SUPPLY CHAIN SYNCHRONIZATION:
IMPROVING DISTRIBUTION VELOCITY TO
THE THEATRE

GRADUATE RESEARCH PAPER

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Abstract

An Air Mobility Command (AMC) and Defense Logistics Agency (DLA) supply chain improvement initiative was recently undertaken with the goal of increasing cargo velocity from the United States to Iraq. An analysis of historical pallet movement was accomplished within the context of the initiative's methodology to determine if *pallet group size* was a significant factor in determining *total time enroute* for pallets bound from the Defense Logistics Agency warehouse in Susquehanna, Pennsylvania to Aerial Ports of Delivery (APODs) in Iraq. Using archived data from command, control, and planning systems, 1257 pallets were tracked from Dover Air Force Base (AFB), Delaware to various APODs in Iraq. Average port hold times for transship locations and total time enroute were calculated. Multiple regression models were tested to determine if a significant relationship existed between pallet group size and total time enroute.

Analysis suggested that no significant relationship exists between pallet group size and total time enroute. For the population of pallets analyzed, the most significant relationship observed was between total time enroute and port hold time at Incirlik Air Base (AB), Turkey. A recommendation was made to continue the initiative and expand it to include information sharing with Incirlik AB in order to increase the probability of success.

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To Jenni, Michael and Cal

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Christopher M. Lanier

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SUPPLY CHAIN SYNCHRONIZATION: IMPROVING DISTRIBUTION VELOCITY TO THE THEATRE

I. Introduction

> "When you do battle, even if you are winning, if you continue for a long time it will dull your forces and blunt your edge…If you keep your armies out in the field for a long time, your supplies will be insufficient. Transportation of provisions itself consumes 20 times the amount transported."
>
> -- *Sun Tzu*

Background, Motivation, & Problem Statement

Since the beginning of the conflict in Afghanistan in 2001, the Department of Defense's (DoD) use of commercial cargo aircraft has skyrocketed. From 1997 to 2001 DoD contracts awarded to carriers participating in the Civil Reserve Air Fleet averaged $500 million annually (Congressional Budget Office, 2007:4). The period 2002-2006 saw that total jump to an average of $2.1 billion a year; a 400% increase (Congressional Budget Office, 2007:4). But with the United States in the midst of a global recession, future defense spending is likely to shrink significantly. Also on the horizon is a drawdown of troops in Iraq as the conflict draws to a close. A Congressional Budget Office report on the future utilization of the Civil Reserve Air Fleet alluded to this projected slowdown in a 2007 report, stating that the fixed-buy portion of contracted movements would likely drop to levels considerably lower than those existing prior to the conflicts in the Middle East (Congressional Budget Office, 2007:1). Considering that significant portions of sustainment cargo flow from the United States to the theatre of operations via commercial contract carriers, the impact of this drawdown could be significant. As the availability of commercial contract lift shrinks, every effort must be made to ensure that each contracted sortie is fully utilized. Inefficiency in collaborative planning and information sharing across the supply chain previously masked by the quantity of lift available will quickly become apparent as dollars for contract airlift dwindle.

Commercial contract carriers operating widebody aircraft out of east coast aerial ports of embarkation (APOEs) play a vital role in the sustainment of our overseas forces. Each day, large quantities of goods are trucked from Defense Distribution Center (DDC) warehouses along the eastern seaboard to McGuire and Dover Air Force Bases. At the bases, the goods are readied for air shipment and placed aboard contracted aircraft for transport to the theatre of operations. The commercial cargo aircraft stage at relatively low threat airfields near the theatre where cargo can be transloaded onto military aircraft. Military aircraft equipped with proper defensive weapons then complete the air transport leg by flying to aeriel ports of debarkation (APODs) located closer to fielded troops in hostile areas.

The purpose of this research paper is to determine if Supply Chain Management (SCM) principles can be used to improve the velocity of cargo movement to the Iraq theatre of operations. Specifically, this researcher will seek to determine if synchronization, planning, and information sharing across the supply chain can facilitate improvements to the velocity for cargo flowing from Susquehanna, Pennsylvania through Dover, Delaware, to the Operation Iraqi Freedom theatre of operations. A new initiative recently undertaken by Air Mobility Command and the Defense Logistics Agency is attempting to synchronize the picking, packing, and shipping of cargo at the warehouse in Susquehanna, Pennsylvania with the flow of scheduled commercial contract airlift through Dover AFB, Delaware. The goal of the initiative is to reduce the amount of time cargo sits idle at the APOE awaiting airlift. Another goal is to increase the total gross weight of cargo on each aircraft. The two goals are complementary. Increased synchronization should result in higher aircraft utilization (more weight) as more cargo arrives at the aerial port ready for immediate movement. Under the current contract, the DoD pays a flat rate per aircraft regardless of actual cargo weight. Every aircraft that departs with less than a full load represents lost lift for which the government has already paid. This research project will investigate data from a two month period in 2008 to determine if the new initiative is likely to yield positive results.

II. Literature Review

In order to understand how SCM principles have the potential to increase the efficiency and speed of cargo traveling to Iraq, it is first necessary to define the term. From an industry perspective, a supply chain is defined as "the network of manufacturers, wholesalers, distributors, and retailers who turn raw materials into finished goods and services and deliver them to consumers (BNET, 2009)." Supply chains offer a way to conceptualize the relationships between companies that share in the creation of a product for the consumer. By thinking of production as a customer centered supply chain, the focus moves from serving intermediate customers (other companies) to serving the ultimate consumer. The goal is to add value to the product or service by optimizing the production process across the entire enterprise. SCM is focused on leading, improving, and controlling the supply chain.

There has been much debate about what the term SCM means over the years. Evolution of the SCM concept may be partly responsible for the confusion. Early definitions were narrowly focused on the inter-departmental relationships within a single company (Cooper, Lambert, and Pagh, 1997:1). SCM defined a new paradigm by which a company focused on internal processes to transition from a stove-piped, compartmentalized mindset to a team oriented posture that focused on increasing customer satisfaction. Early on "the challenge was simply getting production, sales, finance, marketing, and distribution operating in concert to focus on the movement and availability of finished goods (Laseter and Oliver, 2003)." In the 1980's the vision of cross-functional teams was still a foreign concept (Laseter and Oliver, 2003). Research by Hammer and Champy (1993) served as the catalyst for industry focus on cross-functional teams that are a hallmark of SCM today. Put simply, their work posited that long standing rivalries and incompatible business rules between departments often subjugates the efficiency and well-being of the company and customer to the success of the department (Hammer and Champy, 1993:10-11). Each department is driven to make their *department* the best, not necessarily the *company* or the *product*.

Over the last two and a half decades, the definition of SCM has evolved from a focus on breaking down departmental barriers that inhibit efficiency and productivity *within a company*, to removing barriers that exist between companies that are part of the same supply chain. Cooper and Ellram define SCM as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user (1993:13)." The Global Supply Chain Forum (GSCF) state that SCM is "the integration of key business processes from end-user through original suppliers that provides products, services, and information that add value for customers and other stakeholders (Lambert, 2008:2)." Implicit in this recent definition is the notion that companies no longer compete individually, but as supply chains (Lambert, 2008:2). More recent definitions have expanded the scope to include "any combination of processes, functions, activities, relationships, and pathways along which products, services, information, and financial transactions move in and between enterprises (Gattorna, 2006:43)." This comprehensive collection of all processes and participants in the uninterrupted flow of information and goods from start to finish provides the most far ranging of the definitions of the supply chain.

SCM Principles

As with the definition of SCM, the principles that underpin the philosophy have been a source of debate. Cooper, Lambert, and Pagh's work (1997) summarized key elements of SCM from a multiple sources (Appendix A). From this research they distilled the ten common SCM principles listed in table 1.

Table 1. Common SCM Components (Cooper, Lambert and Pagh, 1997:8)

Planning and Control	Work Structure
Organizational Structure	Product Flow Facility Structure
Information Flow Facility Structure	Product Structure
Management Methods	Power and Leadership Structure
Risk and Reward Structure	Culture and Attitude

This researcher has selected three common SCM principles for the purposes of this research project: planning and control, information flow facility structure, and risk and reward structure. The three were selected on the basis of their commonality with similar DoD concepts.

Planning and controlling "are the keys to moving an organization or supply chain in a desired direction (Cooper, Lambert and Pagh, 1997:7)." They are the tools by which disparate organizations put shared goals into action. Without joint planning and controlling, different organizations in the supply chain, and even different functional departments within a single company may be pulling in different directions based on different assumptions and forecasts (Anderson, Britt, and Favre, 2007). *Synchronization* is a prominent component of planning and controlling. It refers to the process by which essential information is shared between members of a supply chain in order to manage demands on member capacity. The goal is for members to synchronize their work flow and processes in order to reduce waste and maximize productivity. A well synchronized supply chain attempts to couple *demand* with *supply chain capacity*. The key element in synchronization is often information flow.

