finally, it is interesting to note that due to the chosen configuration, weapon system NMC rates is a readiness and sustainability measure in lieu of being aligned with customer satisfaction.

AFLMA identified six separate segments in the supply process, and included consideration of process enablers, defined as "those factors internal to the business

perspective that are essential to the performance of the business" (2001:6). All these concepts were incorporated into their Balanced Scorecard are shown below:

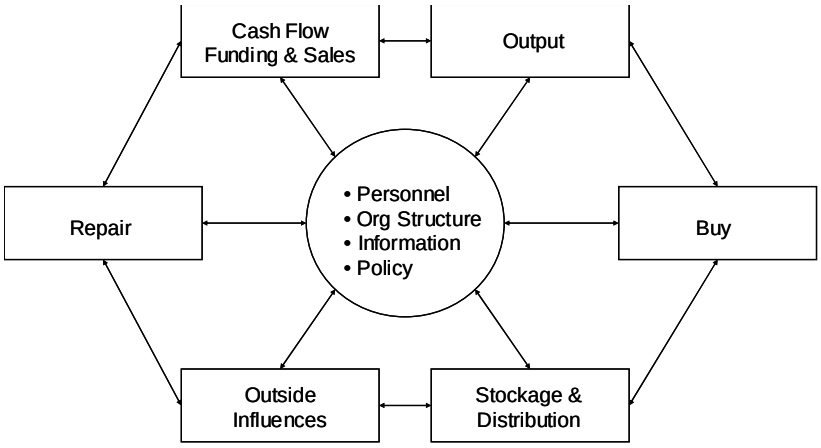


Figure 12. Supply Segment Balanced Scorecard

Twenty-three metrics are identified to support each of the six segments, in addition to 3 metrics that assess the personnel and information enablers. Although AFMC does not have authority over manning effectiveness, the enterprise owner of this measurement plan, AF/IL, does have managerial input to the process owners at the AF Personnel Center. AFMLA noted that this metric set was approved by Brigadier General Mansfield in October 2000. However, the researcher could not verify that this metric set was ever implemented for use.

AFMC identified 10 metrics: 5 performance measures and 5 process indicators. The table below aligns and consolidates the information provided in the metrics guide, as interpreted by the researcher:

Table 9. Collective Overview of AFMC's Measurement Model

Real World	Aircraft Availability	Requirements Generation (D200)	Requirements Allocation —Financial Systems
Performance Measures		*Process Indicators*[1,2]	
Aircraft Availability		Total Requirements Variance	
MICAP Hours		Issue Effectiveness	
MICAP Incidents		Stockage Effectiveness	
Customer Wait Time (CWT)		Backorders	
Net Operating Results		Logistics Response Time (LRT)	

Note 1: Process indicators facilitate root-cause analysis and add additional meaning to performance measures. They are not considered performance measures and are not formally monitored against set targets. Internal targets may be set by organizations seeking to improve specific problem items and areas that have been identified to be affecting a performance measure like Aircraft Availability (2003:37)
Note 2: *While AFMC does not require the monthly reporting of this metric, some organizations may want to review and analyze this metric* (2003:38).

A comprehensive measurement plan should include not only measures of productivity and effectiveness, but also process measures. While all three plans utilized a measurement model in attempt to align the associated measures with the business process models, the line of sight between the process and its measure is obscure, at best. By defining aircraft availability targets in terms of only those processes they control, it is not uncommon for wholesale supply personnel to measure "the stockage and issue

effectiveness it achieves when it passes items to the next segment in the supply chain" (RAND, 2003:27). Without such line of sight, it was increasingly difficult to link the authority, responsibility and accountability for the process from a systems perspective.

Supply Chain Management

As discussed in Chapter II, effective SCM requires a systems approach to global optimization. To measure the efficiency and effectiveness of the DoD supply chain, performance measurement would include all supply chain processes, as shown in Figure 13.

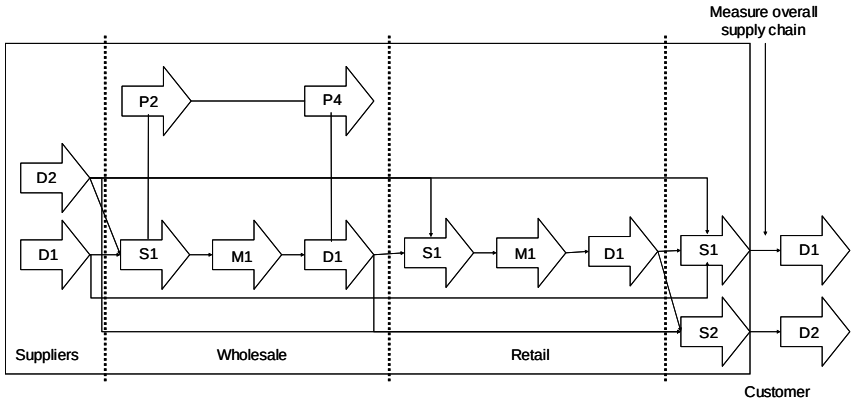


Figure 13. Supply Chain Performance Measurement

However, as noted by LMI, current measures only evaluate the responsiveness of the independent nodes, as shown in Figure 14.

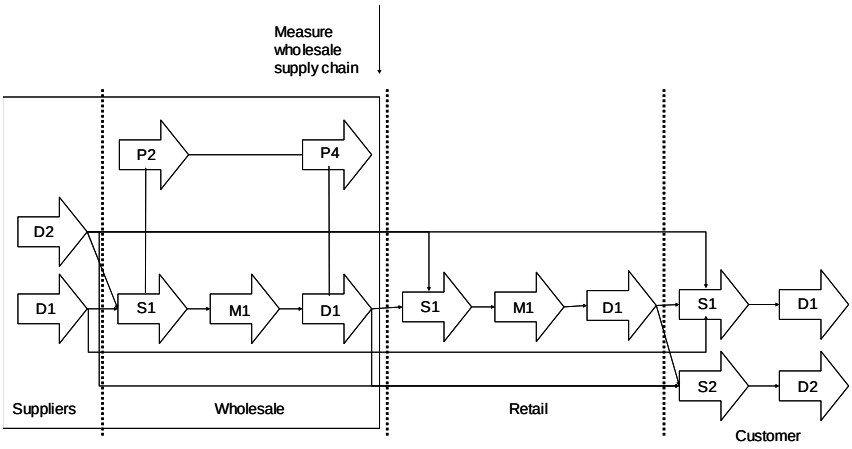


Figure 14. Wholesale Performance Measurement

However, measuring in this manner is "misleading because most orders are requisitions form a retail level for replenishing stock (i.e. repositioning inventory in the supply chain) and do not delay a repair or maintenance action" (LMI, 1999:4-2). Nonetheless, such segmentation is recognized as a "fundamental element of the AF culture…[which tends] to organize itself around functions, such as supply and maintenance, and MAJCOMs, not integrated processes, such as supply chains" (RAND, 2003:xvi). While prohibitive to integrated supply chain management, it enables some semblance of accountability in uncertain times (2003:xi).

