3-2002

Improving Performance Analysis of the Distribution Segment of the Air Force Logistics Pipeline

Heinz H. Huester

IMPROVING PERFORMANCE ANALYSIS OF THE DISTRIBUTION

SEGMENT OF THE AIR FORCE LOGISTICS PIPELINE

THESIS

Heinz H. Huester, Capt, USAF

AFIT/GLM/ENS/02-05

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
20 Mar 2002	Final	June 2001 - Mar 2002

Title and Subtitle Improving Performance Analysis of the Distribution Segment of the Air Force Logistics Pipeline	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Capt Heinz Huester, USAF	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/EN) 2950 P Street, Bldg 640 WPAFB, OH 45433-7765	**Performing Organization Report Number** AFIT/GLM/ENS/02-05
Sponsoring/Monitoring Agency Name(s) and Address(es) Mr. Jose Orsini AFMC/LSO WPAFB, OH 45433	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes The original document contains color images.	

Abstract
Agile Combat Support is focused on providing fast, flexible, responsive, and reliable support as the foundation of all Air Force operations. Combined with the current Air Force focus on ensuring Time Definite Delivery (TDD) and reducing Customer Wait Time (CWT), this new mind-set will place ever-increasing emphasis on supply chain performance as a determining factor in overall campaign effectiveness of future conflicts. An improved methodology for the systematic performance analysis of the distribution segment of the logistics pipeline may aid AFMC transportation personnel (AFMC/LSO) in the quick identification of system bottlenecks, identification of root causes of performance shortfalls, and the recommendation of corrective actions, resulting in improved material flow times, reduced Customer Wait Times, more accurate Time Definite Delivery. Recommendations offered by this thesis are designed to lay the basis for developing the current methodology and to identify future research areas. The recommendations offered include the development of the current methodology across all AFMC logistics functional areas, the development of a more pro-active analysis procedure to identify problems before they affect TDD and CWT, modification of the current analyses procedure to derive more relevant performance information and present the results in a more digestible format, the automation of the pipeline analyses process, and the initiation of an AFMC-wide logistics pipeline analysis cell staffed by the various functional specialists.

Subject Terms
Logistics, Pipeline, Performance, Measuring

Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 90	

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense or the U.S. Government.

AFIT/GLM/ENS/02-05

IMPROVING PERFORMANCE ANALYSIS OF THE DISTRIBUTION SEGMENT OF THE AIR FORCE LOGISTICS PIPELINE

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

Heinz H. Huester, B.S.

Capt, USAF

March 2002

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

AFIT/GLM/ENS/02-05

IMPROVING PERFORMANCE ANALYSIS OF THE DISTRIBUTION

SEGMENT OF THE AIR FORCE LOGISTICS PIPELINE

Heinz H. Huester, B.S.
Capt, USAF

Approved:

/S/ 9 Mar 02

Dr. William A. Cunningham, Advisor
Professor of Logistics Management
Department of Operational Sciences
Date

/S/ 9 Mar 02

Lt Col Stephan P. Brady, Reader
Assistant Professor of Logistics Management
Department of Operational Sciences
Date

Acknowledgements

First and foremost, I would like to give a most special thanks to my wife for her incredible understanding and patience during this last 18 months. Without your caring, never-wavering support, and heart-felt hugs, I simply could not have achieved this goal – I am truly forever in your debt!

I would like to give thanks to Dr. William Cunningham and Lt Col Stephan Brady for steering me through this thesis effort. Your patience provided me the freedom to explore, your wisdom reeled me back in when I was out on the fringe, and your knowledge and insight helped guide me through this (at times most frustrating) project.

I would like to express my appreciation to the faculty and staff of AFIT for making this a most challenging and rewarding educational expe[rience. I truly leave AFIT changed in my thinking and view of the world.

I thank the staff at AFMC/LSO, Mr. Jose Orsini for providing the impetus for this effort, and especially Mr. Chris Arzberger for the patience of letting me come by at a moments notice to answer seemingly endless streams of questions.

I'd like to thank my classmates for sharing your varying viewpoints (and accents), your ability to discuss at length the most minute and insignificant of details, and your willingness to let this "old man" take just a bit more time to "catch on".

Finally, I'd need to thank Capt Dan Mattioda, Capt Ben Skipper, and Lt Rob Overstreet for truly being my sounding boards, my life preservers … and my friends. My hat is off to you gentlemen – I wish you nothing but the best in all your future endeavors!

Heinz H. Huester

Table of Contents

Page

List of Figures

Figure Page

List of Tables

AFIT/GLM/ENS/02-05

Abstract

Agile Combat Support is focused on providing fast, flexible, responsive, and reliable support as the foundation of all Air Force operations. Combined with the current Air Force focus on ensuring Time Definite Delivery (TDD) and reducing Customer Wait Time (CWT), this new mind-set will place ever-increasing emphasis on supply chain performance as a determining factor in overall campaign effectiveness of future conflicts.

An improved methodology for the systematic performance analysis of the distribution segment of the logistics pipeline may aid AFMC transportation personnel (AFMC/LSO) in the quick identification of system bottlenecks, identification of root causes of performance shortfalls, and the recommendation of corrective actions, resulting in improved material flow times, reduced Customer Wait Times, more accurate Time Definite Delivery.

Recommendations offered by this thesis are designed to provide the basis for developing the current methodology and to identify future research areas. The recommendations offered include the development of the current methodology across all AFMC logistics functional areas, the development of a more pro-active analysis procedure to identify problems before they affect TDD and CWT, modification of the current analyses procedure to derive more relevant performance information and present the results in a more digestible format, the automation of the pipeline analyses process, and the initiation of an AFMC-wide logistics pipeline analysis cell staffed by the various functional specialists.

IMPROVING PERFORMANCE ANALYSIS OF THE DISTRIBUTION SEGMENT OF THE AIR FORCE LOGISTICS PIPELINE

I. Introduction

Chapter Overview

This chapter presents the background and purpose of this study of the Air Force Material Command (AFMC) periodic performance analyses of logistics pipeline performance. In addition, it provides the justification for the relevance of this study, as well as the research questions addressed, and the scope guiding this study. Finally, it provides a summary of the research focus.

Background

Historically, the Department of Defense (DoD) has relied on push-based logistics to accomplish the task of supplying/re-supplying soldiers, airmen, sailors and marines in the field. Under this principle, the services simply shipped “everything they could” to the front lines, just in case something might be needed (1: ix). This method of supply/re-supply, though highly effective, is wasteful, manpower intensive, expensive to execute in terms of volume of material moved, and does not guarantee that the needed parts are available when required (1: ix).

Much like the commercial sector logistics transformation, DoD has initiated its own logistics transformation in an effort to reduce its logistics costs and better serve its customers. The current DoD logistics transformation effort is shifting the focus away from the uneconomical and inefficient mass-based logistics process used to support previous wars, and refocusing military logistics more clearly on the three dimensions of cost reduction, responsiveness and agility (1: v).

DoD cost reduction efforts over the last ten years resulted in a 50 percent reduction in spare parts inventory, and a 40 percent reduction in cost for maintenance, supply and other support activities financed through the Defense Working Capital Fund (2: 2-3). However, during this same time period, DoD has had "mixed success in improving the speed, reliability and quality of its basic logistics process" (2: 3). Military logistics processes generally perform poorly compared to those in the private sector and even to DoD's own performance standards (3: 27). Procurement, repair, and distribution processes are generally very slow and highly variable, resulting in customers distrusting the processes and seeking work-arounds. These work-arounds at first glance seem to be solving individual problems, but in actuality waste additional resources, further tax the system, and further deteriorate process performance by choking the pipeline with unnecessary supplies being shipped to cover inefficiencies of the system (4: v-vi).

The General Accounting Office (GAO) has been reporting on logistics inefficiencies for decades now, and in their March 2001 report, *Major Management Challenges and Program Risks: Department of Defense*, once again recommended that DoD needs to "…make more use of supply-chain best management practices similar to those used in the private sector to help cut costs and improve customer service…" while at the same time needing to "…employ various methods to speed up flow of parts through the logistics pipeline" (5: 71).

Each of the services is analyzing the performance of their own supply chains, identifying constraints causing performance gaps, and developing action plans to close the gaps and improve performance. Despite the implementation of numerous logistics reform initiatives during the last decade, key Air Force logistics indicators continued to deteriorate during the time period between 1992 and 2000 (5: 63-71). Budget constraints highlighted that we can no longer afford to throw money at solutions, and that we need to achieve the best weapons system availability and mission capability within the existing fiscal constraints.

The Air Force has shifted current logistics pipeline emphasis on improving Time Definite Delivery (TDD) and Customer Wait Time (CWT). A brief definition of the terms is in order.

Time Definite Delivery. "A reliable, consistent delivery service whose performance varies little from the advertised delivery time or standard" (6: 2). By controlling logistics processes (and minimizing their variances), the logistics system increases the ability of delivering a shipment in a more reliable and consistent manner to the customer (improving TDD). Most organizations can plan around a longer than anticipated delivery time, provided that the item arrives on the date it was promised to arrive.

Customer Wait Time. Customer Wait Time is the average time required between when a customer orders an item, to the time that the logistics system satisfies their need (7). By controlling logistics processes (and minimizing their variances), the Air Force can increase its ability to reduce the time required to process a shipment through the logistics distribution system.

Better customer service in terms of improved time-definite delivery (reliable), reduced customer wait time (fast), as well as the ability to quickly respond to changing demands (responsive), and changing transit and delivery locations (flexible) will require that significant improvements be made in the logistics pipeline. Efforts are under way to improve the visibility of assets moving through the pipeline. With increased visibility, Air Force personnel aim to improve logistics pipeline processes by methodically implementing improvements based on documented performance shortfalls. To maximize our investment dollars, improvements will need to be made not across the board, but at those activities, processes, or nodes acting as constraints/bottlenecks for the rest of the logistics pipeline system.

AFMC transportation analysts currently conduct periodic performance analyses of the Air Force logistics pipeline and recommend improvement initiatives to senior leadership. In addition, AFMC transportation analysts perform ad hoc and special project analysis of limited sections of the pipeline to answer queries concerning poor performance to specific locations. These analyses focus on the time elapsed between when a customer submits an order to when the supply section of the receiving base receives the order. This time period known as Order Cycle Time (OCT), is now referred to as Logistics Response Time (LRT). AFMC currently has one analyst on staff performing these analyses, limiting their ability to consistently perform thorough and complete analyses. AFMC would like to improve their ability to analyze the performance of the logistics pipeline given the manpower restrictions imposed.

Purpose

The purpose of this study is to identify potential improvements in the methodology used by AFMC transportation personnel to quickly and systematically analyze performance of the distribution segment of the Air Force logistics pipeline.

Research Justification

The Air Force logistics vision, outlined in AF Vision 2020 and known as Agile Combat Support, is focused on providing fast, flexible, responsive, and reliable support as the foundation of all Air Force operations (8: 5). Combined with the current Air Force focus on ensuring Time Definite Delivery (TDD) and reducing Customer Wait Time (CWT), this new mind-set will place ever-increasing emphasis on supply chain performance as a determining factor in overall campaign effectiveness of future conflicts.

Performance of the Air Force pipeline has historically been slow and unpredictable. Efficiencies gained in the processing of material through the logistics pipeline directly translate into decreased flow times through the system, decreased inventory tied up enroute to the demand locations, and reduced transportation costs.

An improved methodology for the systematic analysis of the distribution segment of the logistics pipeline by AFMC transportation personnel may pay dividends in the resources required to monitor the performance of the logistics pipeline, and aid in the quick identification of system bottlenecks by location, stock number, or other relevant means of differentiation between shipments. Once identified, AFMC transportation personnel could then ferret out root causes of performance shortfalls and recommend actions to minimize these bottlenecks, resulting in improved material flow times, reduced

Customer Wait Times, more accurate Time Definite Delivery, and ultimately improved aircraft availability and mission effectiveness.

Research Questions

The overarching question guiding this research is, "Can the current AFMC analyses of the Air Force logistics pipeline be improved?" To answer this over-arching question, several investigative questions must be answered first.

1. How is the AFMC transportation section currently determining the performance of the distribution segment of the logistics pipeline?

Step-by-step analyses of logistics processes that do not support organizational goals are a waste of time/effort. The answer to this question will lay the groundwork for understanding the underlying purpose of the various analyses and the metrics determined by AFMC to be significant in presenting pipeline performance. The study will also define and record the actual procedures used by AFMC to measure, analyze, record, and present performance data, and facilitate answering the remaining research questions.

2. How are the results of this analysis used to identify and resolve performance shortfalls in the distribution segment of the logistics pipeline?

Measurement programs cannot simply measure for the sake of measuring, but should result in recommendations that are actionable at the operational level. The answer to this question should identify how potential improvement areas are identified, and the chain of events through which the performance analysis translate into actionable recommendations, implementable in the field.

3. How well does the AFMC transportation analysis support the goals of decreasing Customer Wait Time (CWT) and increasing Time Definite Delivery (TDD)?

These two measures receive a lot of attention in Air Force logistics circles at the moment, and are the foundation from which we judge our ability to provide fast and reliable delivery of shipments. The answer to this question should identify the effect the results of the AFMC analyses have on these two high-visibility measures of performance.

4. What improvements can be made to the existing measuring and reporting methodology used by AFMC?

It is presumptuous to assume that improvements to the AFMC methodology will be necessary, however, since this study was requested by the organization conducting the pipeline analysis, it is reasonable to assume that some areas of improvement may come to light. Answers to this question may identify potential improvement areas that speed up the analyses process in terms of time and resources required and/or identify areas where changes in the analysis procedure may make the analysis more relevant and meaningful to the decision-making process.

Scope

The Air Force logistics pipeline is a complex system of inter-related functions, organizations, and processes, responsible for processing millions of dollars of consumable and reparable assets per day. This thesis studies how to improve the AFMC performance analysis of the distribution segment of the logistics pipeline from the depot to the base of requisition. To remain within the scope of this research, the study will be operate under the following assumptions:

1. Reducing customer wait time is the over-arching objective of the distribution segment of the logistics pipeline. True optimization of the logistics pipeline takes into account many factors such as financial performance, costs, delivery times, customer service times/satisfaction, etc. Reaching a best system-wide answer often means that trade-offs between functions must be weighed, and that individual function may have to operate at a compromised performance level. With the current Air Force emphasis on improving CWT and TDD, this study uses CWT as a starting point in emphasizing the competitive factors set out by Air Force policy.