It is no surprise then, that the literature is perhaps most agreed upon the importance of *information flow* across the supply chain. The efficiency of the entire supply chain is often influenced by the frequency and kind of information passed by members (Cooper, Lambert and Pagh, 1997:8). It is also likely to be the first component integrated across the supply chain (Cooper, Lambert and Pagh, 1997:8). A lack of coordinated information and information systems between members in the supply chain is often cited as a common pitfall for executing SCM (Lee and Billington, 1992:67). It is not necessary for all members of the supply chain to share all their information, just those parts required for the chain to operate at peak efficiency. According to Cooper and Ellram (1993:16), "it is not necessary that all channel members have access to the same information, only that which is needed for them to better manage their supply chain linkages." Managers need to "develop a supply chain-wide technology strategy that supports multiple levels of decision making and gives a clear view of the flow of products, services, and information (Anderson, 2007)." It is important to note that the flow of information is essential. A new enterprise information system that is improperly fielded or that does not meet the information requirements of the supply chain will fail to yield the desired efficiency. To that effect, Hammer and Champy discuss the role of information technology (1993:87) as that of an *essential enabler*. But they caution against carelessly spending money on informational systems that do not contribute to a reengineered process (Hammer and Champy, 1993:87).

Risk and reward structure is the final principle chosen for examination. Cooper states that “the anticipation of sharing of risks and rewards across the chain affects long-term commitment of channel members (1997:8).” Work in the Harvard Business Review by Narayanan and Raman (2004) supports the need to pay close attention to the alignment of incentives in the supply chain. According to their research, “every firm behaves in ways that maximize its own interests, but companies assume, wrongly, that when they do so, they also maximize the supply chain’s interests (Narayanan and Raman, 2004: 96)” Interestingly enough, Narayanan and Raman’s study on the role of incentives in SCM points back to the previous principle of information sharing (2004:96-97). They offer two primary reasons for misaligned incentives. First, supply chain members are hesitant to align their incentives when they cannot observe the actions of other chain members (Narayanan and Raman, 2004:96). Secondly, “it’s difficult to align interests when one company has information or knowledge that others in the supply chain don’t (Narayanan and Raman, 2004:96).”

SCM in the Department of Defense

When considering SCM in the DoD context, the *DoD Supply Chain Management Implementation Guide* and *DoD 4140.1-R DoD Supply Chain Material Management Regulation* serve as foundational documents. The *DoD SCM Implementation Guide* broadly defines the supply chain to include all government and private-sector processes that play a role in delivering resources in support of the United States’ national defense interests (Logistics Management Institute, 2001:5). *DoD Regulation 4140.1* expands upon the definition in the implementation guide to paint a fuller picture of exactly what organizations are members of the supply chain. A partial list of the organizations includes: weapon system support contractors, retail supply activities, distribution depots, transportation networks including contracted carriers, Military Service and Defense Logistics Agency (DLA) integrated material managers (IMMs), and weapon system program offices (Chairman, Joint Chiefs of Staff, 2003:16-17). With the DoD supply chain defined, the *DoD SCM Implementation Guide* defines SCM as "an integrated process that begins with planning the acquisition of customer-driven requirements for material and services and ends with the delivery of material to the operational customer…(2001:14)." The guide also explicitly states that information flow both up and down the chain regarding the goods and services in-process is part of SCM.

Before moving forward, an important differentiation must be made between SCM in the DoD and private industry. In the DoD, the efficiency of the supply chain is subjugated to effectiveness. That is, marginal increases in efficiency will only be acceptable to the extent that effectiveness is not compromised. To illustrate the point, consider the case of blood delivery to a combat hospital. Customer requirements might dictate that a small quantity be flown in an otherwise empty aircraft. This is clearly not the most cost efficient way to move cargo, but that calculation is secondary to life-saving nature of the shipment. The same could be said for food or ammunition. This is an extreme example, but it illustrates the primacy of *effectiveness* over *efficiency* in the DoD supply chain.

With this notion of SCM, the DoD went about selecting principles with which to put the concept into practice. The department sets about communicating its long-term vision and goals through forward looking documents updated every few years. *Joint Vision 2010: Focused Logistics*, *Joint Vision 2020*, and *DoD Logistics Roadmap* are a few of those documents. Although primarily conceptual in nature, each of them includes principles that echo industry SCM components as identified by Cooper, Lambert, and Pagh (1997).

Joint Vision 2010: Focused Logistics outlines the logistics strategies and concepts required to support the military strategy detailed in *Joint Vision 2020*, the plan for DoD force posturing and future war prosecution. Focused logistics is one of the featured components of the DoD's new vision. *Joint Vision 2010: Focused Logistics* defines focused logistics as "the fusion of logistics information and transportation technologies for rapid crisis response; deployment and sustainment, the ability to track and ship units, equipment, and supplies even while in route, and the delivery of tailored logistics packages and sustainment directly to the warfighter (Joint Chiefs of Staff, 1996:i)." Service components will work to gain the big picture and overcome functional and/or service stovepipes (Joint Chiefs of Staff, 1996:i). Both recommendations mirror industry SCM concepts discussed earlier: information sharing and a focus on end-to-end supply chain performance. *Joint Vision 2010: Focused Logistics* also discusses the need for synchronization of logistics support with the move towards a more lean and agile fighting concept (Joint Chiefs of Staff, 1996:1).

Joint Vision 2020 further defined the role of focused logistics in the future fight. Focused logistics will "effectively link all logistics functions and units through advanced information systems that integrate real-time total asset visibility with a common relevant operational picture (Joint Chiefs of Staff, 2000:24). The document describes a future uninterrupted connection to the private sector where shared expertise and benchmark business practices will result in "dramatically improved end-to-end management of the entire logistics system (Joint Chiefs of Staff, 2000:15)." Joint Vision 2020 essentially describes a highly developed, well-managed supply chain dependent upon collaborative planning at the joint, multi-national and interagency level as a precondition for success (Joint Chiefs of Staff, 2000:15).

The *DoD Logistics Roadmap* offers another vision of SCM for the DoD. Published in 2008, the *DoD Logistics Roadmap* lists three goals for the DoD's logistics force: unity of effort, visibility, and rapid and precise response (Joint Chiefs of Staff, 2008:2-1). Table 2 summarizes the definitions of these terms and some SCM related objectives set forth in the document that support the attainment of each goal. The first three columns from the table are from the *DoD Logistics Roadmap* (Joint Chiefs of Staff, 2008:2-1-2-5). The SCM column was added by the researcher and assigns selected SCM principles as identified by Cooper, Lambert and Pagh (1997) to each of the three DoD Logistics Roadmap goal areas in order to relate the two.

Table 2. Logistics Goals, Definitions, Objectives, and related SCM Principles

	Definition	Objectives	SCM Principles
Unity of Effort	Synchronization and integration of logistic capabilities. Implies operations/logistics collaboration from early planning through execution. Increased alignment along the supply chain.	1.3 – Use commercial transportation resources to the maximum extent practicable, integrated with organic resources 1.4 – Adopt enterprise wide-metrics that promote common goals and interoperability	1. Risk and Reward Structure 2. Planning and Control 3. Information Flow Facility Structure
Visibility	Having assured access to logistic processes, resources, and requirements in order to gain the knowledge necessary to make effective decisions.	2.1 – Visibility into customer material requirements and available resources to meet those needs 2.3 – Visibility of in-transit, in-storage, and in-process unites and material for optimized movement planning and execution 2.4 – Implement information technology strategies for improved visibility and interoperability 2.5 – Enable a single authoritative data set for informed logistics decision making	1. Information Flow Facility Structure 2. Planning and Control
Rapid and Precise Response	Ability of the core logistic capabilities, military and commercial, to meet the constantly changing needs of the joint force.	3.8 – Establish a seamless process between deployment and sustainment phases 3.10 – Optimize transportation network	1. Planning and Control

Implementation Challenges in the DoD

The lofty expectations expressed in DoD vision documents are vastly different from the rocky history the department has had with implementation to this point. In a July 2007 report on implementation of SCM in the DoD, the Government Accounting Office (GAO) concluded that despite an average investment of over $150 billion dollars a year, few tangible results are evident (GAO, 2007:1). Moreover, from 2001 to 2006 over 400 recommendations "that focused specifically on improving certain aspects of DoD's supply chain management were made by audit organizations (GAO, 2007:1)." In fact, DoD SCM implementation has been on the GAO's list of high-risk federal government programs since 1990 (GAO, 2007:1). The DoD has acknowledged the shortcomings with its SCM implementation, concurring with 411 of 486 SCM recommendations made between October 2001 and September 2006 (GAO 2007:17). Interestingly though, one of the recommendations the DoD did not concur with was the suggestion to “clarify the scope of responsibilities, accountability, and authority between U.S. Transportation Command’s role as DoD’s Distribution Owner and other DoD components (GAO, 2007: 18).” Although presented evidence to the contrary, the DoD stated that these roles were already clear.

The GAO was not the only organization to understand the importance of defining roles and responsibilities across the enterprise. In a 2006 report on DoD transformation, the Defense Science Board recommended the creation of a Joint Logistics Command responsible for end-to-end supply chain management of the distribution function (DSB, 2006:30). The Defense Science board’s recommendation was based in part on its belief that under the current system, each transport segment is optimized (e.g., from depot to APOE, APOE to APOD, APOD to final consignee, etc.) with a resulting sub-optimization of the supply chain as a whole (DSB, 2006:30). Their report also highlights the unimaginable complexity of sharing information between 600 different information systems (DSB, 2006:30).