Investigative Questions

This research posed the questions: *how do the performance measurement recommendations of the LMI, the AFLMA and AFMC differ*, and *why do the performance measurement recommendations differ*. Due to the individual enterprise levels addressed by each of the performance plan, they differed significantly in scope and level of measurement aggregation as discussed above.

Managerial Implications

AF organizational structure and supply chain segmentation is not conducive to 'one-size-fits-all' performance measures. The segmentation between functional authority and system responsibility represent significant challenges to implementing a coherent supply chain. As such, attempting to measure performance from a supply chain perspective has limited application. Leading to the conclusion that

> in assessing the case for a performance-standards system, it is important not to confuse a focused effort with a productive one. When the output is difficult to measure, as is true in most government bureaucracies and many private ones, installation of specific goals may focus effort but may send the bureaucrats marching in the wrong direction. (Heckman, etal, 1997:394)

V. Discussion, Conclusions and Recommendations

This chapter summarizes this research effort. It briefly discusses some of the limitations of this thesis, and presents some suggestions for future research. Finally, it concludes by summarizing the research.

Limitations

Chapter II presented some of the difficulties of performance measurement in the public sector. Segmentation of the supply chain, sub-optimizing trade-offs, and funding differences all present unique challenges in government organizations. At the crux of these challenges is the apparent division of authority, responsibility, and accountability. Without such line of sight, performance measures represent little more than operational statistics. However, no one organization can address these challenges independently, and overcoming the apparent segmentation of the supply chain would require significant changes to organizational policy and operating concepts.

Researcher as an 'Instrument'

In qualitative research, it is common to refer to the *researcher as an instrument* (Yin, 2003; Leedy and Ormrod, 2001:162). Since the interpretation of data is vulnerable to researcher bias, Creswell and others recommend that the researcher identify "personal values, assumptions and biases at the outset of the study" (Creswell, 1994:163). The researcher in this case study is a Logistics Readiness Officer. Prior to realignment of the officer career paths in logistics, the researcher was a Supply Officer, with fifteen years of experience in AF supply systems, however, all at the retail level. Readers should note that it is not the intention of the researcher to make value judgments of the reviewed

performance measurement plans, as ‘good’ or ‘bad’. The researcher’s objective in undertaking this effort was to compare the contributions of various agencies on the subject, and perhaps discover some thematic commonalities or differences that would benefit decision makers in future efforts to establish performance measurements.

Recommendations for Future Research

During this study, the researcher noted the following opportunities for future research.

To facilitate the organizational policy changes required to facilitate SCM within the AF, a future research effort could conduct a case study focused on determining the exact delineation of authority, responsibility, and accountability within the various supply chain processes. For example, while SCM/IMs have responsibility of item management, they do not have the authority to prioritize repair at the shop level.

A statistical analysis could be conducted utilizing the performance measurements recommended by AFLMA. Since these measures were never employed, there is no data to support or refute the viability of their effectiveness to result in improved aircraft availability.

Finally, future research could explore more advanced methods for disaggregation of metrics to enhance their application. Current methods of aggregation limit their value in application, however, obvious methods of disaggregation, such as by weapon system, would yield an unwieldy number of measures to prove useful at the corporate level.

Research Summary

Despite the abundance of literature available and the efforts of many AF initiatives, performance measurement continues to be a matter of debate in logistics. The

objective of this research was not to identify yet another of set of measures in attempt to assess the performance of AF logistics systems, but to identify some characteristics about the nature of performance measurement in such systems that would enable future managers to develop better measures. To that end, this research identified three performance measurement plans, and assessed them qualitatively.

Through a review of the literature, the researcher developed propositions regarding performance measurement systems. These propositions generically described the characteristics of the developmental components that result in comprehensive measurement systems. From strategic planning to ultimately identifying system trade-offs, this building block approach enables managers identify corporate objectives, key processes, and organizational priorities. Using these propositions, the researcher developed a line of inquiry to assess each of the performance plans. The findings were used to conduct cross-case analysis and develop the salient themes identified in Chapter IV.

Due to the organizational structure and governing policy in AF logistics systems, there are, indeed, some unique challenges to establishing effective and comprehensive performance measures. The multiple layers of authority and the nature of executive relationships at the command level make vertical alignment of performance measures difficult, at best. As a result, many measures can only capture the performance of various segments in the supply chain, and are of limited use from a system perspective. The segmentation of functional authority and system responsibility prevent the development of true 'corporate' measures. Performance measurement will continue to challenge AF

logisticians; however, reapplying ineffective measures or attempting to utilize supply chain measures within the current structure is of limited value.

Appendix A: AFMC Supply Chain Metrics Guide

INDEX	REF	FINDING
Q1	p. 5	"…the right part, to the right place, at the right time at the right price"
	p. 6	"Aircraft Availability is not only the best measure of support to the warfighter, it is also the key input to the requirements process"
Q2a	p. 5	 1. Aircraft Availability 2. Requirements Computation 3. a. Asset Allocation b. Financial Process 4. Real World performance
Q2b/3	p. 5	"Measurement Package: A group of five (plus or minus two) metrics best suited to measure supply system perfromance based on a unique perspective within the supply chain. (ALC Package, AFMC Package, Item Manager Package, etc.)
	p. 51	"The American Production and Inventory Control Society (APICS) advises organizations to focus on five (+/-2) metrics to avoid overload. AFMC recognizes the administrative and managerial burden related with reporting too many metrics. Moreover, some metrics are more important than others depending on the ***organizational focus*** within the supply chain. Measurement packages provide a recommended set of primary metrics by position in the supply chain. The recommended metrics provide the most relevant performance measures and process indicators for a position in the supply chain" *[See table below]*

Section C—Measurement Packages

Supply Chain Perspective	Most Relevant Metrics
Item Manager	**MICAP Hours** **MICAP Incidents** **CWT** TRV
Supply Chain Manager (SCM)	**MICAP Hours** **MICAP Incidents** Backorders **CWT**
Weapon System Supply Chain Manager (WSSCM)	**Aircraft Availability** **MICAP Hours** **MICAP Incidents** **CWT** TRV*(Requires WS-NIIN relationship)
ALC	**Aircraft Availability** **MICAP Hours** **MICAP Incidents** **CWT** NOR TRV
AFMC	**Aircraft Availability** **MICAP Hours** **MICAP Incidents** **CWT** NOR TRV
Air Staff	**Aircraft Availability** **MICAP Hours** **MICAP Incidents** **CWT** NOR
MAJCOM	**Aircraft Availability** **MICAP Hours** **MICAP Incidents** **CWT**

Q4a	p. 5	"Aircraft availability drives a cycle that provides a mathematical and analytical link between process, performance, and customer"
	p. 8	"Beginning and ending with Aircraft Availability, the various functional levels can adequately measure successes and address potential constraints, while retaining the focus on the ultimate delivery to the warfighter"

Q4b	p. 8	The linkage of AFMC supply metrics to customer expectations and core business strengths is essential to effectively evaluate and analyze supply process functions and delivery.
	n/a	Note: *The performance/process diagrams and their associated tables are outlined, and the categorical definitions of the types of measures are provided in Q5a below. Although no other explanation of the relationships is provided, there are follow-on analysis suggestions are provided for each metric. Additional definitions are noted by exception in Q6.*