2. The study will focus on the AFMC analyses process used to determine the performance of the distribution segment of Air Force logistics pipeline. Sponsored by AFMC transportation section, this study draws the environmental boundary around the area of responsibility for AFMC/LSO.

Summary

This chapter presents the background, purpose, justification, research questions, and assumptions under study. The background provides the historical perspective guiding the need for logistics reform. The purpose of this study is to identify potential improvements in the methodology used by AFMC transportation analysts to quickly and systematically analyze performance of the distribution segment of the Air Force logistics pipeline. The justification is presented in that elimination of bottlenecks should allow the Air Force to provide logistics support that is fast, flexible, responsive, and reliable. Finally, the research questions and assumptions are presented that guide this study.

II. Literature Review

Chapter Overview

This chapter provides background information needed to gain a basic understanding of many of the facets that impact this research. This chapter is not a literature review in the classic sense. This is due to the fact that no previous studies have been conducted examining the proper way to conduct performance analyses of the entire supply chain. To compensate, this chapter covers the review of literature covering many topics that are applicable to supply chain analyses, the Air force logistics pipeline, and process improvement and statistical process control in general.

The chapter provides brief definitions of key terms such as supply chains, supply chain management, and a brief comparison of the Air Force logistics system with private sector supply chains. A brief discussion into the importance of organizational metrics, and concepts in process improvement, as well as the theory of constraints philosophy as it pertains to pipeline management is discussed. This is followed by a description of the Air Force logistics pipeline, UMMIPS time standards, the various AFMC performance measurement requirements, and the TRACKER Database. Lastly, other pipeline measuring and reporting initiatives are presented.

Supply Chain Management

One of the biggest challenges facing any logistics organization is the need to respond to an ever-changing environment. To meet this challenge, organizations need to be able to respond in shorter time-frames to changes in variety and volume of product demanded. The term Supply Chain Management has received a lot of media attention in the last few years, for its ability to impact every aspect of supply chain processes. The management of an organization's supply chain has allowed some companies to tailor their structure, processes, and relationships in such a way as to allow them to cope with the various demands placed upon them (9). Before we progress, lets briefly define some key terms:

Supply Chain: The Institute of Logistics and Transportation defines the supply chain as "A sequence of events intended to satisfy a customer", to include "procurement, manufacture, distribution, and waste disposal, together with associated transportation, storage and information technology" (10).

The Center for Electronic Commerce defines the supply chain as "… a collection of inter-dependent steps that, when followed, accomplish a certain objective such as meeting customer requirements" (11).

Supply Chain Management: The Center for Electronic Commerce defines supply chain management as a "Generic term encompassing the coordination of order generation, order taking, and offer fulfillment/distribution of products, services or information" (11).

Simchi-Levi et al, refer to supply chain management as "…a set of approaches to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements" (12: 1).

Numerous studies have documented that more successful organizations have coordinated their various supply chain activities into one seamless process. The payoff for these organizations comes in the form of potential reductions in transaction costs by eliminating unnecessary steps in moving the product to the customer, and/or enhanced customer service by providing a product or service at a time and place acceptable to the customer (12: 3). A study conducted by Pittiglio, Rabin, Todd & McGrath found that companies effectively managing their supply chains enjoyed a "45 percent total supply chain cost advantage over their median competitors" (13: 1). This is a significant improvement in light of the fact that increases in revenues translate only partially into increases in profit, but reductions in costs translate fully into savings that have an immediate impact on the bottom line of any organization (14).

Comparing Air Force Logistics with Private Sector Supply Chains

The GAO has been reporting for years that the military needs to incorporate best management practices from the private sector to help cut logistics costs and increase customer service (5: 71). Though these two types of organizations have different objectives, the integration of private sector best practices to military use appears to be a valid suggestion when the two organizations are compared to each other.

Similarities between these organizations include the fact that civilian companies are beginning to expand their view of their supply chain to include organizations that were previously not under their control. As a result of increased emphasis on supply chain integration and collaboration, civilian companies are increasingly experiencing integration, communication, coordination, and data sharing issues prevalent in the Air Force logistics community for years (15: 28). Demand for product is often difficult to forecast, leaving both organizations focusing on how best to respond to a volatile environment and still satisfy customer needs. Lastly, both organizations make extensive use of complex information systems to track and measure pipeline performance.

Differences between these organizations include the fact that civilian companies are generally smaller organizations with flatter organizational structures, have more control over their logistics activities, while the Air Force logistics system is much larger, more hierarchical, and crosses numerous functional areas. This makes the Air Force logistics system much more fragmented and bureaucratic, and thus more difficult to be innovative and affect lasting change (4: 8). The fundamental difference between the two organizations is the way each attempts to meet customer satisfaction and control costs. Private sector firms establish a desired customer service level (CSL) and then control the costs required to achieve the CSL, whereas the military attempts to maximize CSL given a rather dynamic yearly budget target set by Congress (16).

Both organizations value increased customer service and reduced costs. For private sector firms, losing market share and profits have been powerful motivators to affecting procedural, cultural, or technological changes to solve pipeline problems or respond to a changing environment. Though not driven by the same motivators, the integration of best management practices from the private sector, with their well-documented supply chain benefits, can lead to significant gains in the military logistics system when properly applied.

Measuring Organizational Performance

Organizations that frequently and quantitatively assess the "correct" key operating measures are better able to understand how well their internal process are performing, how their performance compares to that of the competition, and how well they are meeting the demands of their customers (14). As a result, these organizations are better able to understand where bottlenecks exist in their logistics processes, and what actions need to be taken to correct problems (17: 13).

Much has been written in the literature on the theory behind the development and use of performance measures in support of organizational objectives. It is not the aim of this research paper to delve into the theoretical development and use of specific performance measures, however, there is some fundamental background information required to understand the contribution performance measures make towards the achievement of organizational goals.

The Need for Performance Measurement. Under the concept of "anything measured improves", it is believed that performance measures motivate employee behavior towards the achievement of over-arching organizational objectives, however, this may not always the case. Historically, performance measures have been used to measure process performance in terms of machine utilization, worker productivity, or costs (among other indicators). Each separate function in the organization strove towards the attainment of function-specific measures that often led to increased process performance (local performance) that was at times at odds with the objectives of the organization as a whole (global performance) (18: 2-4).

Today, many organizations understand that for performance measures to be effective, they need to support organizational goals (global performance), even at the expense of functional goals (localized performance). Companies refocusing efforts on the achievement of global performance (material throughput, capacity utilization, on-time delivery, inventory levels, total product costs, etc.) are reaping the benefits of decreased total costs, increased customer satisfaction, and enhanced growth opportunities (17: 14).

Through an iterative process of measuring key internal and external processes, analyzing relevant performance data, and evaluating potential improvement initiatives, managers can identify and implement cost-efficient ways to maintain or improve the efficiency and effectiveness of key logistics processes (19).

Characteristics of Performance Measures. The literature is full of opinions listing the generic characteristics that measures should possess, but little has been written over the years on how to actually design and implement a performance measuring system given specific objectives of an organization (effectively leaving organizations to discover themselves how best to choose and implement performance measures). The Government Accounting Standards Board (GASB), in *Concepts Statement No. 2, Service Efforts and Accomplishments Reporting,* lists six basic characteristics that measures should meet (20):

> **Relevance** – Should provide workers and decision-makers a basis of understanding the achievement of organizational goals and objectives.
>
> **Understandability** – Performance information should be communicated in a readily understandable manner to any reasonably informed and interested party.
>
> **Comparability** – Should provide a ready frame of reference for comparing organizational performance with regards to (a) historical performance, (b) established targets, (c) established norms or standards, (d) internal or external comparable entities.
>
> **Timeliness** – Should be reported before it loses its capacity to be of value in assessing accountability and making decisions.
>
> **Consistency** – Should be consistent over time to allow comparisons over time periods, and allow an understanding of the measures and their meaning.

Reliability – Information should be verifiable and free of bias.

Whaler adds that performance measures can be counterproductive if they do not support the strategic objectives of the organization, or are used as a basis for reward or punishment (21: 279). The characteristics listed by Keebler et al have considerable overlap with those listed by the GASB, but add that measures should be quantitative, few in number, encompass both inputs and outputs, be multi-dimensional, encourage appropriate behavior, discourage "game playing", and that the required data should be economical to gather (17: 8). Caplice and Shaffi add that measures should promote coordination between functions (46).

Limitations of Performance Measures. Performance measures are an important tool used by logistics managers to maintain and/or increase performance, but they are only one part of the overall decision-making process. As with any tool, performance measures have some inherent limitations. The GAB lists these limitations as (20):

1. Performance measures may not assist the manager in determining if organizational objectives and/or strategy are correctly set.
2. Performance measures may not assist the manager in determining if the chosen measures are the relevant ones for the organization to achieve the set objectives. It may be possible that other measures than those currently chosen are more relevant.
3. A single performance measure may not adequately portray the performance of an activity. To adequately capture performance will usually require a suite of measures.
4. Performance measures cannot explain the reason performance is at the current level, or what needs to be done to correct or improve it.
5. Measures do not provide the connection between various organizational activities, organizational strategies and overall results.

6. Aggregating information may mask variations in performance of individual functions or activities.

Need for Experimentation. Since no clear path is set for selecting and implementing specific performance measures, the GASB, understanding that performance measurement reporting is considered an essential part of comprehensive performance reporting, calls for experimentation with performance measurement and reporting until the correct measurement system is developed, and also calls for periodic review to ensure the measurement system stays relevant with regards to potentially changing organizational objectives (20).

When experimenting in the design/modification of performance measuring systems, managers should strive to meet the overall characteristics, while understanding the limitations of performance measures. However, they should never forget that the underlying role of an effective performance measurement system is to inform managers how specific processes are performing, how far they are from the desired performance target (variation), and if done correctly, what parts of the processes, if improved, could yield the biggest performance gain (17: 175).

Process Improvement

A survey of the literature found no formal methodology explaining how to properly conduct a supply-chain analysis in an attempt to improve process performance. Current Air Force logistics pipeline goals are to improve Customer Wait Time (CWT) and Time Definite Delivery (TDD). These goals are synonymous with manufacturing goals of increasing productivity and virtual uniformity of output. As such, we can examine manufacturing analysis for basic guidance and apply it to the analysis of logistics supply-chains.

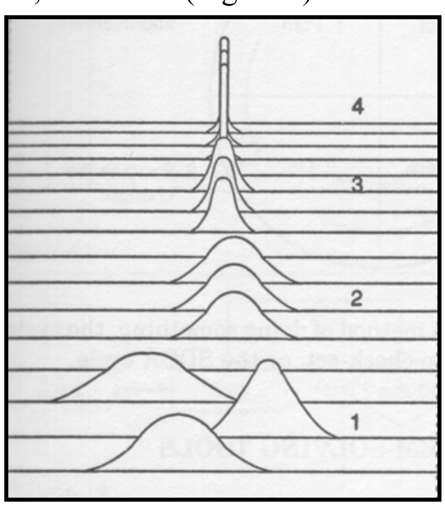
Process Variation. All processes exhibit some form of variation, adding unnecessary problems to jobs performed. The minimization of variation is important because variation is the cause of most unsatisfactory performance in government and industry today. Consequences of process variation manifest themselves in unpredictable performance, schedule delays, lower productivity and reliability, additional reviews to identify undesirable results, higher costs and customer dissatisfaction (21: 4-1).

The control and minimization of process variation is the key to providing predictable outputs, minimizing waste and delays, and reducing costs for a given process. Unfortunately, most managers cannot tell you with any certainty the performance of their processes, and do not know how to determine the root causes of variation in processes under their control (22: 58).

Variation Types. Variation falls into the categories of controlled and uncontrolled variation. Controlled variation is the natural fluctuation of performance due to the result of materials, machines, operators and methods (23: 5). This type of variation accounts for approximately 85 percent of all variation, is attributable to "chance causes" that are predictable and inherent in the process itself, and results in a process that exhibits a stable and consistent pattern over time (21: 4-1). Root causes of controlled variation may not be readily identifiable and their elimination may not be easy to accomplish. Performance improvement initiatives addressing minimization of "chance causes" must be initiated by management, and seek to maintain a stable process over time (23: 5).

Uncontrolled variation is the unnatural fluctuation of performance due to the result of machines going out of adjustment, altered work methods, material differences, differences between workers, and inconsistency on the part of management (23: 6). This type of variation accounts for approximately 15 percent of all variation, is attributable to "assignable causes" that are difficult to predict, and results in a process that is unstable and inconsistent over time (23: 6). The root causes of uncontrolled variation are usually readily identifiable, and the elimination of root causes does not require changes in the process since they may theoretically never be encountered again (21: 4-1; 22: 57). Performance improvement initiatives addressing minimization of "assignable causes" may be initiated by workers on the line, and seek to create (or return to) a consistent process over time (23: 5).

Ernst and Young illustrate the effects of controlled and uncontrolled variation on process performance (Figure 1). In addition, Wheeler and Chambers define a given process as being in one of four states of control, those states being the ideal state, threshold state, brink of chaos, and chaos (Figure 2).



(Source: Ernst and Young, 1990)

Figure 1. Effects of Variation on Process Performance

Examining Figure 1, the performance of grouping #1 is off-target and the process exhibits inconsistent variability (24: 143). The process is out of control and exhibits a changing level of nonconformity in the product stream. Managers of processes exhibiting this kind of performance variance know that something is wrong, but do not know how to correct the problem. Attempts to correct the problem are mostly frustrated and corrective actions implemented are usually short lived due to the random changes in the process. This process is considered to be in a state of "Chaos" (23: 16).