Problems with the distribution supply chain were also felt by customers in the field. A RAND Corporation report cites numerous instances of breakdown in the distribution supply chain and offers recommendations for improvement (RAND, 2005: XIV). The “lack of DLA understanding of Army distribution structures at the theatre, division, and support battalion levels led to a misalignment between how shipments were consolidated on pallets in CONUS for air transport and theatre distribution capabilities, leading to further delays in theatre, as pallets for air cargo were generally mixed across brigades (RAND, 2005:XIV).” Other major problems cited by RAND include: lack of a joint, DoD-wide vision of how the supply chain should operate, organizational policies and incentives not aligned with a common vision, and limited investment in information systems (RAND, 2005:XV). To address these problems with the supply chain the RAND report recommended that U.S. Transportation Command, as the Distribution Process Owner "develop and promulgate a supply chain vision articulating the complementary roles of production, inventory, and distribution, which includes transportation, movement control, transshipment operations, and shipment preparation (RAND, 2005:XV)." Additionally, each joint logistics organization should align its processes with this new supply chain vision (RAND, 2005:XV).

In order to address these deficiencies in SCM implementation, the DoD outlined its way forward in the *2008 Annual Report to the Congressional Defense Committees on the Status of the Department of Defense's Business Transformation Efforts*. In Chapter 8: U.S. Transportation Command, the DoD outlines major SCM goals for the distribution enterprise. Major elements include: "End-to-End (E2E) Total Asset Visibility and In-transit Visibility (ITV); improving decision cycle time by providing Information Technology (IT) support to turn real-time distribution data into actionable information; promoting DoD-wide financial solutions; and optimizing E2E distribution through improved and standardized resources, processes, and systems (Joint Chiefs of Staff, 2008: 181)."

Recent Academic Research

Efforts to find recent academic research into ongoing DoD SCM initiatives yielded two studies. There was a significant amount of additional research available if the breadth of the search was expanded to include SCM principles as applied to weapons systems procurement other acquisitions related activities. But in order to limit the scope of the project, this researcher limited his investigation to that research relating to SCM and distribution enterprise.

In research conducted by Stone, the time cargo spends awaiting transportation (know as *port hold time*) was explored (2008:Abstract). Stone states that the loading, unloading, and air transport segments of the distribution process have been sufficiently streamlined. He contends that most of the remaining inefficiency in the distribution enterprise revolves around the time cargo spends waiting in the port (Stone, 2008: Abstract). Stone attempted to determine if technological breakthroughs in RFID technology could increase granularity of port hold time metrics (Stone, 2008:Abstract). This information could then be used to identify and troubleshoot problem areas in the supply chain.

In research also related to a ground segment of the distribution enterprise, Peterson (2007) examined modal selection and cross docking. His research sought to improve upon work accomplished as part of a Strategic Distribution initiative. During a limited test program the DoD implemented commercial business practices of modal selection and cross docking cargo at distribution nodes with tremendous success on a small segment of the distribution enterprise (Petersen, 2007:3-4). In short, the Strategic Distribution program used real-time information on cargo in transit to minimize warehousing and select the most expeditious mode of transport for follow-on segments. Peterson's research supported the conclusion that with minor improvements and additions, this was a viable model for a theatre distribution environment (Peterson, 2007: 44).

III. Methodology

"Presently, the DoD distribution environment consists of unsynchronized segment distribution nodes, with rescheduling often required at each change of transportation node. DoD employs a myriad of discrete supply chains, but they are not harmonized at the enterprise level. This distribution environment places a heavy materiel-tracking burden on the customer, who usually lacks compete information and end-to-end visibility. This often creates unnecessary uncertainty and workloads at the point of receipt. When the point of receipt is an austere area of conflict, this situation can become especially critical." -- Lou Kratz (Gardner, 2004:2)

Scope

Supply chains offer a very powerful framework for conceptualizing the linkages between organizations in the production of goods and services. But the utility of their inclusiveness can also make them burdensome to study. It is important to narrow the scope of the analysis by identifying from the onset the specific members of the supply chain and processes that are of interest to the researcher. This research will examine cargo movement from the Defense Distribution Center (DDC) in Susquehanna, Pennsylvania through transshipments points at Dover Air Force Base (AFB), Delaware and Incirlik AB, Turkey ending with delivery at APODs in Iraq.

Current DoD Distribution Supply Chain

The following provides a description of the current DoD distribution supply chain.

Organizations

<u>Defense Logistics Agency (DLA)</u> – The Defense Logistics Agency provides sustainment for the warfighter in the field. From beans to bullets, the 23,000 person agency is charged with filling requisitions from deployed troops (DLA, 2009). DLA

maintains over 6.4 million unique stock keeping units in its inventory (Defense Logistics Agency, 2009). Once picked and packed by DLA, goods enter the distribution network.

Defense Distribution Center (DDC) – Located in Susquehanna, PA, the DDC is actually one of 25 such DoD distribution depots located around the world. The center is responsible for picking, packing, and shipping products maintained at their facility.

436th Aerial Port Squadron – Located in Dover, Delaware, this organization is responsible for receiving ground shipments from the DDC in Susquehanna, PA. Aerial port personnel prepare, aggregate, and schedule cargo for onward movement. The majority of movement is via contract airlift operated by commercial cargo carriers such as Atlas Air and Evergreen Worldwide.

618th Tanker Airlift Control Center (TACC) – Located at Scott AFB, Illinois, TACC is responsible for scheduling the flow of contract aircraft through Dover AFB, Delaware and subsequent transshipment points. TACC planners schedule military aircraft for movement of from Incirlik AB, Turkey into Iraq APODs.

728th Air Mobility Squadron (Aerial Port Flight) – Located at Incirlik AB, Turkey, this unit receives the steady flow of contract aircraft bringing in cargo for transshipment. Cargo destined for Iraq is downloaded and scheduled for onward movement via military aircraft; primarily C-17's stationed at the base. The organization has the responsibility for coordinating any changes to the flight schedule for military aircraft based on unusual cargo levels.

Combined Deployed Distribution Operations Center (CDDOC) – Tasked with the mission of assigning modality and priority for intra-theatre movement, this organization has the potential to wield considerable influence on the flow of cargo in Iraq. All requests for intra-theatre movement must be validated by the CDDOC. Although they exercise no direct control over TACC assigned missions flowing to APODs in Iraq, they are a downstream member of the supply chain that feels the effects of routing and scheduling decisions made on the flow of cargo into Turkey from the United States. The CDDOC is the focal point for logistics planning in Iraq.

Process

The distribution process consists of four distinct segments: DDC to APOE, APOE to transship location, transship to APOD, and APOD to final destination. For the purposes of this research specific nodes of the supply chain have been identified: Susquehanna, PA (DDC), Dover AFB, Delaware (APOE), Incirlik AB, Turkey (transshipment base), and various airfields in Iraq (APODs). The final segment of the process often involves extensive coordination as the cargo moves via ground convoys and is beyond the scope of this paper.

The first segment begins as requisitions flow into DLA systems from deployed units in theatre. DLA makes sourcing and shipping modality decisions based on customer requirements and DoD sanctioned business rules regarding timeliness. The time allowed from requisition acknowledgement (order is received) to shipment can vary from 24-hours for category I and II items to 72-hours for category III items (DLA, 2007). Category is determined by a combination of required date of delivery and mission criticality. For example, items deemed critical to mission accomplishment such as aircraft parts must be shipped within 24-hours. Less critical items such as sandbags fall under the 72-hour business rule.

Once orders are sourced to the DDC, they are picked and packed. The shipping floor of the warehouse in Susquehanna, PA has *shipping lanes* assigned to each of the major DODDACs (Department of Defense Activity Address Code) in the theatre. A DODDAC is simply a multi-letter code assigned to each delivery location, similar to a zip code. Each of these shipping lanes is painted to the dimensions of a standard 53-foot tractor-trailer. Large items are moved to the shipping lanes immediately, while smaller items are consolidated in cardboard tri-wall type containers. As a shipping lane nears a full truck-load, the lane receives priority for subsequent pick/pack filling so it can be completed. Once a shipping lane is full, a tractor is dispatched to the dock, a full load is mated, and the truck begins the four-hour trip to Dover AFB.

At Dover AFB, trucks flow into the aerial port and cargo is marshaled into the holding yard. Some items arrive ready for air shipment while others require additional work prior to being categorized as *capped* and ready for shipment. Capping generally consists of placing netting over palletized items to prevent them from moving in flight. It could also entail placing cargo into an intermodal container suitable for air transport. Once a pallet is capped it is ready for air transport. The amount of time cargo spends waiting in the port after it has been capped is a function of airlift scheduling. Under ideal circumstances an aircraft would be waiting on the ramp when sufficient cargo aggregated for a full load. This would require some level of coordination and planning between supply chain members at DLA, Dover AFB, and TACC. Presently, the flight schedule is based on historical demand. Capability exists to add additional flights at significant expense to clear out accumulated cargo, but this is generally a reactive capability. Very little in the way of real-time collaborative planning occurs with respect to flight scheduling and cargo levels at the aerial port. Cargo remains in the yard until an aircraft bound for the proper location arrives at the airfield. When the aircraft arrives, cargo from the DDC as well as originating cargo (non-DDC cargo) is aggregated and loaded for airlift. The transoceanic portion of the airlift segment begins at Dover AFB and ends at Incirlik AB, Turkey. At Incirlik AB the aircraft are downloaded and the cargo is either transloaded directly onto waiting aircraft or placed in the cargo yard. Cargo is aggregated by DODACC and scheduled for delivery on military aircraft operating throughout the theatre. At this point the goal is to accumulate sufficient quantities for each DODACC to assign military lift.