(Section B—Performance Metrics, 2003:9)

Metric:	**Description:**	**Type:**
Aircraft Availability (AA)	Percentage of the time an aircraft is not unavailable due to supply—expressed as 1 minus the Total Non Mission Capable Supply (TNMCS) time	Performance
MICAP Hours	Measurement of the hours accrued in a given month for items affecting mission capability that are on backorder	Performance
MICAP Incidents	Measurement of the number of incidents based on the number of MICAP requisitions accumulated	Performance
Customer Wait Time (CWT)	A pipeline measurement of customer due-outs (not including stock replenishment and kit fills expressed in days measuring the average time between issuance of a warfighter order and receipt	Performance
Net Operating Result (NOR)	Financial measurement showing the difference between revenue and expenses or a bottom line profit and loss indicator	Performance

(Section B—Process Metrics, 2003:9)

Metric:	Description:	Type:
Total Requirements Variance (TRV)	Evaluation of Expected Backorders (RBL forecasted customer due-outs) vs. actual due outs (with option to view masked due-outs caused by laterals and non-project coded kit issues)	Process
Backorders (BO)	Measures the number of demands placed on the supply system that can not be immediately satisfied from existing inventory (including stock replenishment)	Process
Issue Effectiveness (IE)	Measure of supply accounts ability to satisfy any customer demand (issue item off-the-shelf vs. backordering the item)	Process
Stockage Effectiveness (SE)	Measure of supply accounts ability to satisfy customer demand for authorized stockage items	Process
Logistics Response Time (LRT)	A pipeline measurement of warfighter and base/depot retail requisitions expressed in days measuring the average time between issuance of a warfighter/base/depot retail order and receipt at base/depot supply	Process

Q5	p. 8	*Performance Measure*—Data that indicates the strengths and opportunities for improvement in an organization. These measures can highlight organizational effectiveness, customer satisfaction, and the cost-effective use of resources and facilities. Performance measures are reported externally and show the most direct link to organizational goals and customer value. *Process Indicator*—Data that provides information about or contributes to the understanding of a process. Process indicators are used in root cause analysis of deviations in performance measures. Typically, process indicators are not directly related to overall organizational goals and are used for internal reporting.
	p. 37	**Performance Targets:** Process indicators facilitate root-cause analysis and add additional meaning to performance measures. They are not considered performance measures and are not formally monitored against set targets. Internal targets may be set by organizations seeking to improve specific problem items and areas that have been identified to be affecting a performance measure like

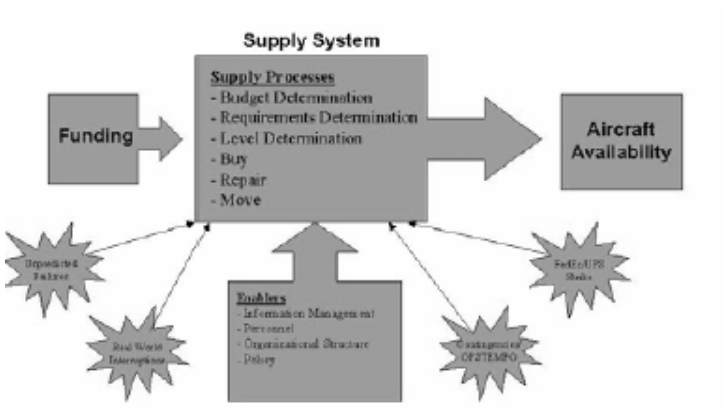
		Aircraft Availability.
	p. 38	**Analysis:** *While AFMC does not require the monthly reporting of this metric, some organizations may want to review and analyze this metric.* [this exception is noted on all process indicators]
Q6	p. 12	It is important to note that the distribution relating **Aircraft Availability** and funding can be precipitous. Even the slightest reduction in funding can result in a significant drop in Aircraft Availability. Likewise, if Aircraft Availability is low, the distribution forecasts a significant increase in Aircraft Availability with only a modest increase in funding.
	p. 15	**MICAP Hours:** Only transactions where AFMC is the primary source of supply are considered. [same exception noted for MICAP incidents, p. 20]
	p. 16	**MICAP Hours:** The targets shown above are the results of the FY02 target-setting exercise and will be adjusted during the FY03 target-setting process. [same exception noted for MICAP incidents, p. 22]
	p. 17	Analysis should be summarized with enough detail to explain trends, spikes, or dips reflected by the data. Analysis should include drill downs, which help isolate areas that are influencing trends, spikes and dips. [same guidance provided for MICAP incidents, p. 22]
	p. 18	Avoid explaining trends by simply identifying top driver NSNs. Instead, try identifying NSNs that have a significant total requirements variance (ADO + Laterals + Non-Project-Coded Kit Issues versus EBO).
	p. 23	**MICAP Incidents**: Avoid explaining trends by identifying top driver NSNs. Often, they represent various problems, but not necessarily the problem(s) that caused the trend. They may indeed have been contributors of many MICAP incidents, but they may have been for months, even when the total number of MICAP incidents was low.
	p. 24	**CWT:** Unlike LRT, requisitions for RSP or replenishment of base stock levels are <u>not</u> included. This is the AF mandated measure of pipeline performance.
	p. 27	When the CWT metric reveals a negative trend, problems have typically already been resolved. That is because CWT measures are determined when orders are filled. So, CWT may look good, even though numerous old backorders are amassing, and not until they are filled does it adversely impact the CWT. [admittedly lagging]
	p. 28	Avoid explaining trends by identifying top driver NSNs. Often, they represent various problems, but not necessarily the problem(s) that

