DOCUMENTED BRIEFING

Effectively Sustaining Forces Overseas While Minimizing Supply Chain Costs

Targeted Theater Inventory

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Summary

During Operation Iraqi Freedom (OIF), the costs of air shipments have garnered attention at different points for several reasons. These reasons include: shortfalls in overall funding—with transportation then becoming one of the reduction targets due to a perception of it being a discretionary cost with an ability to switch to lower-cost options, rising cost trends, and examples or anecdotes of what seem to be relatively unimportant items going by air. Regardless of the reason, each time these circumstances have arisen the first action has been to push for more items to be shipped via sealift.

This type of reaction should not be needed, though. With effective distribution network design, continually monitored and updated, items will be shipped via the ideal mode that meets customer response needs at the lowest total distribution cost possible—not lowest transportation cost. Thus, we recommend that Department of Defense (DoD) supply chain managers design the distribution system to meet customer needs driven by their operational requirements in a way that minimizes total costs, with continuous monitoring and adjustment. In doing so it will become clear that for the lowest total distribution costs to meet customer needs, some items should be sent overseas by air and some should be sent by surface but usually to intermediate theater-level inventory, not directly to units. Thus, the modal choice must be coordinated with global inventory management and stock positioning. This document builds on a previous report *Leveraging Complementary Distribution Channels for an Effective, Efficient Global Supply Chain* by examining in more depth how judicious overseas inventory positioning can reduce total supply chain costs and better align the use of air and sea lift with their ideal uses.[1]

Distribution System Tradeoffs and Implications for Network Design

What are the cost and performance tradeoffs that should be considered in distribution network design? The first factor to consider is the tradeoff between

[1] Eric Peltz and Marc L. Robbins, *Leveraging Complementary Distribution Channels for an Effective, Efficient Global Supply Chain*, Santa Monica, CA: RAND Corporation, DB-515-A, 2007.

replenishment or delivery time and the inventory needed to provide a desired level of customer service. As replenishment time increases, lead-time demand and lead-time variability increase, requiring more inventory for the same level of service. So this creates a cost tradeoff among supply chain options if different lead times have different costs. Another factor that affects costs is how many times something is handled, which increases with echelons of inventory. Thus, there are three costs to trade off—transportation, inventory, and materiel handling—in distribution system design. Performance can also be traded off against cost.

Let us now apply this to the distribution network that supports forces in Iraq to show how the tradeoffs can be applied to improve the distribution system. For equal performance, there are two main ways to provide service to Iraq that trade off these three costs. Centralized theater inventory replenished by surface (i.e., sealift) from the continental United States (CONUS), with intratheater air delivery to distributed aerial ports of debarkation (APODs) across Iraq, has lower transportation costs but higher inventory and materiel handling costs than delivery directly from CONUS to these APODs via strategic airlift. However, these costs vary greatly among items, so sometimes the difference in absolute transportation costs is greater than the difference in inventory costs and vice versa. Assuming responsive, reliable delivery is needed, for some items, the theater inventory with surface replenishment option will be cheapest. For other items, CONUS air without theater inventory is less expensive, depending upon item price, weight, cube, and the demand level. Using these characteristics, we can determine the ideal distribution network design option for each item. For a small, expensive item, inventory cost dominates the network's cost structure, so inventory cost tends to drive the decision on the best option—in this case, CONUS stockage with strategic airlift. For a heavy, inexpensive, high-demand item, transportation cost is the key cost driver, leading to a different optimal solution—theater inventory with surface replenishment.[2] If instead slower delivery is acceptable, allowing for a

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[2] For items for which theater inventory is deemed the most efficient model, a decision also has to be made on the theater inventory levels. The levels should be item dependent, with the levels being set to produce the optimal mix of support from theater and CONUS inventories from a cost standpoint. Theater inventory replenished by surface should

tradeoff between cost and performance, surface direct to units from CONUS can be the best option.

With these tradeoffs in mind, one can then design a distribution network, particularly where the stock is held and how it is shipped, that automatically meets customer needs while using the "right" modes in terms of minimizing total cost. With needs met, customers—units in the field—should not care how they get the materiel. In this construct, the role of customers is to communicate valid requirements. Then it is up to DoD global logistics providers to set up and maintain a network that meets needs as efficiently as possible, automatically, without lots of exception management or being forced to make trades between costs and meeting customer needs. If this is not done, then when an order comes in, a choice sometimes has to be made between paying more than should have been necessary to provide rapid delivery (i.e., using strategic airlift for an item that should have been in theater inventory) and delaying delivery to avoid paying the higher bill (i.e., using sealift for direct delivery to a unit).