Problems with the Supply Chain

As with all supply chains, the efficiency and effectiveness of the process depends heavily on information sharing (Cooper, 1997:8). As it stands now, the DDC has no information regarding the flight schedule produced by TACC. TACC schedules the contract airlift flights based on historical data and input from the aerial ports (Goeb, 2009). Historical patterns dictate the baseline schedule. When excess cargo accumulates at the ports, expensive short-notice contract flights can be added (Goeb, 2009). Under current practices, the DDC might be shipping cargo that is destined to wait for airlift when it arrives at Dover. The opportunity to pick and pack cargo for the next outbound flight might be squandered. Figure 1 illustrates this lack of synchronization. Note the delay as cargo and aircraft are synchronized, delineated as **HOLD**.

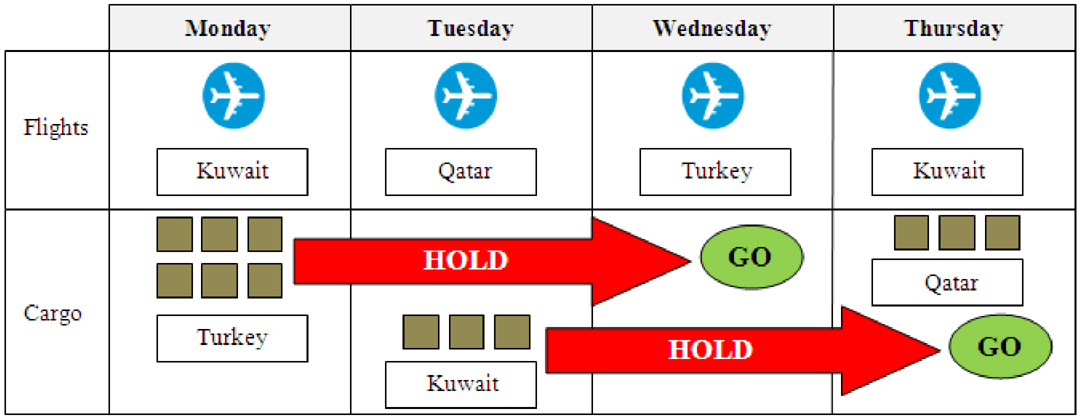

Figure 1. Lack of Synchronization Between Flight Schedule and Arriving Cargo

The lack of synchronization may also contribute to ineffective aggregation by DODDAC. The current process involves shipping lanes nearing completion receiving priority. But the lack of consideration for the airlift schedule may result in lower total shipping volumes to a particular field. For example, one or two shipping lanes for Bagdad might be completed in the course of a normal day, but if the DDC had information about a Bagdad bound flight inbound to the APOE, then they might give the Bagdad priority over other DODACCs in the pick, pack, ship sequence.

New Air Mobility Command Supply Chain Initiative

In July 2008 a panel of AMC and DLA representatives met at Scott AFB, Illinois to conduct an Air Force Smart Operations 21 (AFSO21) lean event. One of the ideas birthed at the event was an initiative aimed at improving the information sharing and scheduling associated with shipments of goods from the DDC warehouses to APOEs on the east coast. In short, the goal is to decrease the average port hold time at the APOEs by ensuring that the correct pallets arrive at the port in sufficient time to make the airlift destined for the desired location. Figure 2 shows the synchronization of cargo and scheduled airlift envisioned. Under the new initiative, the flight schedule dictates which cargo receives priority in the pick, pack, and ship sequence from the DDC at Susquehanna, PA. Notice that the holding period depicted in Figure 1 is absent under the new initiative. Since information about the flight schedule is being shared with the DDC, cargo arrives at the aerial port synchronized with the flight schedule.

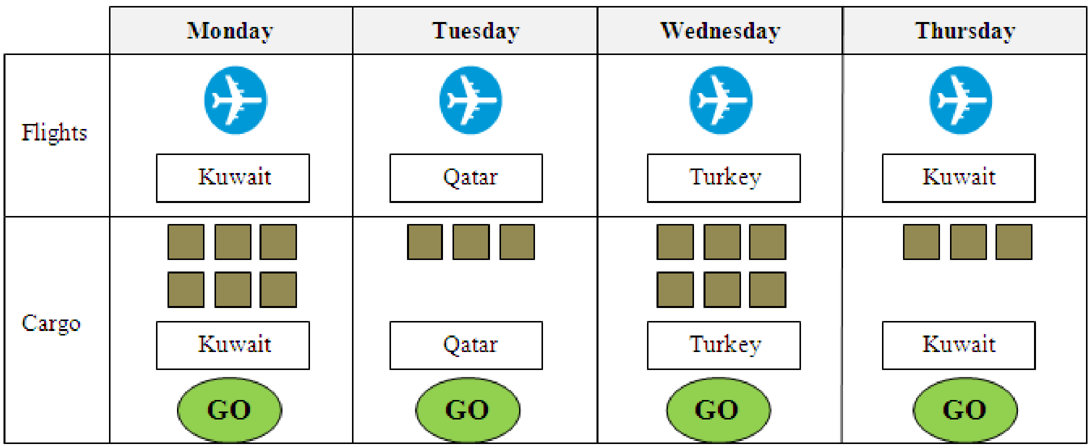

Figure 2. Synchronized cargo and scheduled airlift envisioned by new initiative

This synchronization is accomplished by providing a copy of the current TACC flight schedule (Appendix B) and a tranship table used at locations in theatre. DDC personnel will also receive training on how to read the flight schedule. Armed with this information, DDC members will be able to pick, pack, and ship in accordance with scheduled airlift. Subsequent pallets can be built in accordance with previous business rules, but priority will be given to those lanes with scheduled airlift. If the initiative is successful, larger groups of pallets headed to the same location should result as priority is given to fewer locations instead of spreading the effort evenly across all locations. In theory, this should allow for more efficient scheduling of military airlift at downstream transship points as the number of pallets bound for each final APOD grows. This is due to the fact that larger numbers of pallets bound for a common destination makes it easier to devote an entire sortie to the effort instead of scheduling smaller offloads at many different locations. Small offloads of cargo at multiple destinations complicates route scheduling. Currently, historical patterns of demand and cargo flow dictate a large portion of the theatre airlift schedule and routing (Taylor, 2009). Very few *anticipatory* changes are made to the flight schedule on the basis of inbound cargo from APOEs on the east coast. But with increased predictability as a result of synchronization, more *near real-time* scheduling of military airlift might be possible.

So how does how does synchronization through collaborative planning and information result in increased velocity? In theory, larger groups of pallets heading to a theatre location should move faster than smaller groups of pallets heading to the same location if there is an efficient flow of information across the supply chain. For example, if 20 pallets destined for Mosul, Iraq are loaded onto a Boeing 747 bound for Incirlik AB, Turkey, that information should trigger a *near real-time* scheduling change at Incirlik. A shipment of this size is significantly larger than the normal 1-2 pallets per aircraft that would normally arrive and wait in the cargo yard as a full load is aggregated. This implies a critical linkage. An increase in supply chain velocity that results from synchronization of the TACC, DDC, and APOE processes might be ineffective if the information flow does not facilitate follow-on planning and scheduling flexibility at Incirlik AB, Turkey. Improved synchronization at the beginning of the distribution enterprise must be matched by increased anticipatory planning and responsiveness at the other end of the network if gains are to be fully realized. The effort to synchronize cargo shipments with the airlift schedule is an effort to *manage demand* in order to maximize the capacity of the system and increase velocity. Managing demand by synchronizing at upstream nodes in the distribution network should facilitate more proactive planning efforts at downstream nodes (Lambert, 2008:87). Synchronization should result in *larger groups of pallets bound for the same location* as cargo is picked, packed, and shipped to the APOEs based on scheduled aircraft destination.

With this understanding of the current and proposed distribution supply chain, the following investigative questions arise:

1. What is the average port hold time at Dover AFB, Delaware? For Incirlik AB, Turkey?
2. Is there a relationship between the number of pallets bound for a particular destination and the average port hold time at Dover AFB, Delaware? For Incirlik AB?
3. What is the average end-to-end velocity for pallets moving to a particular DODDAC?
4. Is there a relationship between the number of pallets moving to a location and pallet velocity?
5. If there is a relationship between pallet velocity and number of pallets heading to a location, is that relationship uniform across Iraq, or does location have an impact?

The purpose of these investigative questions is two-fold. First, the researcher would like to establish if sufficient margins for improvement exist with regards to reducing port hold times at Dover AFB and Incirlik AB. This validates the need to pursue the initiative. If the margins for reducing port hold time are already extremely thin, then a cost-benefit analysis might be in order before pursuing marginal increases in velocity. Secondly, the researcher seeks evidence of increased velocity resulting from larger groups of pallets moving through the system. Since the researcher anticipates this will be the principle manifestation of the initiative, it is important to see if there is a historical link between pallet group size and velocity.

Statistical Analysis

Data from a two month period in 2008 was analyzed in order to answer the investigative questions. Basic descriptive statistics were compiled in order to determine the mean port hold time at Dover and Incirlik as well as average time in transit for pallets moving from Susquehanna, PA to various locations in Iraq. Multiple linear regressions were completed in order to determine if a relationship exists between pallet group size and pallet velocity within the distribution system based on location. A multi-variant regression analysis was conducted in accordance with *Statistics for Business and Economics, 9e* (Anderson, Sweeney and Williams, 2005) in order to determine if pallet group size and location have a significant relationship to total time in transit.