Grouping #2 has effectively eliminated uncontrolled variance, providing more predictable (though still off-center) performance (24: 143). The process is unstable, and the variation is inconsistent over time. This type of process does not allow management to "…predict what such a process will yield tomorrow, or next week, or even in the next hour." This process is considered to be on the "Brink of Chaos" (23: 16).

Performance of grouping #3 is more centered on the target value and any remaining variance is the result of systemic problems (24: 143). The process is stable, produces some non-conforming product, and variation is consistent over time. This process is considered to be in the "Threshold State" (23: 13).

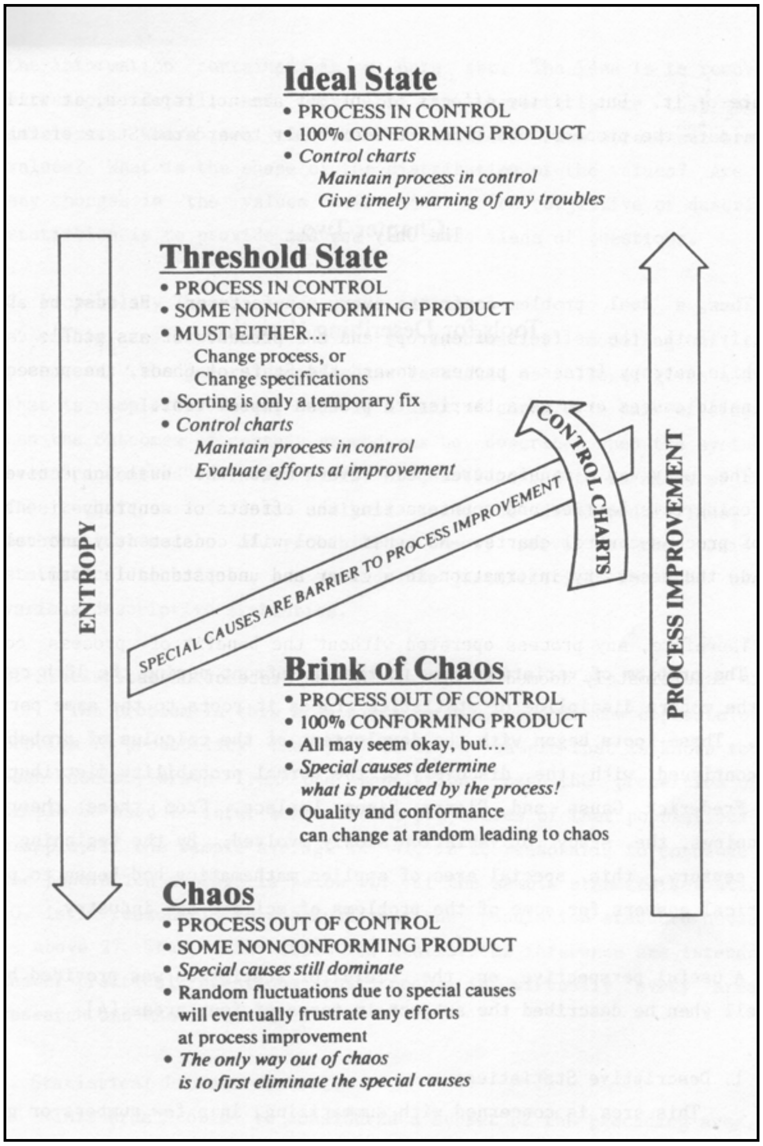
Finally, the results of grouping #4 illustrate a further reduction in controlled variation, driving performance even closer to the desired target value (24: 143). Process is stable, produces 100 percent conforming product, and the variation is consistent over time. This process is considered to be in the "Ideal State" (23: 12).

Compound Variation. Variation has a positive and negative component, that is, shipments may arrive earlier or later than the mean/median processing time. In theory, this implies that if a shipment passing through activity "A" arrives 30 minutes early and a shipment passing through activity “B” arrives 30 minutes late (A and B being serial activities), then the entire process should be completed on time. The assumption being made is that activity “B” is ready and able to act on the arrival of the shipment from activity “A”. In practice however, this is not the case. If activity “A” arrives 30 minutes early, it usually has to wait for the start of activity “B”. Activity “B” being completed 30 minutes late means that the entire process will remain 30 minutes late, regardless of the time made up at activity “A”. As such, the positive effects of process variation (arriving early) are rarely passed downstream to other activities, while the negative effects of process variation (arriving late) are almost always passed to downstream activities. This problem is particularly noticeable for serial processes involving multiple activity nodes. The more activity nodes contained in the process, the more potential for compounding of variation to become a factor. In addition the later that process variation is encountered in a system, the less the impact of the variation is felt, however, the earlier that process variation is encountered in the system, the more its effect is compounded through the rest of the system.

Continuous Improvement. Wheeler and Chambers define a given process as being in one of four states of control, those states being the ideal state, threshold state, brink of chaos, and chaos (Figure 2). They reason that processes are mostly in a state of flux, moving from one state to another either through management action (attempts to improve) or through regression back to chaos (entropy). The only way to move a process from a state of chaos towards the ideal state, or ward of the regression back to a state of chaos is through a continuous improvement process that has as its focus the reduction of process variance.

A virtually uniform product can only be achieved through the careful study of the sources of variation in a process, and through action by management to reduce, or eliminate entirely, sources of extraneous or excessive variation. (23: 4)

Wheeler and Chambers add that "management daily task must be to learn as much as possible about the sources of variation affecting the product, and then take the necessary steps to reduce the variation", and that anything less will "guarantee a lack of progress, low productivity, and an increasingly noncompetitive position" (23: 4).



(Source: Wheeler and Chambers, 1990)

Figure 2. The Four States of a Process

For the purpose of this study, continuous process improvement focuses on achieving performance gains that aim to attain virtual uniformity of output (TDD) and increased productivity (CWT). To achieve either one of these goals, an organization must be able to identify which form of variation affects performance in their processes and the degree of that variation, before they can identify their root causes.

Statistical Process Control. With process performance properly measured, managers can apply the problem solving tools of Pareto analysis, process flow charts, check sheets, cause-and-effect diagrams, histograms, scatter grams and control charts to determine the root-causes of process variance in their system (24: 144-148). Wheeler and Chambers state that control charts are the only way to determine the degree of process variation, identify a process that is in reversal (entropy), and that "any process operated without the benefit of control charts is ultimately doomed to operate in a state of chaos" (23: 20).

The literature is full of very specific instructions on how to apply these tools to process improvement. It is, however, not within the scope of this study to cover the application of the various process improvement tools in resolving specific pipeline issues. The reader is advised to learn more about these problem-solving tools through the available literature.

Theory of Constraints

The Theory of Constraints (TOC), developed by Eliyahu Goldratt, is a continuous improvement philosophy focusing on the identification and elimination of bottlenecks in a process. Central to the TOC philosophy is the idea that bottlenecks control the rate at which material flows through an entire system, and increasing the flow of material through the bottleneck is the only way to increase the throughput of material for the system. Increasing material flow through the bottleneck increases system throughput, which in turn reduces inventories, decreases operational costs and increases customer satisfaction (25). Side effects of TOC include increased flexibility to meet changing customer demands, predictability in meeting delivery schedules, and fewer resources wasted expediting the flow of material to put out production or delivery "fires" (25). TOC follows a basic iterative 5-step process to identify and eliminate system bottlenecks (26: 55).

1. Identify the bottleneck in the system – identify that which limits throughput.
2. Exploit the bottleneck - schedule bottleneck to reap the most throughput.
3. Subordinate all other activities to exploit the bottleneck - only the bottleneck does can limit system throughput.
4. Work to elevate the constraint - increase capacity of the bottleneck.
5. Return to step #1 and iterate the entire process.

Throughput Dollar Days: Many organizations are composed of numerous functions and activities working towards the same end goals, that of customer satisfaction and reduced costs. The performance of these differing functions is often measured by different (and potentially opposing) metrics focusing on local performance objectives instead of global performance objectives. This conflict in the measurement system, and more importantly, the lack of a unifying measure limits throughput for the entire organization.

E. Goldratt in his book *"The Haystack Syndrome"* suggest a single measure that he believes can be used to tie various functions of an organization together in an effort to have them all work towards the same organizational objective of increasing material throughput. Goldratt calls this measure the Throughput Dollar Day. In simple terms, Throughput Dollar Day assigns a value (typically the sales value of an end product) to material flowing through the system. For every day the material resides in a particular function/activity, that function/activity is charged the value of the item. As an item falls behind schedule, its value increases, and as an item moves ahead of schedule, its value decreases. Since workers would try to keep the Throughput Dollar Day metric as low as possible, higher value items would receive more attention and would move through the system faster than lower value items, increasing throughput, and helping the organization reap the benefits of TOC previously mentioned (27: 146-154).

Value of any given material moving through the pipeline does not have to be assigned a dollar-value, but could instead be assigned a value based on priority codes or the degree to which the material is ahead or behind in its flow through the pre-programmed flow schedule. This measure, combined with other TOC principles may tie the various functions of an organization together to all work in a coordinated and harmonious fashion towards the over-riding objective of decreasing system flow times.

Air Force Logistics Pipeline

The Air Force logistics pipeline is a complex assembly of activities, the purpose of which is to get the right part, to the right location, at the right time. As such, the Air Force logistics pipeline is synonymous with the civilian supply chain. The purpose and management of both of these activities should have the same ultimate goal of the realization of customer needs and satisfaction at minimum costs. The Air Force logistics pipeline is sub-divided into 13 major segments, the purpose of which is to ensure that customer demands are met in a timely and cost efficient manner. Table 1 provides a listing of the various segments. The segments are similar to but more detailed than the UMMIPS standards covered in the following section.

Table 1. Key Logistics Pipeline Segments

1	Requisition Submission
2	DAAS Processing
3	Initial Source Processing
4	Depot Processing
5	Transportation from Depot to Containerization Point
6	Containerization Processing
7	CONUS In-transit
8	Port of Embarkation Processing
9	In-transit to Theater
10	Port of Debarkation Processing
11	In-theater Transportation
12	Receipt Take-up
13	Base Processing

(AFMC Unpublished Briefing)

Segments 1-4 comprise the requisition, depot, and Defense Logistics Agency (DLA) portion of the pipeline, while segments 5-13 together comprise the distribution portion of the logistics pipeline. This thesis focuses on the performance analysis of the distribution portion (segments 5-13) between depot and the ultimate user on the ramp.

In the classic sense, the logistics pipeline is envisioned as a single pathway with material moving sequentially from segment 1 to 13. This may perhaps be true for a single item, sourced from a single supplier, and traveling to a single location, but the Air Force ships thousands of parts each day with material moving between numerous activity nodes. The myriads of "pipelines" that result make the system more analogous to a network than a pipeline.

It is no easy task to ensure that material moves through this network as effectively and efficiently as possible. This makes it essential that Air Force logistics managers establish "relevant management controls to support activities nodes and to ensure that every precaution is taken to prevent delays" within the distribution segment of the logistics pipeline (28: 24-31).

Uniform Material Movement and Issue Priority System (UMMIPS)

The DoD UMMIPS time standards aim to reconcile the competing demands of time and cost in an effort to provide the most effective and efficient movement of material through the logistics pipeline. Used in peacetime and wartime, UMMIPS aims to issue material based on the mission and urgency of need of the requiring organization, provide a basis for managing the movement of material along the distribution pathway, and to set forth uniform time standards for the requisitioning and physical material movement through the pipeline (28: 24-4).

UMMIPS assigns priority designators, two-digit numeric codes (01-15), to express the relative importance of materials moving through the logistics system. For units moving high priority material (01-08), expedited handling and high-speed transportation will normally be used, since “it is a prime objective of the DoD to satisfy these priority demands on time, without operating and transportation costs becoming an overriding factor”, while “routine handling and cost-favorable transportation will generally be used for material demands with priority designators 09-15” (28: 24-5).

Assuming the part is on the shelf at depot, UMMIPS uses the priority designator as a basis for assigning an overall time standard for movement of material from depot to the demand location, and breaks out maximum allowable time standards for each activity node along the logistics path (28: 24-4).

Table 2. UMMIPS Time Standards

	Priority 01-03 and NMCS					Priority 04-08					Priority 09-15				
A. Requisition Submission	1					1					2				
B. ICP Availability Determination	1					1					1				
C. Depot and/or Storage Processing	1					2					7				
D. Transportation Hold and CONUS in-transit	3					6					11				
AREA	**CONUS**	**1**	**2**	**3**	**4**	**CONUS**	**1**	**2**	**3**	**4**	**CONUS**	**1**	**2**	**3**	**4**
E. POE and/or CCP Processing and in-transit Carrier	N/A	2	2	2	3	N/A	2	2	2	3	N/A	10	10	10	25
F. In-transit Overseas	N/A	1	1	2	3	N/A	1	1	2	3	N/A	10	15	25	30
G. POD Processing	N/A	1	1	1	2	N/A	1	1	1	2	N/A	3	3	3	8
H. Intra-theater in-transit	N/A	1	1	1	2	N/A	1	1	1	2	N/A	5	10	5	5
I. Receipt take-up by requisitioner	1	1	1	1	1	1	1	1	1	1	2	3	3	3	3
J. Total Order-Ship Time (OST)	7	12	12	13	17	11	16	16	17	21	24	52	62	67	92

Adapted from AFM 23-110, page 24-39

Table 2 illustrates how time standards are broken out by process activities to comprise the total allowable distribution time (in calendar days) for a given material based on previously assigned priority designation codes.

In addition, Table 2 fine-tunes the time standards for material with the same priority designation due to differing receipt locations. Material moving to CONUS locations, or Areas 1-4 are allotted differing time standards based the length of the travel distance/time from the originating depot. Area locations are listed in Table 3.