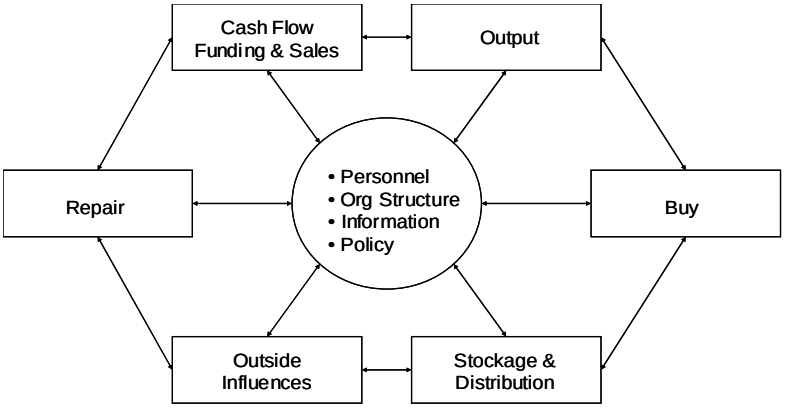
	caused the trend. They indeed may have significantly contributed to long CWT, but they may have been for months, even when CWT was short [aggregation problem].
p. 47	CWT is the congressionally mandated pipeline metric (and is intended to replace LRT)
p. 30	**NOR:** NOR is used as a performance indicator of how activity groups perform in relation to the standard established.
	Calculation Formula: [Total revenue and total expenses include JV] JV = Journal Variance. Miscellaneous Account Ledger used for accounting purposes to record expenses and revenues that are not adequately captured in other accounts. For example, the expenses lost from a warehouse roof collapsing.
	The DoD and AF objective for the Supply Management Activity Group (SMAG) is to break even over a two-year budget cycle.
p. 31	**NOR:** Follow-on analysis should be performed on all NORs including those equal to or near zero. Aggregation of the NOR may mask problems that are more readily apparent at a granular level…The process of drilling through aggregate results to actual findings by NIIN can produce results that differ greatly, in terms of variance, from reported levels as shown by the following example…In this example, $21M of $25M variance is explained by the top two NIINs.
p. 39	**TRV**: This chart and many similar reports in the Total Requirements Variance Tool (currently in development at AFMC), provides a mechanism for Supply Chain Managers (SCMs) to reconcile internal processes that are generating critical spares shortages for warfighters. It also allows for the identification of over-allocated items that may be diverting needed funds from critical spares.
p. 40	**IE**: While this metric is traditionally a reported MSD metric, it does not correlate directly to Aircraft Availability and can drive the wrong behavior if used inappropriately.
p. 43	**SE**: While this metric is traditionally a reported MSD metric, it does not correlate directly to Aircraft Availability and can drive the wrong behavior if used inappropriately.
p. 45	**BO**: While this metric is traditionally a reported MSD metric, it does not correlate directly to Aircraft Availability and can drive the wrong behavior if used inappropriately.
	The AFMC Backorders metric measures the number of demands placed on the supply system that cannot be immediately satisfied from existing inventory—expressed as either units or requisitions in a

		snapshot view (2nd day of each month).
		The Spares Priority Release Sequence (SPRS) provides an effective method of stratifying backorders for analysis. SPRS categorizes backorders according to their impact on warfighter readiness not just the requisition's priority. Analysis of SPRS backorders will focus on those backorders that may provide high readiness payback.
	p. 46	Avoid explaining trends by identifying top driver NSNs. Often, they represent various problems, but not necessarily the problem(s) that caused the trend. They indeed may have been large backorder quantity contributors, but they may have been for months, even when total backorder quantities were low [aggregation problem].
	p. 48	**LRT:** Any record that has a negative value for any segment or is missing more than one segment after the above scrub will be included in the LMARS table but will be excluded from all computations and reports.
	p. 49	Explain whether [long/short] LRT is a function of a problem or good things happening. Is it getting longer because we are struggling in some areas (e.g., fewer backorders are being filled quickly, causing overall age of backorders to increase), or we are doing a better job (e.g., consistently filling new backorders, while filling even more old backorders)?
	p. 50	Avoid explaining trends by identifying top driver NSNs. Often, they represent various problems, but not necessarily the problem(s) that caused the trend. They indeed may have significantly contributed to long LRT, but they may have been for months, even when LRT was short [aggregation problem].
	p. 60	The EXPRESS Supportability Summary provides an additional method for conducting root cause constraints analysis of MICAP data.
		These are the symptoms of bigger issues… • What was the funding vs. requirement? Are we executing the buy program on schedule? • Is transportation expediting critical spares that are "carcass short"? • What was the flying hour program vs. executed? • What is the level of bit n' piece support from DLA? • Was capacity (labor hours, test station throughput, etc) correctly sized to requirement?

	p. 61	Further analysis incorporating NIIN level MICAP hours reveals the asset accounting for the majority of the problem. These highest-ranking assets would provide the greatest return on AA. Note that not all carcass-constrained items cause MICAP hours. The focus needs to be placed on those that do.
Q7	p. 12	It is important to note that the distribution relating Aircraft Availability and funding can be precipitous. Even the slightest reduction in funding can result in a significant drop in Aircraft Availability. Likewise, if Aircraft Availability is low, the distribution forecasts a significant increase in Aircraft Availability with only a modest increase in funding.
	p. 13	**A/A Variance from Target:** Banding includes yellow and red bands for performance below target and a dark green band for performance that significantly exceeds target (which may indicate resources are being directed to the weapon system to the detriment of other systems).

Appendix B: Measuring the Health of USAF Supply (AFLMA Final Report LS199929101)

INDEX	REF	FINDING
Q1	p. 3	Our ultimate measure [of the performance of the logistics system] being AA
	p. 3	"The overall 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" (Klapper, 1999) *NOTE: *LMI, Supply Chain Management reference*
	p. 9	The output of our supply model or system is aircraft availability or weapon system availability. This is our measure of success, per directed guidance.
	p. 10	If we define our success based on maximizing AA, then our processes are successful in attainment of that specific goal.
Q2a	p. 2	Our emphasis for this project was not the test, but the development of the model that would be used to model the real world day-to-day operation of the supply system and its impact on Air Force operations.
	p. 3	In order to develop meaningful metrics in the context of an integrated supply system or chain, we developed a fundamental model of the processes involved in our supply system.
	p. 6	Figure 2-1 Supply System Model 
	p. 8	See Table 2-1. Supply Model Outline
	p. 34	This *[a set of customer-focused supply chain metrics to cohesively attack each segment of supply]* is what the health of supply metric set accomplishes. Each segment is represented and tied to the AF corporate goal of WSA and EAF supportability.

Q2b	p.4	**Existing Metrics:** "Even if we could select a handful of metrics from the vast population available, it would be very difficult to link them to underlying processes and associated metrics that drive their performance."
	p. 4	Any key metrics scrutinized by senior leaders should be directly linked to the more detailed metrics used by low- and mid-level managers to diagnose and correct problems (Indermill, 1995)
	p. 4	Other metrics in this collection [from the Logistics Transformation Team] tend toward a tactical level, and the focus of this project is to develop aggregate metrics at a strategic level.
Q3	p. 1	**Appendix C:** To focus on the critical areas of business, LMI, AFMC and more recently, AF/IL (Logistics Transformation Team) have adapted the use of the ***balanced scorecard*** as represented in Supply Chain Management Master Program Plan, penned by AFMC/LG, and Supply Chain Management: A Recommended Performance Measurement Scorecard, by LMI, which was released in March and June of 1999 respectively.
	p. 2	[Appendix C] We can simply use the balanced scorecard to 'bucket' an organization's segments and the metrics related to those segments. The graphical delineation of each segment of system sets up a drilldown capability.
	p. 3	[Appendix C] 
Q4a	p. 5	**Scope:** Even though a simplistic representation, the model developed will be used as a suitable facsimile of the entire supply process in an aggregate sense.
	p. 5	**Development of a Model:** The most important concept to grasp when developing performance measures is the definition of the process being measured.

	p. 5	The supply chain can be represented simply as a cycle containing BUDGET, REQUIREMENTS determination, LEVEL determination, BUY, REPAIR, and MOVE. This is not a linear relationship, so there isn't a particular sequence for the supply process. These are supply core processes that define, in part, our supply chain.
Q4b	p. 8	The end model was refined by review from Figure 2-1 *[Q2a above]* to Table 2-1 *[below]*

Table 2-1. Supply Model Outline

Aircraft Availability (War and Peace)	
Core Processes	Enablers
• Repair • Buy • Stockage/Distribution • Funding - Requirement - Budget - Execution	• System Effectiveness • Manning Effectiveness • Cash Flow (Fund Collection) Effectiveness

Q4a/b	p. 10	"After the primary goal [AA] is obtained, secondary goals can be addressed as well as the processes associated with them. The processes being the segments of supply that we've developed our metrics to measure. The enablers are, of course, the data systems, personnel, and anything else that enable or make our core processes work."
Q4b	p. 8	"Table 2-2 provides a list of the performance metrics. The 26 metrics are divided into areas of supply core processes. If everything is "healthy," we expect a high output of AA. Of course, if the converse is true, then perhaps there is a problem in one of the core process areas or enabler area.