A Decision Approach for CONUS vs. Theater Inventory

We offer the following approach, based upon the theater demand history and item characteristics, to determine whether to position an item in theater inventory vs. CONUS inventory:

1. Determine the per-shipment transportation cost difference between strategic air and sealift with intratheater air. This should be based upon the actual costs to ship the item.
2. Develop forecasts of the theater fill rate for an item as the inventory level is increased and compute the associated annual inventory holding costs.
3. For each inventory level, determine the annual transportation costs, assuming non-theater fills are shipped from CONUS via airlift.
4. Determine the additional annual materiel handling costs associated with the additional receipt and issue transactions for replenishment shipments

generally be set to fill predictable demand levels, with air from CONUS tending to handle spikes in demand that temporarily exhaust theater inventory.

from CONUS to a theater inventory site for each inventory level in step 2.

5. Determine the inventory level for which the total of the inventory holding, materiel handling, and transportation costs is the lowest. This payback period may be limited through the use of a maximum payback period to reduce inventory and thus financial risk, particularly when long-term demand levels are highly uncertain. For example, for SWA, we have employed a maximum payback period of two years in implementation efforts. If no inventory level produces a positive net benefit or meets the payback threshold, then the item should not be stocked in theater inventory with surface replenishment.

We illustrate this approach for deciding between CONUS and theater stockage with examples using shipments to Southwest Asia (SWA). A common vehicle battery weighs 89 pounds and has a price of $113. The cost to fly the battery via military-managed strategic air averaged $328 from January 2006 to January 2007. Every time a battery is flown, almost three more could be purchased instead for the amount of the airlift bill. And the theater inventory costs to relieve the air channel for each single shipment are much less than the cost of one battery, because the inventory continually turns over. In effect, each additional investment in a battery allows up to six demands per year to be satisfied from theater inventory, saving multiple air shipments. The optimal investment in theater inventory for this battery saves $10.1 million per year in transportation costs, with additional annual inventory and materiel handling costs of about $0.5 million for a substantial savings of about $9.6 million per year.

Aircraft engines are big and heavy, so at first glance it seems they should be shipped overseas via sealift too. However, the Apache and Blackhawk engine, valued at about $700,000 apiece, costs $962 per pound to buy versus $5 per pound to ship by air. Let us first examine what it would take for most engines to be issued from theater inventory. Purchasing additional engines to fill the surface pipeline for theater inventory and produce a high theater fill rate would require $10.7 million in annual inventory holding costs while saving $600,000 in air costs, for a net cost increase of $10.1 million per year. Even at very low theater fill rates, the increased cost of inventory cannot be justified by the decreased transportation costs, so this item should not be stocked in theater inventory with surface replenishment.

Using historical demand data, distribution system costs, and item price and weight data to compute the actual tradeoffs for all items shipped to SWA produces what tend to be logical classes for theater inventory. Items with high recurring demand and low price-to-weight ratios produce the greatest return on investment in theater inventory, with optimal solutions having very high theater fill rates. These include items such as track, tires, and packaged petroleum, oil, and lubrication products. Many engineered automotive products have lower total costs with theater inventory, but the relative return is smaller, along with lower optimal theater fill rate targets (e.g., 67 percent instead of 90 percent plus). Large but very expensive items such as the aircraft engine have increased supply chain costs, with theater inventory replenished by surface, regardless of the theater inventory level. Even more extreme examples of items with increased supply chain costs with theater stockage with surface replenishment are electronics and other small, expensive items.

Reducing Costs and Improving Distribution Performance in SWA

We have been working with Department of Defense supply chain organizations to apply this methodology in SWA since early 2006, with significant progress having been made. Additional potential for improvement in SWA remains, though. At the end of 2007, we found that about 20,500 items should be stocked forward in SWA at the Defense Logistics Agency (DLA) warehouse in Kuwait (DDKS). In most cases, the need for theater inventory has been recognized, but in many cases, theater and/or global inventory levels have not been set high enough to enable replenishments to SWA upon demand, resulting in inventory stockouts even for items with nominally sufficient theater inventory requirements. Improving inventory depths and fine tuning the breadth by adding some additional items has the potential to further reduce strategic air shipments by about $225 million per year. Using conservative assumptions for airlift costs from DDKS to units in Iraq and for inventory holding costs, the result would be a net savings of about $100 million per year. This is on top of $400 million per year in strategic airlift cost avoidance and $200 million per year in net savings already being achieved through improved DDKS inventories.

Besides reducing costs, adding or increasing inventory of the 20,500 items will also improve distribution time in some cases. This is because many of these items are sometimes sent by sealift to theater, even for high-priority shipments (46,000 tons in 2007). With improved theater inventory, the distribution time for the portion of shipments currently going by sealift directly to units in SWA would dramatically improve, as the customers would instead get fast response from DDKS. This would potentially affect 36,000 tons of shipments per year.