Table 3. UMMIPS Area Assignments

Area 1	Alaska, Hawaii, Guam, Caribbean and Central America
Area2	U.K, and Northern Europe
Area 3	Japan, Okinawa, Korea, Philippines and Western Mediterranean
Area 4	All other destinations not included in areas 1-3

Adapted from AFM 23-110, page 24-39

The overall objective of the UMMIPS standards is to provide guidance to logistics managers in satisfying customer demand within prescribed cumulative time standards. Each logistics activity is assigned a portion of the overall allotted network time that should not be exceeded, however, each processing function should not consider their individual standards as "inviolate when subsequent savings in time and improved service to the customer can be realized" (28: 24-4). As such, UMMIPS aims to provide guidance for personnel functioning within the various processing activities to act on material moving through the system in such a way as to meet or surpass the total order and ship time (OST) for material moving through the system. Yet, it is well documented that a large percentage of material moving through the pipeline does not meet the maximum UMMIPS-allowed time standards (4: 37).

AFMC Pipeline Performance Analysis

The AFMC transportation section (AFMC/LSO) conducts various analysis of the logistics pipeline to determine overall performance and to identify and resolve potential problem areas that adversely effect Customer Wait Time (CWT) and Time Definite Delivery (TDD) performance goals. The procedure used to arrive at performance information is similar for all three analyses, but the rationale for accomplishing the various analyses may differ. The main AFMC-conducted analyses are:

Monthly Pipeline Performance Analysis. Analysis of the overall Air Force logistics pipeline using all shipments made worldwide as a basis. This analysis aggregates the performance data for all Air Force shipments to get a general feel for how Air Force pipeline is operating.

Weekly Pipeline Performance Analysis. Analysis of the logistics pipeline using all shipments made in support of unique operational requirements such as Operation Enduring Freedom. This analysis aims to identify problem areas in the pipeline in an effort to reduce CWT into high-interest areas of operation.

Ad Hoc Pipeline Performance Analysis. Analysis of the logistics pipeline using all shipments made in support of specific bases of requisition, or a myriad of other parameters. This analysis aims to resolve customer complaints, or special request for information on performance of specific portions of the logistics pipeline.

In all cases, AFMC transportation analysts are tasked to track shipment performance through the relevant logistics pipeline to determine actual performance, identify root causes of delays and recommend potential improvement initiatives to senior management. The procedures to perform the analysis and the metrics currently used are nearly identical to those used for the monthly analysis (19).

AFMC Pipeline Performance Measures. Air Mobility Command and Commercial Carriers (Fed EX, DHL, etc.) act as third-party suppliers to AFMC, providing the actual mode of transportation for material moving through the logistics system. As a customer of these transportation suppliers, AFMC monitors performance of these organizations and reports result to AFMC senior management (as well as AF/ILT) on a weekly, monthly, and/or ad hoc basis. The measures used by AFMC are designed to portray the general delivery performance of the logistics pipeline, and the performance of third-party transportation providers along a number of parameters. These AFMC-derived measures include:

Logistics Response Time (LRT): Measures the average response time for all shipments (regardless of mode of transportation) as measured from the time the order is placed through requesting base supply function to the time the same base supply function receives the item (29: 1).

Commercial Carrier LRT Time: Measures the average LRT (in calendar days) for all commercial carrier shipments from time of requisition to receipt by base supply function at base of requisition (30: 4).

Commercial Carrier Transportation Time: Measures the average commercial carrier transportation time as measured from the time the carrier picks up the item, to when the carrier delivers the item to the Traffic Management Office (TMO) or base supply (30: 5).

Commercial Carrier On-Time Delivery: Measures the percentage of commercial carrier shipments that were delivered on time as measured against UMMIPS standards for express delivery (30: 6).

Commercial Carrier Receipt Take-Up Time: Measures the average take-up time as measured from the time the item is delivered by commercial carrier and ends with base supply receipt of the item (30: 7).

AMC Possession Time: Measures the average time AMC possesses an item to include the time the item is in-processed at the Aerial Port of Embarkation (APOE) to the time the item is processed through the Aerial Port of Debarkation (APOD) (31: 6).

AMC On-Time Delivery: Measures the percentage of shipments delivered by AMC within the UMMIPS time standards from the Aerial Port of Embarkation (APOE) to the Aerial Port of Debarkation (APOD) (31: 7).

AMC Number of Shipments: Measures the total number of CONUS to Overseas location shipments completed by AMC. Used to identify what areas rely on AMC transportation and to what extent. In addition, it is intended to provide significance to the other AMC-specific measures (31: 4).

Weight Profile: Measures the number of shipments delivered by AMC that met the 150 pounds weight classification to travel via commercial means. This measure aims to identify items that are being shipped incorrectly as per current Air Force guidance, potentially clogging the AMC-operated pipeline nodes (31: 5).

Commercial Eligible: Measures the number of shipments delivered by AMC that were eligible to travel through commercial means. Similar to the weight profile measure, but also includes specific weight, requested delivery date, and special project code requirements (31: 8).

With the exception of the Weight Profile and Commercial Eligible measures, AFMC transportation personnel perceive the remaining measures to be top-level metrics designed to depict the critical performance elements of third-party transportation suppliers. The Weight Profile and Commercial Eligible measures have been added to provide visibility of compliance by Air Force members with corporate policies mandating the movement of cargo meeting specific requirements through commercial carriers as a means to expedite their delivery times and free space on AMC aircraft to move physically larger cargo.

All of these indicators can be broken out to identify performance by theaters of operation, country codes or specific bases receipting materials. Once performance on these measures is determined, transportation specialist attempt to ferret out the root causes of performance shortfalls for a given receipt locations and recommend potential improvement initiatives to appropriate agencies (19).

TRACKER Database (AFLIF – AF Logistics Information File)

The TRACKER database is the primary tool used by AFMC/LSO specialists to gather performance data on the logistics pipeline. TRACKER is a data mining and display tool merging and displaying supply, transportation, acquisition, and maintenance information in one easy to read computer screen presentation. Developed and maintained by AFMC, primary users of TRACKER are AFMC transportation analysts, base level and Regional Supply Squadron (RSS) MICAP researchers, base level transportation researchers, base level flight line maintenance personnel, and depot item managers. The system receives more than 50,000 inquiries per month and usage is climbing. Efforts are currently underway to expand TRACKER capabilities to allow the measurement of the entire logistics pipeline in near real time (7).

Current Pipeline Analysis Initiatives

To address the poor performance of the logistics pipeline, the services have initiated over 400 logistics pipeline improvement initiatives (5: 64). The following list comprises some of the major initiatives addressing the measurement and reporting of logistics pipeline performance and the identification of potential improvement areas:

Chief of Staff Logistics Review (CLR). CLR is a broad Air Force logistics initiative addressing among other things the merger of the base level transportation and supply functions. An underlying assumption of the merger is that combining these two base-level functions will eliminate duplicate activities, speed the flow of materials through the logistics pipeline and reduce overall Customer Wait Time. The initiative is currently being tested at five Air Force locations and pending results, is awaiting implementation Air Force wide (32: 15).

Supply Chain Managers. The aim of this Air Force initiative is to reduce CWT through the management of "buy and repair sources; asset transportation and distribution; systems support/use and metrics reporting; bits pieces and parts support; tools and equipment management; funds availability and expenditures, and providing a key interface with the requirements generating customers" (33: 1). This differs from the item manager concept in that Senior Officers and civilian personnel assigned as supply chain managers are responsible for the performance of the logistics pipeline for all National Stock Numbers assigned to a specific weapons "system". They do not replace the item managers for respective items, but are intended to work with item managers in an effort to improve aircraft system-wide performance (33: 2).

Strategic Distribution Management Initiative (SDMI). This combined USTRANSCOM and DLA effort seeks to improve the DoD end-to-end distribution process by redesigning, streamlining and optimizing the entire DoD global distribution system through the use of commercial "best practices" in supply chain management. SDMI proposes to enlarge the supply chain management environment from the service-level towards the DoD-level. It is felt that this move would minimize the sub-optimization of each service-level logistics chain, and maximize the optimization of the entire DoD logistics pipeline as a composite system (34: 1).

Customer Wait Time Initiative. This Air Force initiative provides a web-based computer interface with the capability to analyze current performance of the logistics pipeline. The aim of this system is to determine CWT and identify possible pipeline constraints. This system combines Supportability Analysis and Visibility system (SAV) data from the Weapons System Analysis and Information Systems (WSMIS) and data from TRACKER to assemble a composite picture of the performance of the entire logistics pipeline. This combination of tools maintains data for the last 15 months and can report, analyze and drill down on requests and requisitions (based on UMMIPS nodes) in an effort to identify bottlenecks where potential process improvements may be necessary. Analysis can be performed at the raw transactions level, all the way to the Air

Force aggregate level. The system is still in development and will not be reporting performance data in time for this thesis. When fully functional, CWT Initiative data will be accessible to all Air Force members (35).

Pipeline Performance Analysis System (PPAS). The purpose of this Air Force system it to "develop a single, integrated, web-based management system which provides visibility and metric capabilities for assets in the pipeline in order to eliminate duplication and reduce overall cost" (36). Currently under development by AFMC, the system aims to become the Air Force one-stop shop for anyone seeking data supporting asset and requisition tracking, retrograde shipment tracking, and depot awaiting repair and awaiting parts tracking. In addition, it will provide pipeline and stock metrics, statistical and backorder analysis as well as financial data on Air Force shipments. The system aims to merge the capabilities of six formal monitoring/analysis systems (to include the CWT Initiative) as well as the capabilities of numerous homegrown systems at wing and MAJCOM level, as well as the various Air Logistics Centers, effectively eliminating all duplicate analysis efforts within the Air Force. One of the primary data sources for PPAS is the TRACKER database currently used by AFMC. To improve asset visibility of material traveling through the logistics pipeline, PPAS aims to merge with the Air Force Total Asset Visibility initiative currently being developed at the Oklahoma Air Logistics Center. Initial operational capability for PPAS has not been established and no firm implementation date has been forecasted (36).

Summary

This literature review attempts to provide some background information needed to gain an understanding of the many facets that impact this research. This chapter provides background information needed to gain a basic understanding of the many facets that impact this research. The chapter provided brief definitions of key terms such as supply chains, supply chain management, and a brief comparison of the Air Force logistics system with private sector supply chains. A brief discussion into the importance of organizational metrics and concepts in process improvement, as well as the theory of constraints philosophy as it pertains to pipeline management was discussed. This was followed by a description of the Air Force logistics pipeline, UMMIPS time standards, the various AFMC performance measurement requirements, and the TRACKER Database. Lastly, the other pipeline measuring and reporting initiatives were presented.

III. Methodology

Chapter Overview

The purpose of this chapter is to provide an explanation of the methodology used to answer the basic research question. The chapter begins by providing a comparison between qualitative and quantitative research paradigms, and provides the justifications for the appropriateness of a qualitative case study for this research. This is followed by a description of the research methodology, as well as the data analysis methods used. Finally, validity and reliability are discussed.

Quantitative versus Qualitative Designs

Two basic research designs are widely discussed in the literature: quantitative and qualitative studies. Quantitative research designs typically start with a theory and the researcher inquires into problems through the testing of theory, measuring with numbers, and statistical analysis of the findings in an effort to determine if a predictive generalization holds true (37: 2). The qualitative design typically starts without a predictive generalization and is more of an inquiry process to gain a more complete understanding of the problem. As such, many qualitative researchers believe that there is not a single ultimate truth to be discovered, but that there can be multiple perspectives held by different individuals (38: 147).

Justification of Qualitative Design

A qualitative research design is generally used when the researcher aims to describe the nature of a specific phenomenon, and aims to interpret new insights, develop new concepts or discover new problems about the nature of a phenomenon (38: 148). As the primary instrument for gathering data, this researcher aims to gain an understanding of the current process/procedures used by AFMC transportation personnel to analyze the performance of the distribution segment of the logistics pipeline, and to identify potential areas of improvement to the analysis process currently in use. Analysis of the process used by AFMC transportation personnel will be conducted through an inductive process by building on observations, abstractions, concepts, and theories. Conclusions and recommendations will be derived from observed details and interviews. Insights gained upon reflection will be reported in a descriptive manner.

Justification for Case Study

Although many more types of qualitative studies are covered in the literature, of the five major types of qualitative studies, the case study was chosen as it met the purpose, focus, methods of data collection and methods of data analysis of this research (38: 157).

Purpose: Understand one person/situation (or very small number) in great detail.

Focus: One case or a few cases in their natural setting.

Data Collection Methods: Observations, interviews, content analysis.

Data Analysis Methods: Categorization and interpretation of data in terms of common themes and/or synthesis into overall portrait of case(s).

Experience of the Author

The researcher is an aircraft maintenance officer, whose a priori experience with the Air Force supply and transportation functions has been limited to that of customer. As such, the researcher spent extensive time interviewing supply and transportation specialists at Air Force Material Command, Wright-Patterson AFB, and reviewing existing literature about the intricate workings of the current supply/transportation systems, and the overall theme of performance measuring of the logistics pipeline.

Data Collection Methodology

The data collection methods employed in this study will be review of existing literature and documents, interviews, and observations.

1. An extensive review of Air Force regulations, instructions and pamphlets, as well as personal interviews with AFMC personnel concerning the general topic of Air Force cargo movement will be used to provide the researcher with a general education on the topic under study.

2. The researcher will interview AFMC/LSO staff to gain insight into the definition of terms, rationale for and the desired output of the various analyses types, methods used to identify pipeline constraints, procedures used to communicate analyses results and recommend improvements, as well as the limitations of and future plans for modifying the existing analyses procedure.

3. The results of numerous monthly performance analyses, as well as ad hoc and special project analyses will be studied to determine the steps required to perform the various analyses. The TRACKER user manual will be used to assist in accessing the TRACKER on-line database and become familiar with the screens and query options available to the user.

4. This will be followed by a literature review concerning the general topics of performance measuring, process improvement and statistical process control to examine how this knowledge can be applied to improving the performance analysis of the logistics pipeline.

5. Observations of AFMC/LSO analyst will be conducted to derive the exact steps required to perform the analyses and determine the performance of the logistics pipeline. Observations of the AFMC transportation analyst will be conducted while the analyst is accomplishing various pipeline performance analyses. These observations will be used to determine the steps and procedures required of the analyst to:

    a. Acquire the raw pipeline performance data, and manipulate the data to derive performance at the differing Air Force, theater, country, and base of requisition levels.

b. Identify pipeline performance shortfalls, ferret out root causes for shipments that did not meet standards, and identify areas of the pipeline that could benefit from the implementation of improvement initiatives.

c. Communicate potential improvement initiatives to senior leaders and individuals/organizations in an effort to quickly affect change to procedures in the field.