Table 2-2 Supply Model Segment Performance Metrics

Output
Aircraft Availability (AActual/AAtarget)
Aircraft Availability (C-Rating)
Repair Effectiveness
Current Repair Asset Position
Keep Up
Catch Up and Time to Catch Up
Draw Down and Time to Draw Down
Depot Repair Time
Supply Chain Responsiveness
Buy Effectiveness
Asset Position by Weapon System
Asset Position (Buy Point)
Items in Buy or On Order
Items in Buy or On Order ($)
Procurement Lead Time Effectiveness
Stockage Distribution Effectiveness
Redistribution Excess
Depot Stock Above Requirement
Customer Wait Time
CWT (Not Meeting Expectations)
System Effectiveness (Information Mgmt)
Significant Problem Items
Manning Effectiveness (Personnel)
Enlisted Manning by Skill Level
Officer Manning by Grade
Sales Effectiveness
Funding Effectiveness
DLA Responsiveness
IE/SE
MICAP Incidents and Hours

Q5	p. 11	**Repair Effectiveness**: "We measure if our depots are repairing what is needed…These three indicators and their derivatives will provide the Air Force with a ***collective leading indicator*** that identifies our ability to repair to meet needs as well as identify near-term future support."
	p. 15	**Buy Effectiveness:** "Essentially tells us if we are buying what is needed to meet worldwide demand…The metrics [No Buy, Buy, and Unneeded Buy] show if needed assets are on order. A measure of the timeliness of the buy segment of the supply chain is the metric procurement lead-time effectiveness.

	p. 18	**Stockage/Distribution Effectiveness:** Redistributable Excess…is the stock at the right location?
	p. 20	**System Effectiveness**: "The D200A worldwide requirement should always at least equal (within rounding) the expected pipeline. Incomplete data due to data capture, transmission, or receipt errors (dirty data) could be the cause for those cases where the D200A requirement fails to meet the expected pipeline…so, requirement problems represent those cases where '***dirty data***' could be the cause for worldwide requirement not meeting the worldwide pipeline and require some external action to correct."
	p. 20	**Significant Problems Items**: "There are two groups of problem items ('N' and 'Z' items) where the base and D200A databases are so inconsistent (the data is suspect) that RBL does not push levels to the bases. These problem items usually mean inadequate requirements and need immediate AFMC item manager action."
	p. 21	**Manning Effectiveness:** "The most important enabler of our supply chain is the human factor. We measure supply manning levels for war-tasked, traditional supply, as well as other significant areas. We look at assigned versus authorizations by skill level in supply, outside supply and UTC tasked."
	p. 22	**Sales Effectiveness**: "We measure sales compared to forecasted requirement. This can be done by weapon system, supply chain manager, or MAJCOM.
	p. 23	**Funding Effectiveness**: We measure the cost per flying hour requirement to the D200A requirement against available funding. This identifies the total requirement compared to the O&M budget and the actual funding. Of course, in an ideal world, all three would match.
	p. 23	**DLA Responsiveness**: To measure DLA and their commitment to the AF as supply chain partner and customer, we measure supply availability and issue and stockage effectiveness based on commodity and by base, including D035K accounts. Supply availability measures the percentage of orders filled. Another traditional measure to gage DLA's support is MICAP incidents and hours by acquisition advice code.
Q6	p. 11	**Current Repair Asset Position**: We focus only on NSNs with a positive repair requirement to prevent the biasing of the statistics by including the zero requirement.
	p. 13	**Draw Down**: We must adjust the daily repair rate by NSN to be less than the daily demand rate. Just as important, the AF should not be repairing items in an "excess" position.

	p. 24	**DLA Responsiveness** *[IE, SE, MICAP Incidents and Hours]*: These may not be the best measures to gauge DLA support; however, these are traditional measures that the Air Force uses as measures of internal support. To establish meaningful dialog between each organization, DLA and the AF, measures need to be the same.
Q7	p. 3	"Changes to the input will be real-world budgetary constraints. However, the resultant output, aircraft availability (AA) or weapon system availability does not change purely because of the budget. There are other influencing factors both controllable and uncontrollable that will either degrade or enhance the performance of the system (our ultimate measure being AA)."
	p. 10	**Aircraft Availability**: Ideally, the Air Force supply system is designed to obtain set aircraft availability goals. The attainment of that number is a true account of the overall success of all the processes and enablers involved in our supply system. Of course, there are instances when you're working your people 16 hours a day, over cannabilization, and spending beyond your budget on spares. The goal is obtained, but at a very high price.
	p. 10	**AA Actual/AA Target:** Notice that it is possible to have more than 100%. It is possible that the actual AA could be greater than the targeted AA. This may be good for a particular weapon system, but not the overall system AA.
	p. 34	**Conclusions:** As pointed out by each team in the Spares Campaign, the AF has ***disconnected metrics*** that drive independent and suboptimal behavior. Of course, this generates disconnects which negatively affect our corporate goals. These disconnects can be corrected by a set of customer-focused supply chain metrics to cohesively attack each segment of supply.

Appendix C: Supply Chain Management (LMI, LG803R1)

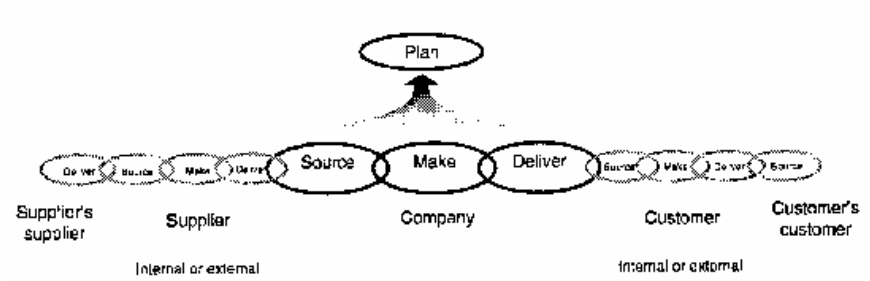
INDEX	REF	FINDING
Q1	3-2	"The ***overriding objective*** of the DoD logistics system is to provide responsive and cost-effective support to ensure readiness and sustainability for the total force in peacetime and war. An effective and efficient supply chain is an important ingredient to overall success."
Q2a	1-2	We decided to adopt the SCOR metrics because SCOR is the only model that links metrics to individual ***supply chain functional processes***.
	3-4	***Figure 3-2. SCOR Model Supply Chain***  "SCOR model's supply chain is composed of four management processes—plan, source, make, and deliver—known as level 1 processes." (Table 3-2 *[below]* defines the processes.)