Sources of Data

All data for this research were compiled from GATES (Global Air Transportation Execution System) and RF-ITV (Radio Frequency-In-Transit Visibility). The data were collected in the fall of 2008 and represent all pallet movement from Susquehanna, PA, through Dover AFB, Delaware and Incirlik AB, Turkey, and on to various locations in Iraq. Raw GATES data from a Microsoft Access database for 2008 was obtained and sorted by destination. Pallets originating at Susquehanna, transiting Dover AFB and Incirlik AB, and arriving at APODs in Iraq were copied into an excel spreadsheet. Using the pallet identification data from GATES, the researcher pulled times directly from the RF-ITV database. Consolidated information from GATES and RF-ITV allowed for tracking of end-to-end movement on 1257 pallets. GATES data also provided the information on aircraft tail number and mission number that allowed the researcher to assign pallet group size. The pallet group size is for transit from APOE to Incirlik AB, Turkey.

Limitations

In order to narrow the scope of the research, only pallets originating at Susquehanna, PA and transiting Dover AFB were selected for investigation. The additional complexity associated with including other east coast DDCs and APOEs would add unnecessary complexity to the core research questions. Any positive or negative results resulting from this research cannot be generalized to other supply chains without consideration of unique factors associated with those chains.

Cargo originating at Dover AFB as well as other cargo arriving for onward movement from other DDCs was not considered. Since the Air Mobility Command improvement effort is focused on the DDC at Susquehanna, PA the researcher thought it prudent to focus on that particular supply lane. The DDC warehouse at Susquehanna also provided the most consistent RF-ITV data observed by the researcher.

Although pallets originating at Susquehanna, PA and transiting Dover AFB are the subject of this research, they form only a small part of the total cargo handled by Turkey. Cargo arriving from other APOEs as well as ground lines of communication for air transport was not considered. Results from this research do not take into account the full interrelated nature to these converging supply chains.

No analysis was completed with regards to the weight of cargo carried on contract aircraft from Dover AFB to Incirlik AB. Any references to increased efficiency in this report are in regards to scheduling efficiency. Gross weight utilization was not investigated and no analysis or recommendations regarding it were offered.

Finally, conclusions drawn about the effectiveness and efficiency of the cargo planning process can only be inferred. No attempt has been made to measure planning behaviors. Informal interviews with aerial port personnel provide insight on how planning occurs, but no surveys or similar instruments were used to formally quantify those efforts.

IV. Results and Analysis

A statistical analysis of the data was completed using SPSS version 16.0. Descriptive statistics, simple linear regressions, and multivariate models were used to answer the research questions in accordance with guidelines developed by Anderson Sweeney, and Williams (2005). The data was entered into SPSS in order to test the regression model. Table 3 lists and describes the variables.

Table 3. Variables entered in SPSS

VARIABLE NAME	DESCRIPTION
Location	4-letter ICAO location code assigned to each APOD
Dover Cargo Processing Time (DoverCPT)	Number of hours from cargo arrival at Dover Aerial Port until "capped" and ready for airlift
Dover Port Hold Time (DovPHT)	Number of hours from cargo arrival at Dover aerial port until departure from Dover AFB
Incirlik Port Hold Time (IncirlikPHT)	Number of hours from cargo arrival at Incirlik Air Base, Turkey until departure for APOD
Total Time (TotalTime)	Total time from arrival at Dover Aerial Port until Arrival at APOD
Location Dummy (LocDummy1)	Unique numerical value from 1 to 9 assigned to each APOD for the purposes of statistical analysis
Pallet Group Size (PalletGroup)	Number of pallets that the pallet of interest traveled with on the contract aircraft from Dover to Incirlik Air Base, Turkey

Most of the variables are self-explanatory. The location dummy was used to determine if a relationship between total time in transit and pallet group size was sensitive to location. Pallet group size indicates how many pallets traveled in a group bound for the same APOD. For example, a pallet bound for Bagdad with a pallet group size of three would indicate that the pallet of interest was placed aboard the contract aircraft at Dover AFB with two additional pallets bound for Bagdad. Pallet group size is for travel from Dover AFB to Incirlik AB only. No data was collected for pallet grouping from Incirlik AB to the APODs in Iraq.

Descriptive statistics from the 1257 pallet population are presented in Figure 3.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PalletGroup	1257	1.00	38.00	12.1575	7.93619
TotalTime	1257	39.00	542.00	95.1472	42.55375
DoverCPT	1257	.00	135.00	3.7884	12.65420
DoverPHT	1257	3.00	184.00	31.3811	15.43856
IncirlikPHT	1257	1.00	348.00	44.6698	37.23103
Valid N (listwise)	1257				

Figure 3. Descriptive statistics for variables entered in SPSS

For TotalTime, DoverCPT, DoverPHT, and IncirlikPHT, the numbers shown are in hours. The number of pallets traveling to the same APOD ranged from 1 to 38. On average, pallets spent 80 percent of the total transit time sitting in a port awaiting airlift. Port hold time at Incirlik Air Base accounted for 47 percent of the average transit time and also had the highest variability. With a standard deviation of 37.2 hours, port hold time at Incirlik equated to almost two days of variability. These facts imply that there is ample room for improvement in terms of reducing port hold time at Incirlik. The minimum port hold time for Incirlik was also noteworthy. At 1.0 hours, evidence of at least one transload is present. This is important, because one can infer that in at least one case, anticipatory planning may have been present. It can be further supposed that future improvements in anticipatory planning might yield similar short port hold times.

Figure 4 depicts mean total transit time and pallet group size by location. Approximately 65 percent of the pallets tracked were bound for Balad or Bagdad. Larger pallet group size and lower mean total transit times for Bagdad and Balad were present. The bars show average total transit time with the black line representing average pallet group size. Subsequent regression analysis explored the relationship between pallet group size and total transit time implied in figure.

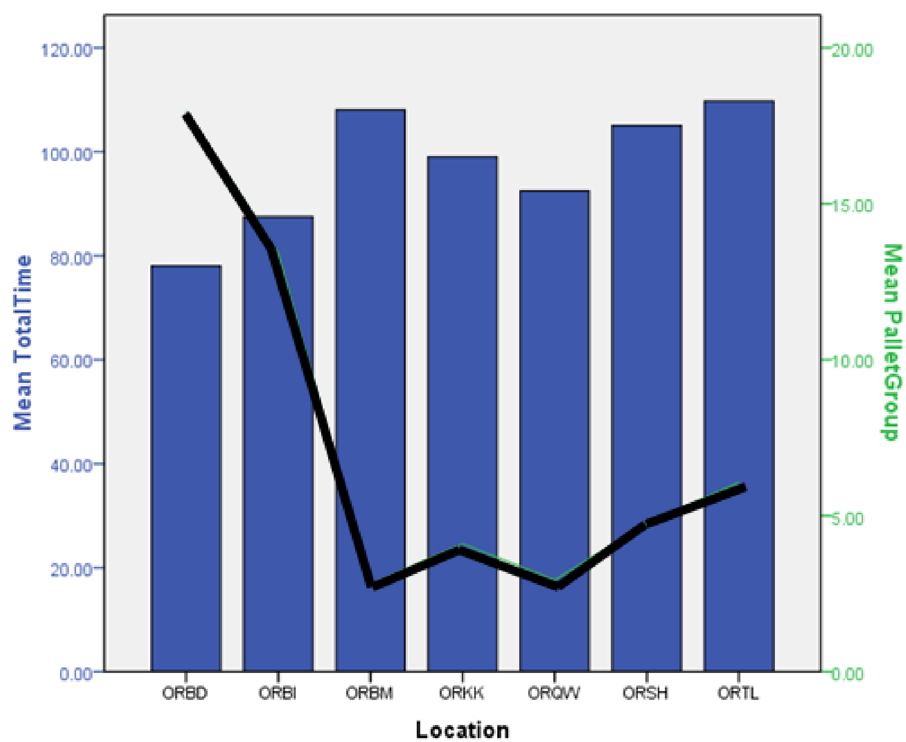

Figure 4. Mean total transit time and pallet group size by location

Figure 5 expands the granularity by showing location breakout and average pallet group size. Pallets from Al Taqaddum (ORAT) and Al Asad (ORAA) were removed from the population for subsequent analysis. Each had only one flight consisting of 5 pallets that skewed the results.

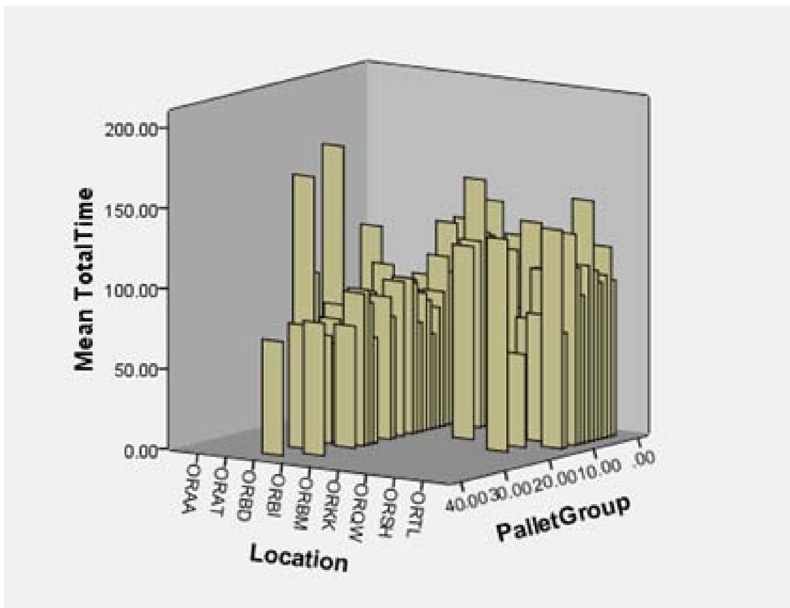

Figure 5. Mean Port Hold Time by Destination and Pallet Group Size

Prior to examining the specific relationship between total transit time and pallet group size, a model was built to explore the relationship between total time and all variables collected by the researcher. A multiple variable regression was accomplished with total transit time as the dependent variable. The independent variables consisted of Dover AFB port hold time, Incirlik AB port hold time, pallet group size, and location.