6. Lastly, the researcher will attend management briefings where results of the current analysis are presented, and conduct interviews with AFMC senior leaders to determine the perceived value of the analyses results, to determine if presented information meets the needs of senior leaders in identifying and resolving logistics pipeline constraints.

7. Throughout this process, interviews with Air Staff, AFMC, and wing level personnel responsible for the performance of various segments of the distribution portion of the logistics pipeline will be conducted to fill in gaps in knowledge, and to seek answers to developing questions.

Initial email contacts requesting permission will be followed by personal or telephone interviews comprised of open-ended questions concerning the area of expertise of the individual being interviewed. Results of the findings will be recorded in detail and used to document the procedure currently used by the AFMC transportation analyst to determine the performance of the logistics pipeline.

Analysis

Creswell reports that the process of data analysis in a qualitative study is eclectic and that no "right way" actually exists. As such, metaphors and analogies are as appropriate as open-ended questions (37: 153). For the purpose of this study, data analysis will be conducted simultaneously with data collection, and the categorization and synthesis methods of analysis appropriate with case study designs will be used (38: 157).

As such, the researcher will observe and document the actual processes employed by AFMC in analyzing pipeline performance, and apply information gathered through interviews and the study of concepts in performance measuring, process improvement and statistical process controls. Synthesizing the information, the researcher aims to identify improvement areas to the current methodology that would reduce the time required to perform the analyses and/or increase their relevance to decision-makers.

Validity and Reliability

Validity is categorized into internal validity (correctly determining causal relationships) and external validity (generalizing findings beyond the immediate case study) (39: 38). To support internal validity of the research findings, the researcher will use the following strategies (38: 106):

> **Triangulation.** Make every attempt to gather multiple source of information in search of common themes.
>
> **Feedback from others.** Feedback from colleagues will be sought to determine if the correct conclusions have been reached based on the collected data.
>
> **Respondent validation.** Conclusions will be returned to respondents in the field to ensure that the conclusions reached make sense based on their experience.

External validity of this study will be limited since the intent of any qualitative research is not to generalize the findings. This does not however place this study at a disadvantage, since quantitative designs have "no special statistical technique for assessing external validity" (40: 261).

The reliability (ability to replicate the study in a like context) of qualitative studies is by their nature somewhat limited. By interviewing various respondents, and returning conclusions to respondents in the field for evaluation, the researcher will increased the likelihood that the study can be successfully repeated in a like context (37: 159).

Summary

The chapter provided an explanation of the methodology used to answer the basic research question. The chapter began with a comparison between qualitative and quantitative research paradigms, and provided the justifications for the appropriateness of a qualitative case study for this research, and the experience of the author. This was followed by a description of the research methodology, as well as the analysis methods used. Finally, validity and reliability were discussed.

IV. Analysis and Findings

Chapter Overview

Reviews of the existing literature on process improvement, concepts in performance measuring and statistical process control, as well as Air Force and DoD literature (to include transportation and supply regulations, instructions and pamphlets), were followed by personal interviews with individuals at various Air Force, AFMC, and wing level positions responsible for segments of the logistics pipeline. Finally, observations of the actual procedures employed by the AFMC transportation analyst in determining logistics pipeline performance were accomplished. This chapter discusses the various issues that emerged as the research evolved.

Data Gathering

Between September and November 2001, the researcher made numerous visits to HQ AFMC to interview logistics specialists from various functional areas. Not being a career transportation officer, the intent of these interviews was to ask open-ended questions in an effort to educate the researcher and to gain a basic understanding of the general topics concerning Air Force transportation issues.

These interviews were followed December 2001 – January 2002 with additional interviews of the transportation specialists to gather detailed knowledge of the analyses process conducted by AFMC/LSO. Answers to the posed questions gave the researcher insight into the rationale behind conducting the various analyses, the desired output of the various analyses types, definition of terms, methods used to identify pipeline constraints, limitations of the current analyses, procedures used to communicate analyses results and recommend improvements, as well as future hopes for modifying the analyses procedure to add relevance to decision makers.

Throughout this time period, additional logistics specialists from AFMC, wing organizations, as well as HQ Air Force were interviewed as required to add detail and gain a better understanding of the logistics distribution process, fill gaps in the information, and to answer newly developing questions and concepts.

During the January to February 2002 time period, a number of observations were made while the AFMC/LSO analyst was conducting the step-by-step procedure required to perform the actual weekly pipeline analyses. During this time period the researcher did not observe the performance of monthly or ad hoc analyses, as the analyst was completely consumed with the performance of the weekly analyses in support of an on-going operation.

Everyone encountered along the way was most helpful and willing to share his or her knowledge. A number of individuals encountered had specific issues/complaints they were trying to communicate (pet peeves) that provided data that may or may not have been relevant to this study. But at no point in time did the researcher get the impression that anyone was trying to unduly influence the direction or conclusion of this study.

Analysis

Analysis of the process used by AFMC/LSO to determine the performance of the distribution segment of the logistics pipeline was conducted through an inductive process of data immersion, building on observations, abstractions, and concepts (as outlined in chapter III).

For the purpose of this study, data analysis was conducted simultaneously with data collection. Insights gained upon reflection were discussed with other logistics experts to determine applicability of gathered data to the subject under study, and to verify the results of observations, understanding gained and conclusions drawn. This resulted in an iterative process, where the researcher often revisited individuals to conduct additional (personal or telephone) interviews, or conduct additional observations, in order to gain a more complete understanding of the subject, or to fill in gaps in the data already gathered.

Results of the analysis were then again shared with other logisticians at the Air Force Institute of Technology as well as with AFMC functional specialists to determine the validity of the conclusions drawn. The findings and conclusions are presented and discussed in order by investigative question.

To re-emphasize, logistics pipeline performance is measured by the time elapsed between when a customer places and order with their supply function and the time that the requested item arrives at the same supply function. The time-period is effectively known as Logistics Response Time (LRT) and for the purpose of this study is analogous to Customer Wait Time (CWT). For the purpose of this study, reducing CWT is the over-arching objective of the distribution segment of the logistics pipeline.

Research Question #1:

How is the AFMC transportation section currently determining the performance of the distribution segment of the logistics pipeline?

To answer this question, the researcher interviewed the AFMC/LSO staff to determine their definition of the part of the pipeline under examination, identification of the various metrics involved deemed to be important to AFMC/LSO, and the objective and scope of the various analyses being conducted by the staff. Data sources used, methodology employed, ultimate use of information gleaned from the analyses, and the various tools employed was also discussed. The researcher then followed AFMC personnel through all relevant phases of the analyses from data gathering, determination of overall logistics pipeline performance, identification of performance shortfalls, presentation of key metrics to senior management, and constraint resolution procedures.

Personal interviews of members of the AFMC/LSO staff (19, 43, 44) were used to determine the methods available to resolve performance shortfalls identified by the analysis. Follow-up interviews were conducted with AFMC/LSO staff members to help elaborate on the procedure, fill in holes in the process, and determine rationale for decisions.

The sources and method of gathering raw pipeline performance data were obtained through personal interviews of the AFMC programmer and transportation analyst. Over the shoulder observations and interviews of AFMC/LSO personnel were conducted to derive the step-by-step procedures required to extract pipeline performance information from the raw data, and identify performance shortfalls of completed shipments.

The researcher attended the weekly staff meeting with the AFMC logistics commander to determine which metrics were presented and how the results of the performance analysis are presented to the senior staff. The entire procedure was outlined and returned to AFMC/LSO for review and elaboration to ensure all relevant procedures and information were captured.

Observation.

Data Sources. AFMC/LSO currently uses the TRACKER database as the main data source for their logistics pipeline performance analysis. TRACKER uses open-systems architecture to gather and store data from various legacy computer systems (listed in chapter II) and to produce historical record families. Record families can be accessed on-line or batch processed for off-line analysis (36).

Actual pipeline performance data is gathered in the field in the form of arrival and departure data as logistics information and/or material moves through the various segments of the logistics pipeline. The raw data for all DoD shipments is captured by various legacy computer systems and sent to Defense Automated Addressing System (DAAS) for processing, storage and subsequent retrieval. Data captured by DAAS is updated as it becomes available, in some cases as often as every 15 minutes. Data fields required on specific shipment types for AFMC analyses are forwarded from DAAS to the TRACKER system in a batch format, arriving usually on the Monday following the week under review (41). Pipeline performance data made available through DAAS to the TRACKER database are provided by the following legacy systems (42: 20):

> **MILSTRIP/MILSTRAP:** Provides Standard Base Supply System (SBSS), and D035 data at the supply/wholesale level and from other service/agency transactions.
>
> **Cargo Movement Operations System (CMOS):** Provides data for Government Bill of Lading transactions for all AF/ANG/AFRES sites, all marine shipments, and from the Advanced Transportation Control & Movement System (ATCMD) for international military transactions.

CONUS Freight Management System (CFM): Provides data for Government Bill of Lading transactions for shipments from other services, AF Publications Center/ALC Procurement Traffic Contracts, and DCMA/Vendors.

Distributed Standard System (DST): Provides data for Government Bill of Lading transactions for all AF/ANG/AFRES sites, and ACTMD.

Commercial Carriers Tracking Systems: Provides data for shipment status and transit time, and data from carrier invoices.

Enhanced Transportation Automated Data System (ETADS): Provides data on military sealift/airlift to include advanced shipping notices, receipt at port, port lift and manifest numbers.

D043: Provides data on national stock numbers, Source of Supply, fund codes, nomenclature and budget codes.

D035: Provides depot maintenance data such as receipts from shops.

JO41: Provides contracting data on new procurements.

G009: Provides contracting data on repair contracts.

Together, these computer systems provide the vast majority of the performance data required to conduct the performance analyses for each and every completed Air Force shipment. If a further breakdown is required, more detailed transportation data are available through the Global Air Transportation Execution System (GATES) for shipments under AMC control, or through similar computer systems for shipments under the control of commercial carriers. Efforts are currently underway to incorporate data from GATES and the Commercial Carrier computer systems into the initial data capture for use by the TRACKER database.

Performance Analysis Overview. The generic procedure for conducting the analyses is virtually the same for the weekly, monthly, and ad hoc analyses, though the purpose of each analysis is slightly different (discussed in chapter II). The various analyses differ only in the point of the pipeline (theater, country or base of requisition) the analysis is started. The following detailed process description was derived from observing the AFMC transportation analyst perform the weekly/monthly analyses.

Initial Data Cut. The raw arrival and departure data for each shipment is received from DAAS, processed and converted by AFMC/MSG into a Microsoft Excel spreadsheet format for grouping and sorting by the transportation analyst. The total number of Air Force shipments tracked for the time period under study is determined and the data stream analyzed to ensure that data required for the analysis in support of a specific measure has been successfully recorded. For example, the Logistics Response Time (LRT) measure needs the requisition at supply and delivered to supply data fields to be complete – other measures have their own relevant data fields. Shipments that do not have relevant data fields recorded are deemed unsuitable and discarded from the analysis (19, 41). Attempts to determine the reason for missing data fields are made – time permiting.

Overall Systems Performance. Shipments with required data fields recorded are analyzed for overall logistics pipeline performance. In the case of the monthly analysis, all Air Force-wide shipments are aggregated and overall pipeline performance is determined to be the "average" for all Air Force shipments completed world-wide during the last month for a relevant metric (listed in Chapter II). In the case of the weekly analysis, overall pipeline performance is determined to be the "average" for all shipments completed during the last week in support of specific operations (i.e. Operation Enduring Freedom) or specific areas of interest (such as poor performance to a receipting base) for a relevant metric. In either case, shipments completed are aggregated to arrive at an "average" for a relevant metric, and performance is compared against historical performance and established UMMIPS or locally determined time standards for a given theater, country or base of requisition.

Performance by Theater of Operation. The monthly analysis breaks overall logistics performance down into logistics performance for shipments made in support of USAFE, PACAF, or CENTAF. All shipments completed in support of a specific theater are aggregated to arrive at an "average" for the entire theater of operation for a relevant metric, and performance is compared against historical performance and established UMMIPS or locally determined time standards.

Performance by Country Code. If theater-wide logistics performance does not meet established time standards, data for all shipments completed to that theater are broken out into logistics performance for shipments made in support of specific countries within each theater. All shipments completed in support of a specific country of operation are aggregated to arrive at an "average" for that specific country for a relevant metric, and performance is compared against historical performance and established UMMIPS or locally determined time standards.

Performance by Base of Requisition. If county-wide logistics performance does not meet standards, data for all shipments completed to that country are broken out into logistics performance for shipments made in support of specific bases of requisition within each theater. All shipments completed in support of a base of requisition are aggregated to arrive at an "average" for that specific base of requisition for a relevant metric, and performance is compared against historical performance and established UMMIPS or locally determined time standards.

Root Cause Identification. Specific bases of requisition deemed to be experiencing sub-standard pipeline performance, undergo analysis of all transactions exceeding the desired time standards. Segment-by-segment shipment data is analyzed to determine the exact flow times of information and material through each node of the logistics pipeline (from depot to base of requisition) in an attempt to determine individual causes for delays.

Should more detailed transportation data be required, the analyst retrieves the data from GATES or the Commercial Carrier computer system by manually exporting individual TCN numbers from TRACKER into GATES (or the commercial-carrier computer system), and gathers the remaining data fields for each shipment.

With all shipment data gathered, the analyst then synthesizes the data, composes an overall mental picture of the material flow, and determines what the analyst perceives to be the root cause(s) for the logistics delays. Root causes traced to specific nodes within the logistics pipeline may trigger (depending on the number of shipments affected) a more detailed analysis of the performance of the offending node.