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 the 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

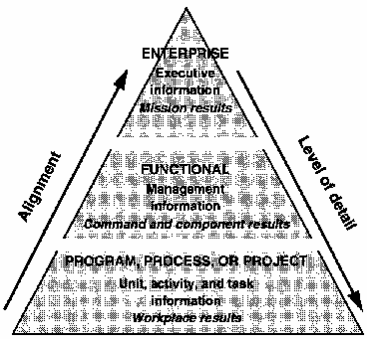
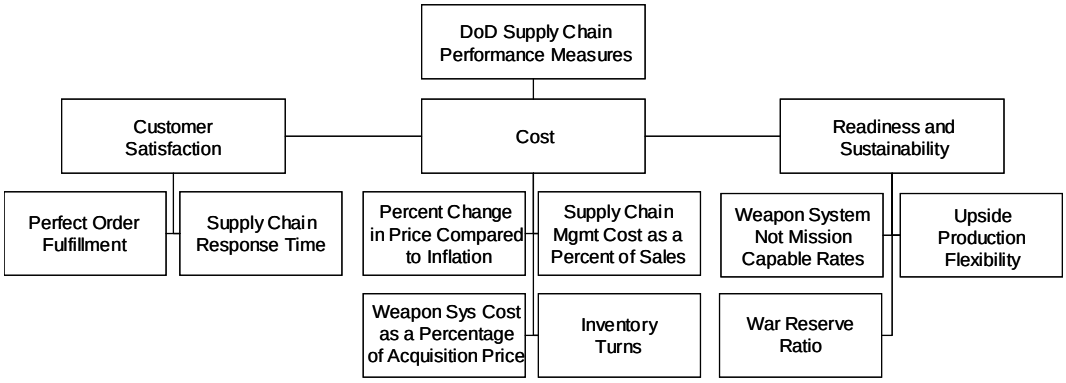
Q2b	3-3	 PERFORMANCE MEASURES PYRAMID Figure 3-1 shows the ***three levels*** of DoD performance measure users. The top level of the pyramid is the enterprise level (i.e. the primary focus of this report). In our framework the DUSD(L) is this level. The next level of the pyramid is the functional level (e.g., supply, maintenance, and transportation). The last level of the pyramid is the process level.
	3-3	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 perfromance.
	3-3	The ***functional metrics*** are linked to at least one enterprise metric and measure a major function's performance. The ***process metrics*** (e.g., warehousing, requirements planning) are related to one or more functional metrics and are diagnostic in nature.
	5-2	Each enterprise metrics require 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).
Q3	3-5	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]
	3-5	Note 8: We excluded human relations and training perspectives in our modified adaptation of the balanced scorecard for DoD logistics.
	1-2	"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



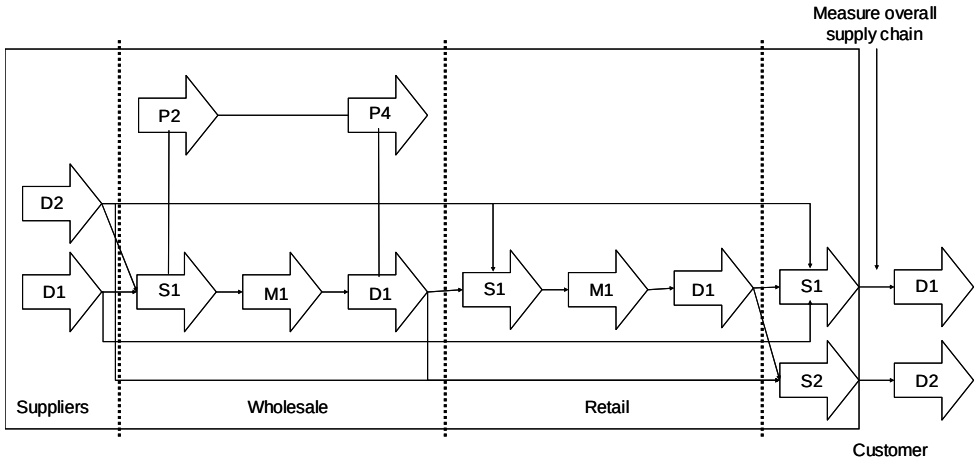
Q2/3	3-5	"By combining the best elements of several structures, we developed a ***hybrid performance measurement framework*** ideally suited for the DoD supply chain. We use the three levels of linked metrics (enterprise, functional, and process) recommended by the *Logistics Functional Requirements 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 perspectives (customer satisfaction, cost, and readiness and sustainability) to build the balanced scorecard."

Table 4-2. Recommended Enterprise Performance Measures

Recommended key supply chain management metrics	Perspective		
	Customer satisfaction	Cost	Readiness & sustainability
Perfect order fulfillment	X		
Supply chain response time	X		
Percent change in customer price compared to inflation	X	X	
Supply chain management costs as a percent of sales (at standard price)		X	
Weapon system logistics costs as a percent of the acquisition price		X	
Inventory turns		X	
Upside production flexibility			X
Weapon system NMC rates			X
War reserve ratio			X

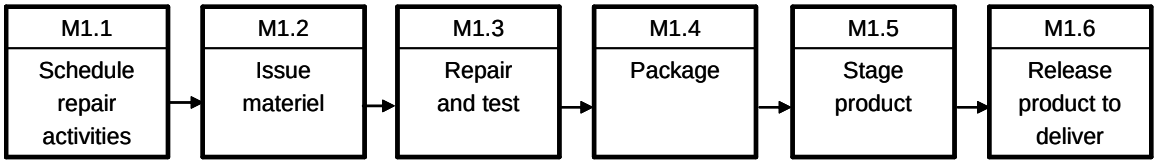
	3-3	"[The SCOR model] is a framework for examining the supply chain in detail, defining and categorizing the processes that make up the supply chain, assigning metrics to the processes, and reviewing comparable benchmarks."
Q4	3-5	"Process metrics diagnose process results (internal and short-term). Functional 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
	n/a	NOTE: *This performance plan includes a total of 110 metrics: 9 enterprise level, 27 functional level, and 74 process level. Therefore, this protocol will emphasize the enterprise measurements, with functional and process level metrics included as needed.*
Q4a/b	A-1	Figure A-1 *[shown as figure 3-2 above in Q2a]* 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)
	A-1	"Level 2 processes, the next level of the SCOR model, comprises elements of the level 1 processes. The SCOR level 2 processes are used to display supply chain threads, such as the [process] map…"

Figure 4-1. Supply Chain Performance Measurement



Q4a/b	A-3	"Level 3 of SCOR divides the level 2 processes into subprocesses."
	5-9	"Appendix D describes several process metrics to diagnose functional metrics." *[Conceptual example provided below]*