The results of the regression are presented in Figure 6.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.941[a]	.885	.885	14.43154

a. Predictors: (Constant), IncirlikPHT, DoverPHT, PalletGroup, LocDummy1

b. Dependent Variable: TotalTime

Figure 6. Regression summary for total time and four independent variables

With an adjusted R square of 0.885 (*p*-value = .000) the model suggests that changes in these four variables account for changes in total transit time with a relatively high degree of accuracy. With this model as the baseline, individual variables were explored.

Table 4 summarizes the results of five additional regression models utilized.

Table 4. Summary of regression models

MODEL	INDEPENDENT VARIABLE(S)	DEPENDENT VARIABLE	R SQUARE	ADJUSTED R SQUARE	STD. ERROR OF THE ESTIMATE	*P*-VALUE
1	Pallet Group Size	Total Time	0.057	0.056	41.344488	.000
2	Pallet Group Size, Location (Balad & Bagdad)	Total Time	0.006	0.005	35.04375	.029
3	Pallet Group Size, Location (All except Balad & Bagdad)	Total Time	0.007	0.004	48.51842	.087
4	Pallet Group Size, Location (All)	Total Time	0.103	0.102	40.33428	.000
5	Location	Total Time	0.101	0.100	40.36990	.000

With model 1, the relationship between total transit time and pallet group size was examined. With an adjusted R square of 0.056, the relationship between pallet group size and total time was relatively weak. Models 2 and 3 attempted to check for sensitivity to location by segregating the population into two distinct groups. Model 2 checked the strength of relationship between total time and pallet group size for those pallets destined for Balad and Bagdad since they accounted for 65 percent of the total pallets tracked. Model 3 tested the relationship between total time and pallet group size for all locations in Iraq with the exception of Balad and Bagdad. The researcher hypothesized that more frequent flights to Balad and Bagdad might result in less sensitivity to pallet group size. But in both cases there was no significant increase in the strength of the relationship. When the relationship between total time and location is examined across all APODs (model 4) the R square value amounts to 0.102, which is not significantly different from location alone (model 5) which accounts for 0.100. The results of this analysis do not support the existence of a relationship between pallet group size and total time in transit for the population of pallets studied.

In the course of building the first regression model for total time enroute, a correlation table was computed. In addition to showing no support for correlation between total time in transit and pallet group size, the analysis points to another area for examination. The Pearson Correlation Coefficient of 0.869 for total time in transit and Incirlik AB port hold time indicates a strong linear relationship between the two. A Pearson Coefficient of 1 indicates a perfect linear relationship between two variables (Anderson, Sweeney and Williams, 2005:112). Although no causation can be implied, the relationship between the two appears to be significant enough to merit further study. Table 5 shows the Pearson Correlation Coefficient for each variable.

Table 5. Pearson Correlation Table for Original Regression Model

Correlations

		TotalTime	PalletGroup	LocDummy1	DoverPHT	IncirlikPHT
Pearson Correlation	TotalTime	1.000	-.238	.317	.350	.869
	PalletGroup	-.238	1.000	-.634	.029	-.266
	LocDummy1	.317	-.634	1.000	-.022	.372
	DoverPHT	.350	.029	-.022	1.000	-.011
	IncirlikPHT	.869	-.266	.372	-.011	1.000
Sig. (1-tailed)	TotalTime	.	.000	.000	.000	.000
	PalletGroup	.000	.	.000	.149	.000
	LocDummy1	.000	.000	.	.214	.000
	DoverPHT	.000	.149	.214	.	.342
	IncirlikPHT	.000	.000	.000	.342	.
N	TotalTime	1257	1257	1257	1257	1257
	PalletGroup	1257	1257	1257	1257	1257
	LocDummy1	1257	1257	1257	1257	1257
	DoverPHT	1257	1257	1257	1257	1257
	IncirlikPHT	1257	1257	1257	1257	1257

Based on the strength of correlation indicated, additional regression models were built to check the validity of the relationship. Table 6 shows the results of the additional regression analysis.

Table 6. Additional Regression Analysis Summary of Results

MODEL	INDEPENDENT VARIABLE(S)	DEPENDENT VARIABLE	R SQUARE	ADJUSTED R SQUARE	STD. ERROR OF THE ESTIMATE	*P*-VALUE
6	Incirlik Port Hold Time	Total Time	0.793	0.793	14.04258	.000
7	Pallet Group Size	Incirlik Port Hold Time	0.071	0.070	35.90194	.000
8	Pallet Group Size, Location	Incirlik Port Hold Time	0.140	0.138	34.55737	.000

The adjusted R square total of 0.793 for total time and Incirlik Port Hold time represents the strongest relationship demonstrated for all the variables the researcher examined. Models 7 and 8 were attempts to determine how much influence pallet group size and location had on Incirlik Port Hold time. In both cases the variables tested still did not demonstrate the capability to account for more than 0.14 of the variability in Incirlik AB Port Hold Time.

Based on the results of the statistical analysis, there is no support for a historical relationship between pallet group size and total transit time. Furthermore, the research indicates that the strongest historical indicator of total transit time is Incirlik AB port hold time.

V. Conclusions and Recommendations

The results of this research on pallet movement from Susquehanna, Pennsylvania to various APODs in Iraq did not support evidence of a strong relationship between pallet group size and velocity in the distribution network. This implies that efforts to consolidate pallets at upstream locations in order to facilitate downstream efficiencies have limited effectiveness when not part of a larger effort to synchronize *planning efforts* across the entire supply chain. This analysis has implications for both current and future initiatives aimed at improving various Air Force supply chains.

Recommendations for Current Initiatives

As mentioned previously, a new initiative to improve pallet velocity to Iraq APODs has recently commenced. Under the joint DLA and Air Mobility Command initiative, the picking, packing, and sorting of pallets at Susquehanna, PA will be synchronized with the flow of scheduled contract airlift transiting Dover AFB, Delaware. Although this initiative was undertaken with only three major nodes in the distribution supply chain in mind (TACC, DLA, and APOEs), the potential for significant gains is larger than the designers might have anticipated. If the initiative is successful, incremental improvement in pallet velocity through the Dover AFB aerial port may result. The mean Dover AFB port hold time of 31 hours for the pallet population studied left ample room for improvement. Those incremental gains will come primarily as a product of pallets making earlier flights to downstream locations. It is the researcher's opinion however, that potentially *significant* gains in pallet velocity are possible as a result of information pulling efforts at downstream locations. Aerial port personnel have the capability to see the flight schedule and inbound cargo (from APOEs) via current enterprise information systems. What they do not possess is a current picture of what cargo is in the process of being picked, packed, and shipped to the APOEs. If they were able to pull this information from upstream in the supply chain they might be able to work with TACC to *synchronize* the transload flight schedule based on actual *anticipated demand* for movement versus historical trends and flight schedules. This might entail changing the flight schedule for Iraq bound flights prior the cargo actually arriving at Incirlik AB. Aerial port personnel are already being proactive with regards to anticipating inbound cargo. This additional pull of information from further upstream in the supply chain would merely enhance their flexibility to respond to changes in demand and better match their capacity to it.

Information Flow and Planning Efforts at Incirlik AB, Turkey

In an interview conducted with Chief Master Sergeant Martin Taylor of the 728th Air Mobility Squadron at Incirlik, he shared that the aerial port there proactively seeks information on inbound cargo in order to facilitate transload operations and scheduling of C-17s out of Turkey (Taylor, 2009). Chief Taylor's airmen have created an **Operation Iraqi Freedom Hub Cape Report** that they compile on a daily basis. The report is used to synchronize the flow of cargo from the holding yard and inbound 747s with outbound C-17 flights. Figure 7 shows a sample report.