Time Constraints. The analysis is a completely manual procedure. To gather complete transaction data for a shipment, the analyst must manipulate the Excel spreadsheet to group and re-group data by relevant theater, country or base of requisition groupings, and perform the requisite calculations for each metric. Root cause identification requires the analyst to manually transfer the TCN numbers of late shipments from TRACKER to GATES one cell at a time. This is a tedious procedure, requiring a lot of time, due to the fact that the number of delayed shipments can reach well into the hundreds if not thousands for a given analysis.

Being limited on time, the single AFMC analyst is unable to analyze the performance of every transaction or node in the pipeline. Hence, the analyst seeks early on to determine where efforts are best placed to identify transactions or nodes with the most significant performance improvement potential. At each step along the analysis, the transportation analyst makes a determination of performance that warrants a further break down of the logistics pipeline into smaller and smaller segments, ultimately arriving at the base of requisition, whose overall on-time performance may signal significant improvement potential. Areas with the most significant improvement potential are determined by AFMC to be those areas with the most considerable substandard performance, or those areas that fall within the desired time standards, but are outperformed by all other nodes in the same category (theater, country code, base).

Data Presentation. Results of the various performance analyses are compiled into a set of performance measures (described in Chapter II). These measures, along with any constraint resolution initiatives are briefed to the senior transportation manager, who in turn presents the information at the weekly AFMC Logistics Commander stand-up. Metrics illustrating logistics pipeline performance for the time period under scrutiny, as well as any improvement initiatives are presented for each break out along the analyses. Appendix A and B are representative performance metrics.

Appendix A represents the overall theater-wide results of a weekly analysis conducted in support of an on-going operation. The format is representative for presenting findings by country or base of requisition is representative of the type of presentation provided at the conclusion of each analyses. The metric merely illustrates the average performance of all shipments made in support of this operation with respects to the standard for the time period under scrutiny.

Appendix B breaks the theater-wide performance down further by country codes. In this particular case, only Oman has exceeded the performance minimum standard. A further breakdown of the performance of shipments into Oman is provided and identifies excessive ICP time, Depot Processing time, and Total Ship Time as contributing factors to this substandard performance. In addition, it identifies Commercial Door to Door and Supply Receipt Time as being the main contributors to the poor performance.

Analysis. AFMC transportation personnel see the primary purpose of the pipeline analysis to 1) identify performance trends, problem areas, and provide a big picture view of logistics performance to Air Force agencies, 2) serve as a basis for possible changes in Air Force transportation policy, and 3) ultimately to reduce Customer Wait Time and improve Time Definite Delivery (19, 43, 44). Being tasked by various agencies (AF/ILT, MAJCOM, wing and base level) to conduct pipeline analysis, it was difficult for this researcher to determine which analyses were part of the organizations primary processes and which analyses were part of their secondary processes. Every request appeared to receive the same handling priority, causing lots of last minute hustling to satisfy the customer requests.

Due to a shortage of personnel, time and resources, the AFMC/LSO is limited to conducting reactive analyses to determine past performance of various segments of the logistics pipeline or respond to a perceived shortfall in on-time delivery to specific delivery locations. The analyses are not currently structured to enable AFMC to use them in a pro-active manner to measure on-going performance, identify problems as they begin to evolve and intervene to correct causes of delays before they result in deliveries that do not meet the specified time standard. As such, the analyses are only used to determine and report performance, and to serve as a basis from which to make improvement recommendations that aim to minimize the same cause of delays for future shipments.

Current technology employed by AFMC makes the pipeline analyses an almost completely manual procedure. This results in an extremely detailed and time-consuming enterprise, where data is repeatedly manipulated to derive pipeline performance. As a result, the analyst spends far too much time manipulating the data than analyzing it for potential sources of delays, determining trends in performance, or as a basis from which to make improvement recommendations.

AFMC/LSO is unable to perform a systematic analysis of the logistics pipeline on a continuous basis. Unfortunately, the pipeline analyses are conducted by only one office (AFMC LSO/ LOT), and that office is staffed by only one full-time analyst. Restricted by time, the analyst focuses attention on the project receiving the highest visibility at the time (very few monthly analyses of the pipeline have been conducted since the start of Operation Enduring Freedom), effectively minimizing visibility of the performance of the remaining segments of the pipeline. In addition, for those analyses conducted, the analyst is again restricted by time to examine only those receipting bases whose performance identifies them as being "worst performers." The focus on bases that are in effect the "worst performers" effectively negates visibility of potential problems in the remaining segments of the logistics pipeline supporting that operation. Problems of even greater magnitude than those discovered could be lurking in the other segments of the pipeline, but are not detected due to associated segments of the pipeline masking the overall performance of that particular distribution system.

AFMC/LSO currently does not have the resources to identify systemic pipeline problems before they begin to impact on-time delivery. By measuring on-time shipment performance to receipting bases, AFMC is measuring the output of the distribution segment of the logistics system. Little analysis is conducted on process measures for trans-shipment nodes in the distribution system where root causes ultimately reside. If systemic problems are found, it is more by accident then by design, and then only if a cause is determined to be the root cause of delay for numerous "bad actor" shipments.

Research Question #2:

How are the results of this analysis used to identify and resolve performance shortfalls in the distribution segment of the logistics pipeline?

Observation. With all data gathered, grouped, and transactions without all relevant data fields completed are discarded, AFMC determines overall pipeline performance to various theaters of operation, country codes and bases of requisition. Logistics pipeline performance at each break out of data is compared against historical performance as well as UMMIPS or locally determined time standards. Locally determined time standards are used when performance to specific theaters, countries or bases of requisition are consistently better than those listed in the UMMIPS standards. Areas experiencing sub-standard logistics pipeline performance have detailed shipment data scrutinized to determine root causes of the delays. If the analyst identifies common causes for different delays or potential trends over time, AFMC/LSO recommends improvement initiatives through proper channels for constraint resolution.

Resolutions of identified performance shortfalls are treated on a case-by-case basis, with AFMC/LSO attempting to handle the constraint resolution at the lowest possible level. AFMC/LSO has frequent email, telephone and message contact with logistics managers at the theater, command, and wing levels, to get clarification of perceived problem areas, and to forward improvement recommendations to individuals responsible for specific nodes of the pipeline. If unable to affect a change, concerns can be elevated to AFMC/LG or AF/ILT for resolution.

Analysis. The current methodology is better suited for the identification of shipments arriving late to a specific location than for the identification and minimization of the root causes of their delays. AFMC/LSO has developed a relatively straightforward procedure to identify which shipments arrived late to a specific location, and then tracing their performance back through the various activity nodes of the pipeline. However, late arrival of shipments may be the result of significant delays encountered at a specific activity node, or the result of compound variance acquired as the shipment travels through the distribution system. If the delay was the result of a significant delay at a particular activity node, but the delay affected only this one shipment, or if the delay is the result of compound variation across the system, it is somewhat difficult to recommend any action be taken at a given activity node. In addition, the same problem (or worst) could be residing in some other activity node or segment of the pipeline. But because that segment is not the "worst performer" that segment of the pipeline is not currently being examined and the problem may never be identified and become a candidate for resolution. It is not until that segment of the pipeline (or those associated with it) deteriorates sufficiently that the current analyses methodology would flag it for management attention.

Resolution of pipeline constraints does not fall under the purview of AFMC/LSO. The logistics pipeline is a conglomeration of numerous functions and activities that need to work harmoniously together to achieve their end result. Unfortunately, many segments work under different authority chains, supporting differing organizational goals. Since no single entity "owns" the pipeline process, no single entity has the authority to solve pipeline problems that cross over functional boundaries. This makes the implementation of improvement recommendations somewhat difficult. Naturally, some functions may not want to be told what to do by some outside agency, or be somewhat reluctant to adjust their performance in such a way as to go counter to their organizational metrics in an effort to make the system perform well. In addition, cost of improvements would have to be borne by the function although they may not necessarily reap the reward of their investment. As a result, improvement recommendations made by AFMC may be implemented by affected functions, or they may not, depending on the working relationship between the organizations, perceived value of suggestion, or applied political power.

The ability to track the implementation of improvement recommendations is somewhat limited under the current analyses. Reasons for delays noted during the last analyses may or may not be seen in the results of follow-up analyses. This is due to the fact that nor formal reporting system is in place and that more than one factor may be affecting a specific measure. For example, a reduction in one of the factors affecting

AMC possession time may have been replaced by the increase in another factor, and together the overall AMC possession time measure remains unchanged or may have actually worsened even though the improvement recommendations were implemented. In some cases, the identified performance shortfall from the last analysis may just disappear in the current analysis, without anyone being able to determine the reason why.

Research Question #3:

How well do the AFMC transportation analyses support the goals of decreasing Customer Wait Time (CWT) and increasing Time Definite Delivery (TDD)?

AFMC does not measure CWT directly since the ability to capture the supply interface on the order and receipting end of the transaction does not yet exist at most bases. Due to the lack of a CWT metric, AFMC uses LRT as a measure, and assumes that the supply function places the order immediately after the customer notifies the supply function, and that the supply function sends the shipment immediately to the customer upon receipt. Actual CWT times will in fact be longer than reported LRT times, however, given the current limitation in measuring CWT, using LRT should provide a fair representation of overall pipeline performance.

Observation. The current pipeline analyses conducted by AFMC support the goals of improving Time Definite Delivery and Customer Wait Time to some degree. But since time and personnel are limited, the analyses can only examine the delays of "bad actor" shipments – those that have the worst performance. If common causes for delays are identified for numerous completed shipments, transportation personnel feel justified in taking necessary action to elevate the cause of the delays. In addition, AFMC forwards applicable intervention strategies to relevant agencies for resolution. AFMC/LSO feels that by identifying sub-standard performance on this weeks analyses, they are alerting relevant parties to the root causes and effectively minimizing the degree to which these root causes are a factor in next weeks pipeline performance, contributing to the improvement of CWT and TDD for future shipments.

Analysis. This method may in fact identify and reduce process variance to some degree, but does not necessarily translate into improvements in system-wide CWT or TDD. This is due to a number of reasons. AFMC/LSO uses the UMMIPS or locally derived time standards as a basis of judging pipeline performance, aggregates pipeline performance into "average" measures, does not make adequate use of process variance as a means of identifying performance, and is generally unable to identify deteriorating process performance until it has already negatively affected on-time delivery of shipments.

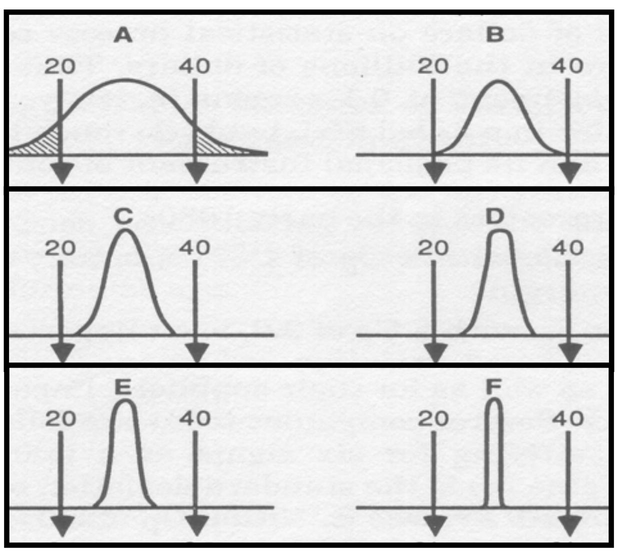
AFMC analyses use UMMIPS or locally determined time standards to judge overall pipeline and individual segment performance. This method appears to favor compliance with established standards over the continuous improvement of system performance, and usually results in performance that varies "as much as possible, because anything within "specifications" is considered "good enough" (23: 11-12). Though interviews with wing level personnel made clear their knowledge of the CWT (and hence the continuous improvement) philosophy, comments along the lines of "as long as I meet my time standard for this node", and "I don't care what happens before cargo arrives here or after it leaves" quickly illustrate that Continuous Improvement and reduction of overall CWT is not the driving motivator in day-to-day activities. This observation is mirrored by the AFMC analysis that focuses on returning "average" pipeline performance to within set UMMIPS or locally derived time standards.

Under the current methodology, shipments arriving early are combined with shipments arriving late to determine an "average" processing time. As long as that "average" falls within the established "standard" the logistics pipeline is determined to be working well. There are a number of problems with this approach. Excessive averaging masks poor performance by combining segments of the pipeline with poor processing times with segments that exceed the established standard. Management attention will not be drawn to the source of the poor performance until the performance of other segments of the pipeline deteriorate to the point of no longer masking the poor performing segment. This lets problems in the system linger until they begin to affect on-time delivery of shipments, instead of encouraging the initiation of improvement initiatives that would minimize the potential for future delays. It also does not allow management the opportunity of learn from the superior process and share lessons learned with other like segments in an effort to improve system performance.

Under the current methodology, the late arrival of shipments is generally viewed as a negative result, while early arrival of a shipment is generally viewed as a positive result. Averaging the early and late arrivals to compose "average" performance hides true performance data. Under the TDD concept, early arrivals should carry the same stigma (and receive the same management attention) as late arrivals, since neither one arrived "on time". Early arrivals carry with them the potential for extra transportation charges, increased holding costs or exposure to the elements, or the potential for having held up the transportation of other shipments that (as a result) arrived late at the receipting base.

The current AFMC analyses does not examine process variance in the determination of pipeline performance. By only using average processing time and not identifying the variance about the mean or median, AFMC/LSO has no way to accurately compare the performance of similar segments of the pipeline, or determine if a process is in control, on it's way to being out of control, or already in chaos. In addition, there is no real way to determine if further process improvements can be made by variance reduction or if a process re-design is required to reduce the desired mean or median time. Figure 3 (45) can be used to illustrate all three of these points.

1) If segments A-F represent the performance of six separate segments of the pipeline all grouped around the same desired mean processing time of 30 days, then current AFMC methodology of using only average process times would rate all six of these segments at the same performance level. However, when process variance is included along with desired mean times, it is easy to see that these six segments operate at different performance levels, with segment F performing at the ideal state (data grouped tightly about the mean).