A Standard Process for Determining Theater Inventory

A standard process to plan and manage theater inventory should be adopted. It would start with periodic review and action by the agencies that manage the items to be forward positioned. The periodic review would identify the items for which theater inventory would produce lower total supply chain costs based upon transportation, inventory, and materiel handling costs and would simultaneously determine the associated inventory levels that would minimize total costs. This, in effect, focuses the theater stockage objective on the weight fill percentage, not requisitions filled—on minimizing distribution system costs, not inventory costs. Additionally, the managing agencies also need to set global inventory levels sufficiently high to have confidence that timely replenishment of forward positioned stocks can occur.[3]

Improving Forward Distribution Depot (FDD) Inventory Policy

It is sometimes believed that FDDs, such as DDKS, provide a time advantage over CONUS. However, this is not always the case when compared with the response time provided by strategic air shipments from stock held at CONUS strategic distribution platforms (SDPs), the main Department of Defense distribution hubs. Generally, when the FDD can rely on a good scheduled truck-type network with frequent (e.g., daily) deliveries, the FDD does outperform the SDPs in terms of distribution speed. Otherwise,

[3] Within DoD, wholesale inventory levels are typically set to achieve targeted fill rates without regard to where the fill comes from. Decisions on where to stock items have historically been based on demand percentages by region or proximity to repair or vendors to reduce first destination transportation costs. This is beginning to change as the services and DLA modernize their supply information systems.

performance is similar. For example, distribution times from the FDD in Kuwait and for air shipments from the SDP at Susquehanna, Pennsylvania (DDSP) to Iraq are similar. Likewise, distribution time from the FDD in Yokosuka, Japan and the SDP at San Joaquin, California to units in Okinawa and Singapore are similar. In contrast to these examples, the FDD in Germersheim, Germany provides faster response to units in Germany than does DDSP. As the benefits vary, so too should the stockage objectives for the FDDs.

As all FDDs present a total cost benefit, at least to some locations for selected items, the initial selection of theater inventory should employ the approach previously described. If the FDD also presents a distribution time advantage, then the stockage list might be expanded. Critical items that do not meet the FDD stockage criterion of reduced total supply chain cost could be added to theater inventory to gain a readiness benefit through faster distribution. If, however, the item does not meet the total cost criterion for theater inventory, this would increase costs, so a cost-performance tradeoff judgment will have to be made. How much, if any, additional cost is acceptable to gain the time advantage offered by the FDD? Additionally, for these items it could make sense to replenish the FDD by air to minimize inventory costs. If the item did not meet the total cost criterion for theater inventory, then this generally indicates that it is less expensive to fly the item to theater than to use surface along with additional theater inventory. Using air to replenish the FDD for these additional items would minimize the inventory investment while still gaining the FDD response time advantage.

The Financial Barrier of Different Budget Accounts

Another potential barrier to effective DoD theater inventory positioning is associated with the different budget accounts that fund parts of the supply chain. The transportation savings resulting from forward stockage accrue to the service of the ordering unit through reduced over the ocean transportation (OOT) charges. Due to the nature of OIF, much of this benefit in SWA would accrue to the Army. However, increased inventory investment required to support forward positioning at DDKS has to be made by DLA through its working capital fund, the General Services Administration, and the Army, and, within the Army, the investment comes from the Army Working Capital Fund while OOT is paid through the Office of the Deputy Chief of Staff, G-4 with operation and maintenance account dollars. In other theaters, different services would benefit to greater degrees, along with having to use some of their own working capital fund dollars. Thus, there could be a role for the distribution process owner (DPO) to advocate for increased working capital obligation authority and even upfront "cash" or total obligation authority, when needed, to seed theater inventory to reduce total distribution costs.

Conclusion

In summary, based upon our analysis of shipments to SWA, as of the end of 2007, there were immediate additional opportunities to cut sustainment airlift by about two-thirds, cutting overall airlift about one-third or one or two strategic airlift flights per day, by improving SWA theater inventory. This does require inventory investment to be effective, and the strategic airlift savings would be partially offset by intratheater air costs. This will also improve requisition wait time (RWT) by shifting some shipments from surface direct from CONUS to customers to much shorter shipment times from DDKS. Longer-term, standard policy for FDDs should be agreed to, and it should be used to guide stockage decisions. Ultimately, the services' and DLA's enterprise resource planning based materiel planning systems should reflect this policy.

To better align incentives and responsibilities for FDD inventory management, the percentage of weight filled from each FDD should be established as a DPO metric, with results stratified by provider. Reports should be accompanied by the airlift cost and RWT impacts of shortfalls in theater inventory. Additionally, OOT costs should be borne directly by providers, rather than customers, as they are determined primarily by stock positioning. This would produce a better incentive for supply managers and organizations to minimize total distribution costs rather than focusing on minimizing inventory costs.