HUB MISSIONS						
MSN#	ICAO	APOD	Pro	Att	ETD/Z	DEP/Z
9/068						
ABV0863TS068	ORBD	OR9		7	0045	0057
ABV2063B5068	ORBD	OR9		18	1730	
9/069						
ABV2029B6068	ORBM	OSM	15	11	0100	
AJYF501YT068	ORBD	OR9	0	0	0225	
ABV2063YT069	ORBD	OR9	18		0715	
ABR20Y7C1069	OAKN	KDH	18		0915	
ABV2063C3069	ORQV-ORBD	O6R-OR9	17		1100	
ABV2045C506	ORBD-ORSH	OR9-O2R	18		1545	
PBV0559TV068	ORBI	SDA	18		2201	
9/070						
ABV2063YT070	ORBD	OR9	5		0530	
ABV2063D1070	ORSH-ORBD	O2R-OR9	5		0630	
ABR20Y7D1070	OAKN	KDH	5		0830	
ABV2059D3070	ORBI	SDA	18		1000	
ABV2063D5070	ORBD	OR9	7		1530	
ABV2029D4070	ORBM	OSM	18		1715	
ABV2065D7070	ORBI-ORKK	SDA-KIK	13		2000	
ABV2059D6070	ORBI	SDA	0		2300	

THIS COLOR IN PRO COLUMN IS NOT WAITING ON ANY INBOUND INFO & HAS LESS THAN 10 PALLETS

THIS COLOR IN PRO COLUMN HAS LESS THAN THREE PALLETS FOR ONE STOP OF A TWO STOP MSN

THIS COLOR IN PRO COLUMN IS WAITING ON INBOUND CARGO INFO

THIS COLOR IN PRO IS 100% UTILIZED A/C

OEF MISSIONS HIGHLIGHTED IN YELLOW

FEEDER CARGO														
MSN#	ETA/z	ATA/z	3OR	KIK	O2R	O6R	OR5	OR9	OSM	SDA	TA8	OEF	Totals
9/068														
BBVHX390A067	0030												0.0
BBRKX370A067	1230		0.0	0.0	2.0	1.0	0.0	20.0	4.0	1.0	10.0	0.0	38.0
BBVKD390B068	2030		0.0	3.0	4.0	0.0	0.0	14.0	0.0	3.0	7.0	11.0	42.0
9/069														
BBV1D390B068	0830		0.0	2.0	1.0	0.0	0.0	2.0	17.0	20.0	0.0	0.0	42.0
BBV1D390C069	2030												0.0
9/070														
JBVGV39XB068	0430		0.0	0.0	2.0	0.0	0.0	7.0	5.0	1.0	2.0	13.0	30.0
TOTALS			0.0	3.0	6.0	1.0	0.0	34.0	4.0	4.0	17.0	11.0	80.0

BACKLOG OF PALLETS IN PROCESSED STATUS (NOT MANIFESTED/LOAD PLANNED OR FRUSTRATED)										
	ORAA/3OR	ORKK/KIK	ORSH/O2R	ORQV/O6R	ORAT/OR5	ORBD/OR9	ORBM/OSM	ORBI/SDA	ORTL/TA8	OEF
$	0.0	1.0	8.0	4.0	0.0	7.0	0.0	18.0	18.0	12.0
T-1 ADS										
T-1 LOG										
T-2 ADS										
T-2 LOG									2.0	
T-3										
RSS									2.1	
TOTALS	0	1	8	4	0	7	0	18	22.1	12

17 PLT POS TO ACCOMMODATE FOR RAVENS REQUIREMENTS

UPDATED AS OF	068/1200Z
TOTAL SINGLE PALLETS ON HAND	68.0
TOTAL EPP's for TRAINS ON HAND	2.0

HIGH LINE SPACE	
AVAILABLE	30
USED	2
OPEN	28

GRID LOCATIONS	
AVAILABLE	350
USED	68
OPEN	282

C-17 TAILS	OP WT	MOMENT	STATUS	ETIC	REMARKS
91191	280646	25761	PMCM		
10192	282945	25872	PMCM		
21110	286736	25937	PMCM		
21102	282336	25790	PMCM		
70045	286592	26022	NMCM	PP28	--- LOGISTICS LOCKS REQ SUPPLEMENTAL

Figure 7. OIF Hub Cape Report

The *hub missions* depicted on the left side of the figure represent outbound C-17 flights and are color-coded to indicate how much of their capacity is utilized. Inbound or *feeder* cargo is depicted on the upper right side of the report while backlogged cargo sitting on the yard awaiting lift is shown in the lower right side of the report. The "OIF Hub Cape Report" is created on a daily basis utilizing a combination of GATES pulls for inbound cargo and local products for current yard inventory (Taylor, 2009). This homegrown Excel product facilitates the aerial ports efforts to schedule outbound lift. According to Chief Taylor, these products allow them to forecast requirements for outbound lift scheduling two to three days in advance and identify problems with backlogs. In addition to the OIF Hub Cape Report, the port at

Incirlik AB occasionally obtains the *utilization log* from the Dover AFB load planning team that shows what they plan to put on aircraft bound for Turkey. The Hub Cape Report represents a laudable effort to *anticipate* demand at the local level. Aerial porters at Incirlik AB have identified that fact that they cannot simply wait for cargo to show up and then develop a plan. They are looking to their immediate left and immediate right in the supply chain to *synchronize* the flow through their node by pulling the information they need. What is needed is a product or tool that allows them to look *two* nodes to the left and right in the supply chain in order to enhance synchronization and responsiveness. If the aerial port at Incirlik had visibility on the number of pallets being built and scheduled to depart Susquehanna, PA for Dover as well as those currently inbound to their station, the ability to forecast demand would be enhanced. It would provide additional lead time to coordinate changes to the flying schedule and increase the likelihood shortened transload times.

How the Cargo Synchronization Initiative Could Make a Difference at Turkey

Currently, C-17 missions operating out of Turkey to Iraq APODs are scheduled according to three primary factors: the previous year's schedule, on-hand cargo, and inbound cargo (Taylor, 2009). Using the previous year's schedule is probably the least responsive to actual demands. Although it might set a reasonable baseline in terms of the overall number of sorties that need to be scheduled, variations in APOD distribution have to be accounted for on the fly based on on-hand and inbound inventories and demand at forward locations. That is where the current AMC and DLA initiative could potentially improve performance. If more blocks of pallets in larger groups destined for the same location becomes common, it might facilitate more responsive and precise scheduling effort. Instead of planning an even distribution of missions to various Iraq APODS based on historical averages, the added predictability and volume may facilitate precise scheduling based on actual demand. The key to the potential increases however lies in coordinating the *information flow* and *planning* between partners. Additional information sharing links should be established between the DLA distribution center and the aerial port at Incirlik AB. It is not enough to speed the flow of cargo through Dover AFB if the aerial port at Incirlik is not given enough time to plan for the increased velocity. By sharing information on the flow of pallets out of the distributions centers through the port at Dover, the scheduled flow of cargo out of Turkey could be optimized. While the flow of information should be the focus of future efforts, shared *information systems* would likely enhance the responsiveness of the entire distribution supply chain. At the very least, improved information systems might serve to moderate inefficiencies in planning that reduce flexibility (Skipper, Hall, Landrum and Hanna, 2006).

Recommendations for Future Initiatives

This research also has implications for future initiatives aimed at improving the velocity of the distribution supply chain. Consider the distribution system as a whole when considering an improvement to the parts. It is not enough to look at the proposed improvement through a soda straw. Agencies within the lens of the improvement may well show progress, but the system as a whole might suffer. Prior to the regression analysis, the researcher hypothesized that pallet group size and APOD location were key factors in determining the total time in transit. In reality, Incirlik port hold time turned out to weigh most heavily on the total time in transit. Should the initiative have focused on trying to improve throughput at Incirlik rather than Dover? The question is difficult but it should be asked and answered. The question is not specific to this improvement initiative. If independent variables W, X, and Y bear on dependent variable Z then it makes sense to see which variable offers the most "bang for the buck" with respect to producing the desired changes.

Another critical part of the analysis must be the exploration of both formal and informal information relationships that exist. Prior to the interview with Chief Taylor, the researcher supposed that very little in the way of information sharing was happening between Dover and Incirlik. The facts were quite the opposite. At an informal level using the electronic equivalent of duct tape and baling wire, the troops at Incirlik AB were pulling the information together they needed in order to facilitate synchronization of inbound and outbound cargo. Understanding this flow of information is critical to evaluating how changes in processes might have second and third order effects on the supply chain.

Recommendations for Further Research

During the course of the analysis the researcher utilized the RF-ITV database to track pallets from origin (DLA) to destination (APOD). The painstaking process of fusing GATES and RF-ITV data in order to accurately track movement made more detailed analysis involving more locations time prohibitive. The contract agency responsible for maintaining the RF-ITV database has subsequently produced an analysis tool that would enable much more robust research on a much larger dataset. A more robust regression model utilizing other APOEs on the east coast would provide additional granularity for the picture of cargo flowing into Iraq.

Another area for further research involves information sharing between DLA and AMC at the squadron and element level. A common trait among troops in theatre is their ability to *make the mission happen* despite a lack purpose designed information sharing systems. Day in and day out young airmen and soldiers cobble together the information they need to accomplish the mission with a hundred different ingenious spreadsheets. A possible idea for research is to accumulate copies of the spreadsheets in use at the aerial ports and find out which currently owned enterprise information systems could be used to more efficiently automate the data.

Finally, an analysis of post-implementation velocity of Susquehanna to Iraq bound pallets would prove valuable. Pre-initiative velocity could be compared to post-initiative velocity to determine the effectiveness of the change in business rules.

Final Thoughts

Improving supply chains is not an easy line of work. Changing processes and business rules within a single company is often a daunting task in itself. To take a supply chain wide approach often involves considerable compromise and lots of elbow grease. The current AMC and DLA initiative to improve pallet velocity is a step in the right direction. Although analysis of a historical population of pallets does not point to huge increases in velocity as a result of synchronization efforts, second order planning effects at Turkey may bolster the return on investment in synchronization at Dover.