(Source: Bohe, Keki, 1991)

Figure 3. Effect of Reducing Process Variation

2) If segments A-F represent the performance of the same segment of the pipeline, measured at different times, and all grouped around the same desired mean processing time of 30 days, it is easy to see that the process (moving from condition A-F) is becoming much more controlled and predictable. Conversely, if the process is moving from condition F-A, it is easy to see that the process is going out of control and requires management intervention before it goes it adversely affects on-time delivery.

3) Reducing sources of process variance is a logical first step in improving CWT and TDD, however, it will only take you so far. Once management sees that the ideal state is reached (condition F), it should understand that any further efforts to improve performance through variance reduction is futile, and only a re-design of the process will reap any more performance gains. Conversely, with the process in condition A, management should be aware getting the process in control through variance reduction may be more beneficial (and cheaper) than redesigning the process itself.

AFMC/LSO does not currently measure the variation in process performance of the various activity nodes. Without this knowledge, there simply is no ability to determine the performance of the various nodes and to determine the effects of compounding variation across the system. AFMC currently measures the output of the logistics distribution system and determines delays causing shipments to arrive late. If several late arrival shipments share the same root cause, AFMC may investigate the performance of a particular segment of the pipeline in more detail (provided there is enough time). However, AFMC does not currently have the time or the resources to systematically examine the many activity nodes in the pipeline to determine the cause of their process variance. As a result, critical process information is unavailable that would allow AFMC/LSO and process owners to determine the current state (mean and variation) of an activity node. This allows potentially deteriorating variation (at unexamined activity nodes) to go un-noticed until such time as they become severe enough to contribute to delayed shipments to some base of requisition.

As such, it cannot be implied that the elimination of last weeks root cause can be used as a basis for predicting next week's CWT and TDD performance. This leaves transportation personnel chasing their tails each week in an attempt to put out the most urgent fire they have discovered. AFMC is currently unable to conduct analysis at this level of fidelity, due to shortages in personnel, time and computer resources.

Research Question #4:

What improvements can be made to the existing measuring and reporting methodology used by AFMC?

Answers to this investigative question will be presented in the recommendations section of chapter V.

Summary

This chapter discussed the methodology employed to answer the research questions. It outlined the events that transpired in pursuit of the research, as well as the information gathering and data analysis process. In addition, the chapter presented the findings as they pertain to the detailed analyses process currently employed by AFMC, how the results of the analyses are used to identify and resolve pipeline constraints, and how the analyses affect the improvement of Customer Wait Time and Time Definite Delivery. The next chapter will answer research question number four and offer recommendations that if implemented could improve the analyses process and make the results more relevant to decision makers.

V. Conclusion

Introduction

Research for this thesis brought the researcher into contact with many highly competent logistics professionals, dedicated to improving the distribution segment of the logistics pipeline. The AFMC/LSO office was no exception. It was the initiative of AFMC/LSO that brought about the TRACKER database program, and the current pipeline performance analysis capability used by AFMC. Together, these two initiatives provide organizations from base to Air Force level the ability to quickly view the most current status of on-going and completed cargo shipments, determine the performance of the logistics pipeline, and to determine where constraints for particular shipments or channels lie. Developed as the current AFMC analyses procedure is, potential improvements to the weekly/monthly process could make result of the analyses more relevant to logistic decision makers. The following recommendations implemented individually or sequentially would add capability to the methodology currently employed by AFMC/LSO.

Recommendations

Recommendation #1. AFMC/LSO should limit its focus on the transportation segments of the pipeline while other functions within AFMC concentrate on segments under their control.

The AFMC/LSO analyses provide a valuable service to AFMC and Air Force managers. However, the task of tracking the movement of information and material through the entire logistics pipeline, and identifying delays encountered by shipments along the way regardless where the root cause of the delay resides (depot, supply, transportation, etc.) should not be the sole responsibility of the transportation section of AFMC. The transportation section should only be tracking the performance of activity nodes that come into play after the shipments have been released from depot. That would leave representatives at HQ AFMC from functional areas like depot, supply, etc. to track the performance of their respective activity nodes and determining the effect their respective functions have in contributing to the improvement of Customer Wait Time and Time Definite Delivery.

Many ad hoc analyses are conducted in support of inquiries from theater or base of requisition commanders or agencies. These analyses should be performed by personnel representing the theater-level functions, not AFMC transportation personnel. In-house, or on-line training for non-AFMC personnel should be conducted or elaborated on in an effort to educate personnel on systems usage and procedures.

The extra time gained through these changes would allow AFMC/LSO the conduct more in-depth analyses of the transportation segment and increase the possibility of finding root causes of delays in activity nodes under their control.

Recommendation #2. Develop a more pro-active analysis procedure.

Moving to a more proactive process could identify and address the root cause of shipment delays before they mature to the point of causing deliveries to arrive late at receipting bases. This proactive approach can be accomplished by 1) systematically examining the performance of all activity nodes in the distribution system, and 2) tracking the flow of shipments enroute, and comparing their progress against prescribed flow time standards.

The current procedure chases after root causes of delays that have already resulted in late delivery of shipments. Though improvements in delivery times for future shipments may be realized using this method, a more valuable long-term approach is to examine the on-going performance of existing activity nodes for changes in process variance. This would allow management to identify and address the deterioration of variance and minimize the root cause of delays before they have materialized in late delivery of shipments.

Tracking the flow of shipments enroute and comparing their progress against established flow times would allow AFMC analysts to detect variances in performance against established flow times of individual shipments. Problems in shipping could be detected as they occur and corrective action could potentially return the shipment to an on-time status. Increasing visibility of shipment performance at all management levels (in near real time), would allow personnel at the operational level more control in identifying and resolving problems, instead of the management level of AFMC.

Recommendation #3. Modify the analyses procedure to derive more relevant performance information and present the results in a more digestible format.

The current analyses methodology derives "average" performance for a given area of interest (a specific metric, country, base of requisition, etc.), resulting in the excessive averaging of performance data. Averaging performance data masks potential problem areas in the pipeline by combining activity nodes with substandard performance with activity nodes with above standard performance to arrive at an overall "average" determination of pipeline performance for the last time period under scrutiny.

Excessive averaging also makes it difficult to determine which nodes are operating consistently above standards. This makes it difficult for management to determine the reasons for this superior performance and to share that knowledge with similar nodes in the pipeline. As it stands, the results of the analyses leave little room for interpretation of results, little knowledge of expected results for next week's analyses, and provide decision makers with little opportunity to intervene at parts of the system that may be meeting standards but losing control of key processes.

A more thorough analysis should include average performance by node, but should also include acceptable and actual variances, standards, and trends lines over time. It should make more effective use of Statistical Process Controls (control charts) to determine where processes are beginning to deteriorate and where efforts ought to be placed to prevent process breakdowns.

Results of these types of analyses need to be presented in a more graphical way to upper management through the use of charts and graphs showing actual performance over time, instead of bar charts of a single moment in time as is currently being used. This would allow more accurate identification of process performance and a more thorough discussion of root causes (or exceptional performance) and potential actions in response to findings.

Recommendation #4. Automate the AFMC pipeline analyses process. Technology currently in use by AFMC/LSO has the analyst spending more time manipulating data than actually analyzing pipeline performance. Gathering all relevant performance data on individual activity nodes of the pipeline and comparing it to pre-defined performance parameters should be accomplished by machine not man. The computer should compare performance data of each activity node against acceptable standards (mean and variation) and flag the analyst when performance falls outside the standard. Only then should the analyst get involved and then only to determine the root cause of the substandard performance.

The analyst would be free to perform a more thorough analysis, allowing him to drill down deeper to identify root causes of delays, examine more activity nodes for similar problems, or identify activity nodes where the performance is deteriorating but still within standards. It would also go a long way to facilitating a pro-active approach to analyses, and increasing the potential to make a significant impact on CWT and TDD improvement.

Recommendation #5. Stand up an AFMC logistics pipeline analysis cell.

The primary function of this organization would be to systematically examine the performance of the various activity nodes of the distribution segment of the logistics pipeline with emphasis being placed on increasing the throughput of material (decreasing CWT) and improving on-time delivery (improving TDD). Staffed with individuals from the various logistics disciplines, this organization would be tasked to analyze performance shortfalls for all segments of the logistics pipeline, from order taking to order receipt. Specialist from each function would research performance of activity nodes falling under their expertise and control, and the results would be compiled to paint a composite picture of pipeline performance.

Improvement recommendations would be based on observed variances in process performance (processes in control or not) and would focus on reducing that variance until such time as the process is stabilizing. The focus would then shift to Continuous

Improvement in an effort to reduce overall processing time. A version of the analyses model used by the AFMC/LSO (including the previously mentioned recommendations) could be used as a basis from which to develop the AFMC-wide analyses process.

Future Research

During the course of this thesis, a number of potential research topics came to light. Some of these topics are related to the potential improvement of the analysis process itself, while other topics are related to the general topic of improving Customer Wait Times and Time Definite Delivery. The following potential research topics came to light concerning the AFMC/LSO analysis process itself:

Conduct an analysis of off-the-shelf software that would speed up the information processing and display function of the AFMC analysis. The Pipeline Performance Analysis System (PPAS) may perform these functions in the future, however, no information is currently available on capabilities, or projected dates for PPAS to be operational. Off-the-shelf technology more suited to this operation could fill the gap, saving valuable time and resources, and may translate into more thorough analyses, being conducted more frequently, and the results being available in more real time for users.

Develop a more proactive pipeline analyses methodology. Moving from reactive to more proactive analyses compresses the timeline from when problems develop to when they are identified by the system. Compressing the timeline to near real-time allows the minimization of the number of shipments passing through the activity, and the identification of processes that may be still within prescribed limits but are showing signs of going out of control.

Identify computerized system requirements to monitor pipeline performance and activate automatic alarms to flag the deteriorating performance of an activity node before the overall performance reaches the preset allowable limits or standards. Management action could then be focused on these processes, and the source(s) of the variance identified and addressed (minimized or eliminated) before the processes deteriorate to the point of affecting on-time delivery of shipments.

The following potential research topics came to light concerning the topic of improving Customer Wait Times and Time Definite Delivery:

Determine the effect of implementing an Air Force-wide cargo reservation system on improving Customer Wait Time and Time Definite Delivery. A reservation system (similar to the passenger reservation systems used by commercial airliners) would have visibility of all transportation options, dates/times of travel and costs involved, etc. This would allow depot, DLA and the customers to select the most effective and efficient movement based on need, cost and availability of transportation. Educated trade-off decisions could now be made, processing nodes could more effectively plan their work and equipment schedules, potential customs issues could be resolved ahead of time, shipments could be tracked against the established schedule, and pre-identified problems adjusted accordingly. In addition, AMC would know ahead of time the fill-rates of their aircraft before departure (pro-actively schedule aircraft), and ground transportation could be scheduled to meet arriving airflow.

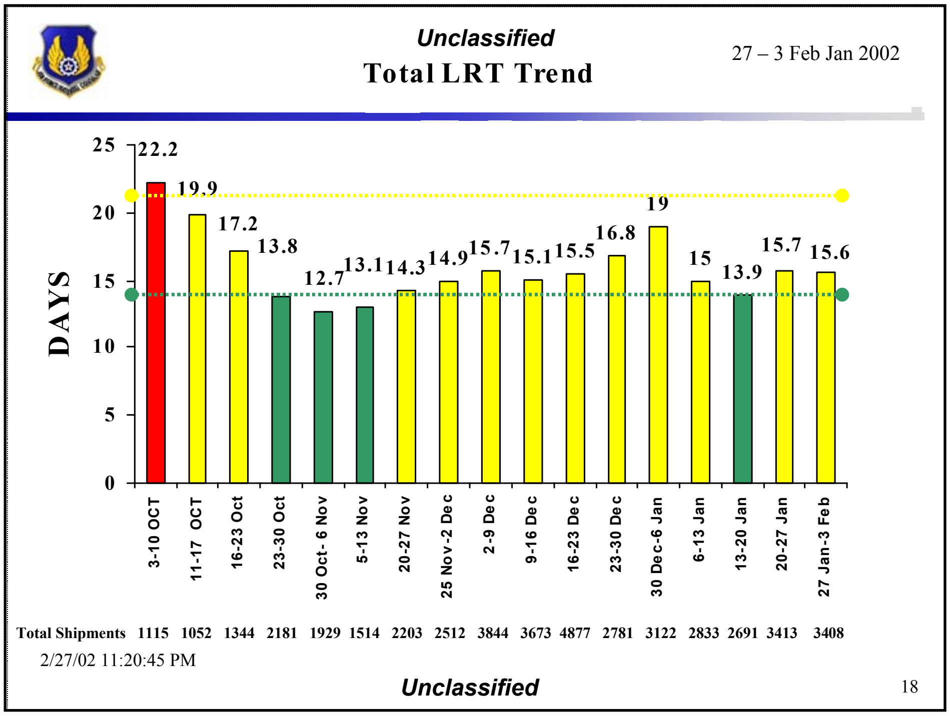
Identify the relationship between performance measures used to measure function performance and their effect on Customer Wait Time and Time Definite Delivery.

Current activity node performance measures may or may not be properly aligned to these global measures and may not provide the proper incentive towards their attainment.

Determine if Goldratt's "Throughput Dollar Days" measure can be used to unify activity nodes in working towards improving CWT and TDD. Activities/nodes in the logistics pipeline appear to be more focused on their individual "local" performance than the "global" performance of the system as a whole. While exceeding the UMMIPS time standards is encouraged, there is little incentive provided to actually do so. Measuring activity performance using a modified version of Goldratt's "Throughput Dollar Days" instead of the currently established measures may or may not provide that incentive.

Summary

The current methodology employed by AFMC/LSO is a significant improvement over past capabilities. This chapter presented several recommendations based on the findings of this thesis. The findings are the result of research conducted into the current methodology employed by AFMC, plus the analysis of the data gathered during the course of this thesis. Improvements to the analyses methodology can be gained by the incremental implementation of recommendations and through further research into the analysis process as it relates to the distribution segment of the logistics pipeline.