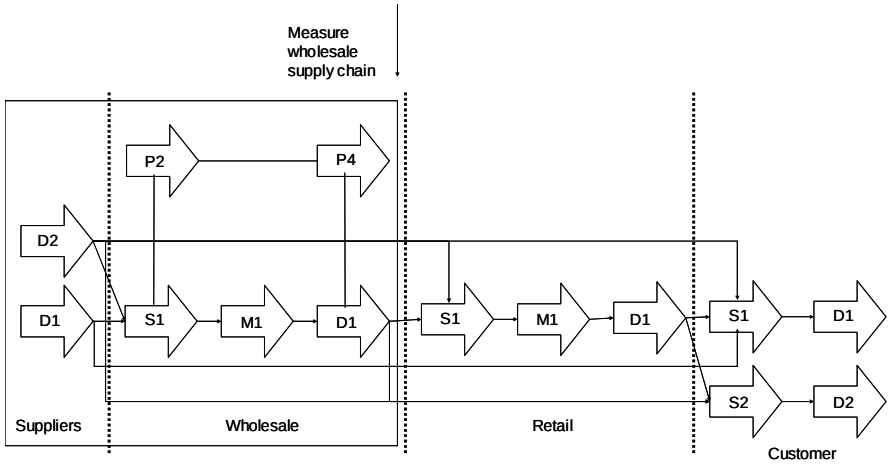
Figure D-5. SCOR Process Model: Maintain Stocked Product



Q5	iii	"The supply chain 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…the DUSD(L) tasked the LMI to propose a set of balanced measures that senior decision-makers can use to monitor ***supply chain effectiveness***.
Q5	v	"With this balanced performance measurement scorecard, senior DoD logistics managers can monitor the effectiveness and efficiency of the supply chain as the 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."
	3-2	"The enterprise metrics measure the overall effectiveness of the supply chain."
Q6	1-3	**Perfect Order Fulfillment:** more than any metric, captures most aspects (e.g., on time, right quantity, acceptable quality, adequate paperwork) that a customer considers important.
	4-3	"the ratio of perfectly satisfied orders to total orders"
	4-4	**Supply Chain Response Time:** For DoD, it is the sum of the average *source* and *order* cycle times.[2]
		Note 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.
	4-6	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.
	4-2	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.
	n/a	NOTE: *Both references above refer to 'point of measurement' as*

		displayed in Figure 4-1 above [Q4a/b] versus Figure 4-2 below.

Figure 4-2. Wholesale Performance Measurement



	1-3	**Percent Change in Customer Price compared 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.
	4-6	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.
	1-3	**Supply Chain Management Costs as a Percent of Sales (at Standard Price)**: It represents all costs associated with operating a supply chain as a percent of the value of the material moving through it. Industry uses this metric for benchmarking.
	4-7	Ideally, this metric is measured from the customer's perspective (Figure 4-1)…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.
	4-7	Until the DoD logistics community implements activity-based costing (ABC), allocating supply chain management costs to the cost categories discussed [such as MIS costs, materiel acquisition costs, order management costs] is not likely. However, total costs and revenue can be collected (because they are elements for setting cost recovery rates) at wholesale and retail levels.
	1-3	**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.
	1-3	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 weapons system's life-cycle cost.
	1-3	**Inventory Turns**: 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).
	4-8	Inventory turns should be measured from the customer's perspective (Figure 4-1) using the standard price of material 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.
	Iv	**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.
	4-8	**Upside Production Flexibility**: We define upside production flexibility to be the number of days to achieve 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 ware reserve requirements.[3]
	4-8	**Note 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.
	1-4	**War Reserve Ratio**: measures the 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.
Q6	4-9	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 percentage of the acquisition price.
	4-9	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.
Q7	v	"With this balanced performance measurement scorecard, senior DoD logistics managers can monitor the effectiveness and efficiency of the supply chain as the 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."
	2-3	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.
	3-2	"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."

Bibliography

A.T. Kearney, Inc. *Measuring and Improving Productivity in Physical Distribution*. Chicago: National Council of Physical Distribution Management, 1984.

Air Force Logistics Management Agency. *Measuring the Health of USAF Supply*. Report LS199929101. Maxwell AFB: AFLMA, January 2001.

Air Force Materiel Command. *AFMC Supply Chain Metrics Guide*. Wright-Patterson AFB: HQ AFMC, 25 November 2003.

Air Force Materiel Command. *The Metrics Handbook*. AFMC Pamphlet 90-102. Wright-Patterson AFB, OH: HQ AFMC, 1 May 1995.

Air Force Materiel Command. *FY 2002 – FY 2009 Supply Management Mission Area Strategic Plan*. Wright-Patterson AFB, OH: HQ AFMC, 11 January 2002.

Alasuutari, Pertti. *Researching Culture: Qualitative Methods and Cultural Studies*. London: Sage Publications, Inc., 1995.

Berg, Bruce L. *Qualitative Research Methods for the Social Sciences* (3rd Edition). Boston: Allyn & Bacon, 1998.

Blackerby, Phillip. "GPRA Strategic Planning: Start Here," *Armed Forces Comptroller Magazine*, Vol. 39: 21-26 (Spring 1994)

Boland, Tony and Alan Fowler. "A Systems Perspective of Performance Management in Public Sector Organizations," *International Journal of Public Sector Management*, Vol 13: 417-446 (2000).

Brewer, Peter C. and Thomas W. Speh. "Using the Balanced Scorecard to Measure Supply Chain Performance," *Journal of Business Logistics*, Vol 21: 75-93 (2000)

Brunell, Tom. "Measuring the One That Got Away—Gauging SCM's Benefits is Tricky When Most Have Yet to Implement It," *EBN*, Issue 1254: 65 (19 March 2001)

Camm, Frank, and Leslie Lewis. *Effective Treatment of Logistics Resource Issues in the Air Force Planning, Programming, and Budgeting System (PPBS) Process*. RAND Project AIR FORCE, F49642-01-C-0003, MR-1611, 2003.

Committee on Governmental Affairs. *Senate Committee on Government Affairs GPRA Report*. 103d Congress, 1st Session, Report 103-58, 1993. Washington: OMB, 1993.

Creswell, John W. *Research Design: Qualitative and Quantitative Approaches*. Thousand Oaks, CA: Sage Publications, Inc., 1994.

Department of the Air Force. *Air Force Basic Doctrine*. AFDD 1. Washington: GPO, September 1997.

Department of the Air Force. *Logistics Strategic Planning*. AFPD 20-1. Washington: GPO, 22 April 1993.

Department of Defense. *DoD Supply Chain Materiel Management Regulation*. DOD Regulation 4140.1-R. Fort Belvoir, VA: DTIC, 23 May 2003.

-----. *Department of Defense Dictionary of Military and Associated Terms*. JP 1-02. Washington: GPO, 12 April 2001.

Eccles, Robert G. "The Performance Measurement Manifesto," *Harvard Business Review*, 69: 131-137 (January-February 1991).

Eccles, Robert G. and Philip J. Pyburn. "Creating a Comprehensive System to Measure Performance," *Strategic Finance*, Vol 74: 41-44 (October 1992).

Frigo, Mark L. "Strategy-Focused Performance Measures," *Strategic Finance*, 83: 10-15 (September 2002).