Appendix A

Table 1
Key Components of Supply Chain Management

A Supply Chain Management Perspective

Houlihan (1985):
- Planning and control structure
- Product flow facility structure
- Information flow (IT-structure)
- Values and attitudes
- Organizational culture
- Management methods

Stevens (1989):
- Process (work) structure
- Planning and control structure
- Product flow facility structure
- Information flow (IT-structure)
- Organization structure
- Management methods
- Power and leadership structure

Cooper & Ellram (1990 & 1993):
- Process (work) structure
- Planning and control structure
- Product flow facility structure
- Information flow (IT-structure)
- Risk and reward structure
- Leadership structure
- Corporate philosophies

A Business Process Reengineering Perspective

Hammer & Champy (1993):
- Process (work) structure
- Organization (job) structure
- Values and attitudes
- Management and evaluation structure

Andrews & Stalick (1993):
- Process (work) structure
- Organization structure
- Technology structure
- Reward structure
- Measurement system
- Management methods
- Organizational culture
- Political power
- Individual belief systems

Hewitt (1994):
- Process (work) structure
- Information flow (IT-structure)
- Decision authority

MIT-model by Towers (1994):
- Process (work) structure
- Organization and skill structure
- Technology structure
- Values and behavior
- Management philosophies and decision structure

(Sourced from Cooper et al, 1997:7)

Appendix B

TACC Flight Schedule provided to Susquehanna DDC Personnel

Monday, December 29, 2008

DOV To Intra

Date	Time	DeltaMsn		Mission	#Acft	Planned		Actual		MAI	Route
Tuesday, December 30, 2008											
365	7:55		1D390C	BBW1D390C365	B7472	42	59			DC	DOV-HHN-ADA----
365	16:10		1XP30C	BBW1XP30C365	B7472	42	59			DC	DOV-HHN-3OR----
365	20:45		GF390K	JBWGF390K365	C005A	35	49			DC	DOV-RTA-ADA----
365	23:15		0559TS	PBW0559TS365	C017A	18	25			DC	DOV-SPM-SDA----
365	23:55		WX39XC	BBWWX39XC365	MD011	34	48			DC	DOV-LEJ-ADA----
				Daily Cap Total		*171*	*240*	*0*	*0*		
Wednesday, December 31, 2008											
366	3:15		RF630C	XBWRF630C366	C005B	35	49			DC	DOV-RTA-OR9----
366	11:55		1X390D	BBW1X390D366	B7472	42	59			DC	DOV-HHN-ADA----
				Daily Cap Total		*77*	*108*	*0*	*0*		
Thursday, January 01, 2009											
1	3:35	123	REG60B	XBWREG60B360	C005A	16	24				KWI-OZP-DOV-FFO---
1	12:30		HX390E	BBWHX390E001	MD011	35	49			DC	DOV-HHN-ADA----
1	20:30		02590E	ABW02590E001	C005B	35	49			DC	DOV-RTA-SDA----
				Daily Cap Total		*86*	*122*	*0*	*0*		
Friday, January 02, 2009											
2	5:20		KD390F	BBWKD390F002	B7472	42	59			DC	DOV-HHN-ADA----
2	20:45		RF630F	XBWRF630F002	C005B	35	49			DC	DOV-RTA-OR9----
				Daily Cap Total		*77*	*108*	*0*	*0*		
Saturday, January 03, 2009											
3	3:00		0859TS	ABW0859TS003	C017A	18	25			DC	DOV-SPM-SDA----
3	3:45		RJ63CS	XBWRJ63CS003	C017A	16	22			DC+	DOV-RMS-OR9----
3	9:20		KX390G	BBWKX390G003	B7471	42	59			DC	DOV-HHN-ADA----
3	21:00		02630G	ABW02630G003	C005B	35	49			DC	DOV-RTA-OR9----
				Daily Cap Total		*111*	*155*	*0*	*0*		
Sunday, January 04, 2009											
4	7:30		0859TS	ABW0859TS004	C017A	18	25			DC	DOV-RMS-SDA----
4	11:30		WX39XA	BBWWX39XA004	MD011	34	48			DC	DOV-LEJ-ADA----
4	21:00		03P30P	PBW03P30P004	C005B	35	49			DC	DOV-RTA-3OR----
				Daily Cap Total		*87*	*122*	*0*	*0*		
Monday, January 05, 2009											
5	7:55		1D390J	BBW1D390J005	B7472	42	59			DC	DOV-HHN-ADA----
5	19:55		1D390B	BBW1D390B005	B7472	42	59			DC	DOV-HHN-ADA----
5	21:00		02630B	ABW02630B005	C005B	35	49			DC	DOV-RTA-OR9----
				Daily Cap Total		*119*	*167*	*0*	*0*		
Tuesday, January 06, 2009											
6	5:20		KD390C	BBWKD390C006	B7471	42	59			DC	DOV-HHN-ADA----
6	11:55		1X390C	BBW1X390C006	B7472	42	59			DC	DOV-HHN-ADA----
6	20:45		GF390K	JBWGF390K006	C005A	35	49			DC	DOV-RTA-ADA----

Trans-Ship Table provided to Susquehanna DDC Personnel; a second sheet for Charleston AFB was also a part of the table but has been excluded for brevity.

Inbound Logistics Trans-Ship Table

McGuire

OA1: OA1 (*Bagram AB, Afghanistan*) / KBL (*Kabul, Afghanistan*) / JAA (*Jalalabad, Afghanistan*) / OA4 (*Salam, Afghanistan*) / ASB (*Ashgabat, Turkmenistan*) / AZ1 (*Camp Bastion LZ, Afghanistan*) / AZ2 (*Deh Dadi LZ, Afghanistan*) / AZ3 (*Sharana LZ, Afghanistan*) / AZ4 / BIN (*Bamyan, Afghanistan*) / CCN (*Chakhcharan, Afghanistan*) / FAH (*Farah, Afghanistan*) / FBD (*Faizabad, Afghanistan*) / HEA (*Herat, Afghanistan*) / ISB (*Islamabad, Pakistan*) / MZR (*Mazar I Sharif, Afghanistan*) / OA2 (*Shindand, Afghanistan*) / PEW (*Peshawar, Pakistan*) / TE2 (*Tereen, Afghanistan*) / UND (*Kunduz, Afghanistan*) / FRU (*Bishkek, Kyrgyzstan*)

IUD: IUD (*Al Udeid AB, Qatar*) / DHF (*Al Dhafra AB, UAE*) / RUH (*Riyadh, Saudi Arabia*) / TTH (*Thumrait, Oman*) / JIB (*Djibouti, Djibouti*) / KDH (*Kandahar, Afghanistan*)

KWI: KWI (*Kuwait City, Kuwait*) / KEZ (*Ali Al Salem, Kuwait*) / IZE

RMS: RMS (*Ramstein AB, Germany*) / MHZ (*RAF Mildenhall, England*) / ADA (*Adana AB, Turkey*) / TLV (*Tel Aviv, Israel*) / CAI (*Cairo, Egypt*) / AKT (*Akrotiri, Cyprus*) / SPM (*Spangdahlem AB, Germany*) / LKZ (*RAF Lakenheath, United Kingdom*) / ESB (*Ankara, Turkey*)

LGS: LGS (*Lajes AB, Azores*)

THU: THU (*Thule AB, Greenland*)

Dover

ADA: SDA (*Baghdad, Iraq*) / OR9 (*Balad, Iraq*) / O6R (*Qayyarah West, Iraq*) / O8R (*Tall Afar, Iraq*) / KIK (*Kirkuk, Iraq*) / TA8 (*Ali (Tallil), Iraq*) / OSM (*Mosul, Iraq*) / O2R (*Al Sahra, Iraq*)
(see note 1)

SDA: SDA (*Baghdad, Iraq*)

OR9: SDA (*Baghdad, Iraq*) / KIK (*Kirkuk, Iraq*) / O6R (*Qayyarah West, Iraq*) / OR9 (*Balad, Iraq*) / TA8 (*Ali (Tallil), Iraq*) / OSM (*Mosul, Iraq*) / O8R (*Tall Afar, Iraq*) / O2R (*Al Sahra, Iraq*)
(see note 2)

3OR: 3OR (*Al Asad, Iraq*) / OR5 (*Al Taqaddum, Iraq*)

OR5: OR5 (*Al Taqaddum, Iraq*)

Note 1: For all Commodity Code: 2 and 3 cargo, utilize the OR9 (*Balad, Iraq*) channel

Note 2: No more than ten non-OR9 (*Balad, Iraq*) pallets per aircraft

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14. ABSTRACT
A 2009 Air Mobility Command and Defense Logistics Agency Supply Chain Management initiative seeks to increase cargo velocity to the Iraq Theatre of operations by synchronizing the picking, packing, and shipping of cargo from Defense Distribution Centers with the flow of scheduled airlift through aerial ports of embarkation (APOE) on the east coast of the United States. If this initiative is successful, not only will the port hold time be reduced at the APOEs, but the potential exists for larger groups of pallets to be aggregated at APOEs for onward movement. This research investigated the relationship between pallet group size and pallet velocity for cargo movement from Susquehanna, PA to various locations in Iraq. No evidence of a significant relationship between pallet group size and pallet velocity was identified. Port hold time at Incirlik Air Base, Turkey demonstrated the greatest influence on pallet velocity. Improvements to information sharing and collaborative planning were recommended to improve the initiative.

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