Appendix A. Theater-Wide Performance Analyses

Pipeline Analysis: Total LRT 15.6 days, 3408 shipments

ICP Time : 3.8 days, 3035 shipments
- **Backorder Time:** 7.8 days, 517 shipments
- **Backorder Status Delay Time:** 3.2 days, 579 shipments
- **Immediate Issue Time:** 2.3 days, 2515 shipments

Depot Processing Time: 1.3 days, 2596 shipments

Total Ship Time (Shipment Available to Supply Receipt Date): 10.0 days, 2971 shipments
- **Conus In-Transit Time:** 1.9 days, 674 shipments
- **AMC Possession Time:** 7.9 days, 731 shipments
- **In-Transit, Within-Theater to Supply Receipt Time:** 1.6 days, 693 shipments
- **Commercial Carrier Door to Door Transit Time:** 5.4 days, 1279 shipments
- **Supply Receipt Time:** 1.9 days, 1374 shipments

LRT decreased from 15.7 to 15.6 days. Improvements in Total Ship Time from 11.5 to 10.0 days this week were offset by increases in ICP Time from 3.0 to 3.8 days and Depot Processing Time from 1.2 to 1.3 days.

Appendix B. Performance Breakdown by Country

Unclassified

Logistics Response Time Other Source of Supply
PROJ CD 9GF, 9BU, 9BY

LOCATION	LRT	STATUS	% IN WARTIME STD
BAHRAIN	13.7	GREEN	76.5
DIEGO GARCIA	11.3	GREEN	87.6
GERMANY	4.3	GREEN	100
KUWAIT	11	GREEN	81
OMAN	24.3	RED	38.3
PAKISTAN	14.9	YELLOW	55.1
QATAR	16.2	YELLOW	76.5
SAUDI ARABIA	8.7	GREEN	90.6
TURKEY	16.4	YELLOW	64.6
UNITED ARAB EMIRATES	17	YELLOW	66.8
UNITED KINGDOM	7.5	GREEN	87
UZBEKISTAN	12.2	GREEN	88.6

◆ RED: Exceeds peacetime standard of 21 days

◆ YELLOW: Between 14 and 21 days

◆ GREEN: Less than or equal to 14 days

2/27/02 11:20:45 PM

Unclassified

27- 3 Feb 02 16

OMAN ANALYSIS: 822 Shipments

# Shipments	Day	#Shipments	Days
35	50+	315	0-14
368	21-50		
104	15-20		

Pipeline Analysis: Total LRT 24.3 days, 822 shipments
ICP Time : 5.1 days, 750 shipments
Backorder Time: 15.0 days, 45 shipments
Backorder Status Delay Time: 4.1 days, 54 shipments
Immediate Issue Time: 4.2 days, 705 shipments
Depot Processing Time: 2.0 days, 637 shipments

Total Ship Time (Shipment Available to Supply Receipt Date): 16.7 days, 732 shipments
Conus In-Transit Time: 1.9 days, 191 shipments
AMC Possession Time: 7.6 days, 186 shipments
In-Transit, Within-Theater to Supply Receipt Time: 2.1 days, 184 shipments
Commercial Carrier Door to Door Transit Time: 13.3 days, 242 shipments
Supply Receipt Time: 6.3 days, 239 shipments

LRT not meeting standard was due to ICP Time of 5.1 days, standard is 3 days, Depot Processing Time of 2.0 days, standard is 1.0 day, and Total Ship Time of 16.7 days, standard is 10 days.

Main driver for Total Ship Time was Commercial Door to Door of 13.3 days and Supply Receipt Time of 6.3 days.
PAKISTAN ANALYSIS: 69 Shipments

# Shipments	Day
38	0-14
25	15-20
6	21-50
0	50+

QATAR ANALYSIS: 204 Shipments

# Shipments	Day
156	0-14
8	15-20
34	21-50
6	50+

TURKEY ANALYSIS: 99 Shipments

# Shipments	Day
64	0-14
7	15-20
22	21-50
6	50+

UNITED ARAB EMIRATES ANALYSIS: 238 Shipments

# Shipments	Day
159	0-14
11	15-20
48	21-50
20	50+

Bibliography

1. Dumond, John, and others. *Velocity Management, A Business Paradigm that has transformed U.S. Army Logistics.* RAND, Arroyo Center, 2001

2. Eden, Rick. *How is the DoD Logistics Transformation Going?* RAND report, DRU-2505-C. March 2001.

3. Muno, Karl, Pezoulas, Patrick. *Identification and Reduction of Bottlenecks Concerning MICAP Re-Supply of F-16 Weapons System Avionics Line Replaceable Units.* AFIT/GTM/LAL/97S-6. School of Logistics and Acquisitions Management, Air Force Institute of technology, Wright-Patterson AFB OH, September 1997

4. Girardini, Kenneth and others. *Improving DoD Logistics, Perspectives from RAND Research.* RAND Report, National Defense Research Institute. 1995.

5. General Accounting Office. *Major Management Challenges and Program Risks – Department of Defense*. GAO-01-244. Washington: Government Printing Office, 2001.

6. Department of the Air Force. Air Force Weapons System Reparable Asset Management. AFPD 20-3. Washington: HQ USAF, 1 June 1998

7. DePasquale, Patricia. Air Force Material Command, MSG/SLW. Wright-Patterson AFB OH. Personal Interview. 19 Dec 2001.

8. Department of the Air Force. *Air Force Vision 2020.* Washington: HQ USAF, 1 Sept 1997.

9. Christopher, Martin. *Creating the Agile Supply Chain.* ACET Vol 1, 4/1/99. n. pag. http://www.ascet.com/login.asp?s_id=183&d_ID=200&mode=print. 26 November 2001, 1705 hrs

10. Institute of Logistics and Transportation. *What is Logistics in the Supply Chain?* n. pag. www.iolt.org.uk/whoweare/what.htm. 26 November 2001, 1535 hrs.

11. The Center For Research In Electronic Commerce. *What is Supply Chain Management?* n. pag. http://cism.bus.utexas.edu/resources/ecfaq/ecfaqc2.html. 26 November 2001. 1600 hrs.

12. SimchiLevi, David and others. *Designing and Managing the Supply Chain.* Boston: Irwin McGraw-Hill, 2000.

13. Quinn, Frank. *The Payoff Potential in Supply Chain Management*. ASCET, Vol 1, 4/1/1999. n. pag. http://www.ascet.com/login.asp?s_id=&d_ID=233&mode=print. 26 November 2001, 1710 hrs.

14. Cunningham, William. Class handout, LOGM 620, Activity Based Costing. School of Engineering and Management, Air Force Institute of Technology, Wright-Patterson AFB OH, June 2000.

15. Quinn, Frank. *Collaboration: More Than Just Technology.* ASCET, Vol 3, 5/1.01. n. pag. http://www.ascet.com/documents.asp?d_ID=493#. 6 February 2002, 1214 hrs.

16. Swartz, Stephan. Class Handout. LOGM 627, Supply Chain Management. School of Engineering and Management, Air Force Institute of Technology, Wright-Patterson AFB OH, February 2002.

17. Keebler, James S. and others. *Keeping Score: Measuring The Business Value of Logistics in the Supply Chain.* Council of Logistics Management, University of Tennessee, 1999.

18. Lapide, Larry. *What about Measuring Supply Chain Performance?* ACET Vol 2, 4/1/00. n. pag. http://www.ascet.com/documents.asp?d_ID=283#. 6 February 2002, 1545 hrs.

19. Arzberger, Christopher. Air Force Material Command Transportation Analyst, Wright-Patterson AFB OH. Personal Interview, May 2001 – February 2002.

20. Government Accounting Standards Board. *Concepts Statement No. 2, Service Efforts and Accomplishments Reporting*. n. pg. http://accounting.rutgers.edu/raw/seagov/pmg/perfmeasures/character.html. 30 January 2002.

21. Robson, George D. *Continuous Process Improvement*: *Simplifying Work Flow Systems*. New York: Free Press, 1991.

22. Dobyns, Lloyd, Crawford-Mason, Claire. *Thinking about Quality: Progress, Wisdom, and the Deming Philosophy.* New York: Random House, 1994.

23. Wheeler, Donald and Chambers, David. *Understanding Statistical Process Control.* Tennessee: SPC Press Inc. 1986.

24. Ernst and Young Quality Improvement Consulting Group. *Total Quality: An Executives Guide for the Nineties.* Homewood: Business One Irwin, 1990.

25. Swartz, Stephan. Class handout. LOGM 637, Theory of Constraints. School of Engineering and Management, Air Force Institute of Technology, Wright-Patterson AFB OH, October 2001.

26. Goldratt, Eliyahu M. *Production the TOC Way.* Avraham Y. Goldratt Institute, 1996.

27. Goldratt, Eliyahu M. *The Haystack Syndrome.* New York: North River Press Inc., 1990.

28. Department of the Air Force. *USAF Supply Manual.* AFM 23-110. Washington: HQ USAF, 1 Jan 2002.

29. Arzberger, Christopher. *Logistics Response Times, AFMC Depot Managed Items.* Unpublished Briefing. 12 October 2001.

30. Arzberger, Christopher. *Commercial Carrier Logistics Pipeline Metrics.* Unpublished Briefing. 14 March 2001.

31. Arzberger, Christopher. *AMC Transportation Pipeline Metrics.* Unpublished Briefing. 13 March 2001.

32. Department of the Air Force. *Chief of Staff Logistics Review.* Briefing to Lt Gen Zettler, AF/IL, HQ USAF, 19 Jan 2001.

33. Department of the Air Force. *Guide to Supply Chain Management,* HQ AFMC/LGI, Wright-Patterson AFB OH, 1 Aug 1999.

34. Brown, Daniel G. USTRANSCOM DCINC. "*Comments to NDTA Executives*". Address to the National Defense Transportation Organization, Alexandria VA. 14 Sept 2000.

35. DePasquale, Patricia. Unpublished briefing *Customer Wait Time Demonstration*. Air Force Material Command, MSG/SLW. Wright-Patterson AFB OH. 19 Dec 2001.

36. DePasquale, Patricia. Unpublished briefing *Pipeline Performance Analysis System*. Air Force Material Command, MSG/SLW. Wright-Patterson AFB OH. 19 Dec 2001.

37. Creswell, John W. *Research Design: Qualitative and Quantitative Approaches.* California: Sage Publications, 1994.

38. Leedy, Paul D., Ormond, Jeanne E. *Practical Research.* New Jersey: Prentice Hall, 2001.

39. Yin, R. K. *Case Study Research: Design and Methods.* California: Sage Publications, 1984.

40. Dooley, David. *Social Research Methods.* New Jersey: Prentice Hall. 2001.

41. Rhodes, John. Programmer. HQ AFMC/MSG, Wright-Patterson AFB OH. Personal interview. 8 October 2001.

42. Department of the Air Force. *TRACKER User Manual.* HQ AFMC/LG, Nov 2000.

43. English, Howard. Director, Logistics Support Office, Wright-Patterson AFB OH. Personal Interview. 15 Feb 2002.

44. Orsini, Jose. HQ AFMC/LG/LSO-LOT, Wright-Patterson AFB OH. Personal Interview. May 2001 – February 2002.

45. Bhote, Keki R. *World Class Quality: Using Design of Experiments to Make It Happen.* New York: American Management Association. 1991.

46. Whalers, James L. *A Study of Performance Measures in a Synchronous Intermittent Manufacturing Environment.* Michigan: UMI Dissertation Services, 1993.

Vita

Captain Heinz H. Huester graduated from Shawnee Mission West High School in Overland Park, Kansas. Two months later, he entered basic training at Lackland AFB, Texas. Graduating technical school as an Aircraft Fuel Systems apprentice, he was subsequently stationed at Dyess AFB, Texas, Rhein-Main AB, Germany, and Laughlin AFB, Texas. Having worked eight different airframes by this time, he was chosen to instruct his career field at Chanute AFB, Illinois. He left the Air Force November 1988 to study Industrial Design at the University of Illinois, Champaign-Urbana. He reentered the Air Force through the Reserve Officer Training Corps as an aircraft maintenance officer and completed assignments at McChord AFB, Washington and Barksdale AFB, Louisiana before entering the Graduate School of Engineering and Management, at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB, Ohio. Upon graduation from AFIT, he will be assigned to the Air Force Operational Testing and Evaluation Center, Edwards AFB, California.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
20-03-2002	Master's Thesis	June 2001 - Mar 2002

4. TITLE AND SUBTITLE
IMPROVING PERFORMANCE ANALYSIS OF THE DISTRIBUTION SEGMENT OF THE AIR FORCE LOGISTICS PIPELINE

5a. CONTRACT NU MBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Huester, Heinz H., Capt, 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 P Street, Building 640, WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/ENS/02-05

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Mr. Jose Orsini
AFMC/LSO e-mail: Jose.Orsini@wpafb.af.mil
Wright-Patterson AFB OH (937) 257-4351

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
Agile Combat Support is focused on providing fast, flexible, responsive, and reliable support as the foundation of all Air Force operations. Combined with the current Air Force focus on ensuring Time Definite Delivery (TDD) and reducing Customer Wait Time (CWT), this new mind-set will place ever-increasing emphasis on supply chain performance as a determining factor in overall campaign effectiveness of future conflicts.

An improved methodology for the systematic performance analysis of the distribution segment of the logistics pipeline may aid AFMC transportation personnel (AFMC/LSO) in the quick identification of system bottlenecks, identification of root causes of performance shortfalls, and the recommendation of corrective actions, resulting in improved material flow times, reduced Customer Wait Times, more accurate Time Definite Delivery.

Recommendations offered by this thesis are designed to provide the basis for developing the current methodology and to identify future research areas. The recommendations offered include the development of the current methodology across all AFMC logistics functional areas, the development of a more pro-active analysis procedure to identify problems before they affect TDD and CWT, modification of the current analyses procedure to derive more relevant performance information and present the results in a more digestible format, the automation of the pipeline analyses process, and the initiation of an AFMC-wide logistics pipeline analysis cell staffed by the various functional specialists.

15. SUBJECT TERMS
Performance Measurement, performance analyses

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON** / **19b. TELEPHONE NUMBER** *(Include area code)*
U	U	U	UU	90	Dr. William Cunningham (937) 255-6565, ext 4283 william.cunningham@afit.edu

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