Frost, Bob. *Measuring Performance: Using the New Metrics to Deploy Strategy and Improve Performance*. Dallas: Measurement International, 2000.

Governmental Accounting Standards Board. *Concepts Statement No. 2, Service Efforts and Accomplishments Reporting*. Washington: GASB, April 1994.

Heckman, James, Carolyn Heinrich, and Jeffery Smith. "Assessing the Performance of Performance Standards in Public Bureaucracies," *The American Economic Review*, Vol 87:389-395 (May 1997).

Kaplan, Robert and David P. Norton. "The Balanced Scorecard—Measures that Drive Performance," *Harvard Business Review*, Vol 70: 71-79 (January-February 1992).

-----. "Balance without Profit," *Financial Management*, 23-26 (Jan 2001).

-----. "Strategic Learning & the Balanced Scorecard," *Strategy and Leadership*, Vol 24: 19-24 (October 1996).

-----. "Using the Balanced Scorecard as a Strategic Management System," *Harvard Business Review*, Vol 74: 75-85 (January-February 1996)

Lee, Thomas W. *Using Qualitative Methods in Organizational Research*. Thousand Oaks, CA: Sage Publications, Inc., 1999.

Leedy, Paul D. and Jeanne Ellis. *Ormrod. Practical Research: Planning and Design* (7th Edition). Upper Saddle River, NJ: Prentice Hall, Inc., 2001.

Logistics Management Institute. *DoD Supply Chain Management Implementation Guide*. McLean, VA: LMI, 2000.

-----. *Logistics Functional Requirements Guide*, Report LG806S2, August 1998.

-----. *Supply Chain Management: A Recommended Performance Measurement Scorecard*. McLean, VA: LMI, June 1999.

Manship, Wesley E. Capt. "Air Force Supply: Measures, Metrics and Health," *Today's Logistics: Selected Readings and Analysis*, Maxwell AFB, Gunter Annex, AL: AF Logistics Management Agency, 2001.

McAdam, Rodney and Brian Bailie. "Business performance measures and alignment impact on strategy: The role of business improvement models," *International Journal of Operations & Production Management*, Vol 22:972-996 (2002).

Monczka, Robert M. Dr. and Jim Morgan. "What's Wrong with Supply Chain Management?" *Purchasing*, Vol. 122: 69-72 (16 January 1997).

Neely, Andy, Mike Gregory, and Ken Platts. "Performance Measurement System Design," International Journal of Operations & Production, Vol. 15: 80-117 (1995).

Niven, Paul R. *Balanced Scorecard Step-by-Step for Government and Nonprofit Agencies*. Hoboken, NJ: John Wiley & Sons, Inc, 2003.

Porter, Michael E. "What is Strategy?" *Harvard Business Review*, Vol 74: 61-78 (November-December 1996).

Porter, M. E. "The Importance of Being Strategic," *Balanced Scorecard Report*. Boston: Harvard Business School Publishing Corporation (2002).

Provost, Lloyd, and Susan Leddick. "How to Take Multiple Measures to Get a Complete Picture of Organizational Performance," *National Productivity Review*, Vol. 12: 477-490 (Autumn 1993).

Schiederman, Arthur M. "Why Balanced Scorecards Fail," *Journal of Strategic Performance Measurement*, Special Edition: 6-11 (January 1999).

Silverman, David. *Doing Qualitative Research: A Practical Handbook*. London: Sage Publications, Inc., 2000.

Simchi-Levi, David, Philip Kaminsky, and Edith Simchi-Levi. *Designing & Managing the Supply Chain*. Singapore: McGraw-Hill Education, 2003.

Sink, D. Scott. "The Role of Measurement in Achieving World Class Quality and Productivity Management," *Industrial Engineering*, Vol 26: 23-27 (June 1991).

Stephens, Scott. "Supply Chain Operations Reference Model Version 5.0: A New Tool to Improve Supply Chain Efficiency and Achieve Best Practices," *Information Systems Frontiers*, Vol 3: 471.

Supply-Chain Council, Inc. *Supply-Chain Operations Reference-model: Overview of SCOR Version 5.0*. Pittsburgh: SCC, 2002.

United States General Accounting Office. *Air Force Plans and Initiatives to Mitigate Spare Parts Shortages Need Better Implementation*. GAO-03-706. Washington DC: GAO, June 2003.

United States General Accounting Office. *Defense Inventory: Air Force Item Manager Views of Repair Parts Issues Consistent With Issues Reported in the Past*. GAO-03-684R. Washington DC: GAO, May 2003.

United States General Accounting Office. *The Department Needs a Focused Effort to Overcome Critical Spare Parts.* GAO-03-707. Washington DC: GAO, June 2003.

United States General Accounting Office, Program Evaluation and Methodology Division. *Case Study Evaluations*. GAO/PEMD-91-10.1.9. Washington DC: GPO, November 1990.

Vector Research, Inc. *Department of Defense Guide for Managing Information Technology (IT) as an Investment and Measuring Performance*. Version 1.0, Arlington: Vector Research, Inc., 10 February 1997.

Yin, Robert K. *Case Study Research: Design and Methods* (3rd Edition). Thousand Oaks, CA: Sage Publications, Inc., 2003.

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
03-12-2004	**Master's Thesis**	Sep 2003 - Mar 2004

4. TITLE AND SUBTITLE

AIR FORCE MATERIEL COMMAND: A SURVEY OF PERFORMANCE MEASURES

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Leonard, Marcia E., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Street, Building 642
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GLM/ENS/04-10

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Performance measurement has long been a matter of debate in logistics. However, in the recent past, there has been a renewed emphasis as AF leaders continue to seek funding for weapon system spares despite marginal improvements in mission capability. The Chief's Logistics Review, Logistics Transformation Program, AFMC Constraints Assessment Program, the Spares Requirement Review Board, the Spares Campaign, and the Depot Maintenance Reengineering and Transformation all represent efforts to find and implement effective answers (RAND, 2003:ix). And, while there appears to be a consensus that better performance measures are needed, there is little agreement on exactly what should be measured, and how.

Many performance management plans have been developed and recommended. In 1999, the Logistics Management Institute (LMI) published *Supply Chain Management: A Recommended Performance Measurement Scorecard* to guide senior DoD logistics managers. Then, in 2001, the AF Logistics Management Agency developed an set of aggregate or strategic level metrics, *Measuring the Health of USAF Supply*, at the request of AF/ILS. Most recently, in November of 2003, the Supply Management Division published the *AFMC Supply Chain Metrics Guide*. However, each of these performance measurement plans each is distinctly different. This research seeks to determine how and why these performance measurements plans differ, and to examine what such differences might reveal about the nature of performance measurement in AF logistics systems.

15. SUBJECT TERMS
Performance Measurement, Metrics, Strategic Planning, Government Performance and Results Act, GPRA

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Stanley E. Griffis, Major, USAF (ENS)
U	U	U	UU	105	19b. TELEPHONE NUMBER *(Include area code)* (937) 255-6565, ext 4708; e-mail: Stanley.Griffis@afit.edu

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18