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MBA PROFESSIONAL REPORT

**DUPLICATE CLASS IV (LUMBER)
ORDERING WITHIN DEFENSE
LOGISTICS AGENCY AND ITS
IMPACT IN EACH COMBATANT
COMMAND**

December 2015

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LOGISTICS AGENCY AND ITS IMPACT IN EACH COMBATANT COMMAND**

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ABSTRACT

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Through a statistical sampling and data analytics, this research has identified that there is a duplicate ordering problem prevalent within the Defense Logistics Agency's ordering system. The problem becomes more prevalent given variables such as unit ordering, time of order, quantity of orders, and days between each order. These duplicates can lead to congestion through the supply chain management system. Further, this duplicate ordering problem can lead to unnecessary costs associated with holding and shipping lumber as well as the lumber itself. Due to lumber's unique dimensions and weight, the cost with shipping it are much larger than other traditional DLA products. Identifying the frequent occurrence of duplicate orders can in turn provide the next step in finding a solution to the problem.

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LIST OF ACRONYMS AND ABBREVIATIONS

AFRICOM	Africa Command
ASL	Authorized Stock List
ATP	Army Techniques Publication
AMC	Air Mobility Command
AOR	Area of Operations
APOE	Aerial Port of Entry
BSB	Brigade Support Battalion
CALL	Center for Army Lessons Learned
CAS	Contract Administration Service
CCTV	Closed Circuit Television
CENTCOM	Central Command
COCOM	Combatant Command
CONUS	Continental United States
COP	Combat Outpost
CRSP	Centralized Receiving and Shipping Point
CW2	Chief Warrant Officer 2
DDDE	Defense Distribution Depot Europe
DODAAC	Department of Defense Activity Address Code
DORRA	Defense Logistics Agency (DLA) Office of Operations Research and Resource Analysis
DDKS	Defense Distribution Depot Kuwait Southwest Asia
DLA	Defense Logistics Agency
DOD	Department of Defense
DORRA	The Defense Logistics Agency Office of Operations Research and Resource Analysis
DTIC	Defense Technical Information Center
DTS	Defense Transportation System
E3	Private First Class (Army)
E4	Specialist (Army)
E5	Sergeant (Army)

E6	Staff Sergeant E-6 (Army)
E7	Army Sergeant First Class (Army)
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
EUCOM	European Command
FIFO	First In First Out
FOB	Forward Operating Base
GCSS	Global Combat Support System
HT	Heat Treated
KD	Kiln Dried
LIFO	Last In First Out
LTC	Long-Term Contracts
METT-TC	Mission, Enemy, Terrain and Weather, Troops and Support available, Time available, and Civil Considerations
MTOE	Modified Table of Organization and Equipment
MTOR	Military Table of Organizational Equipment
NORTHCOM	North American Command
NPS	Naval Postgraduate School
NCOIC	Non Commissioned Officer in Charge
OEF	Operation Enduring Freedom
OUA	Operation United Assistance
O2	First Lieutenant (Army)
PACOM	Pacific Command
PBUSE	Property Book Unit Supply Enhanced
POE	Port of Entry
PS	Product Standard
RFID	Radio-Frequency Identification
RIP/TOA	Relief in Place / Transfer of Authority
RON	Requisition on Order
SAARS	Standard Army Retail Supply System
SSA	Supply Support Activity
SCM	Supply Chain Management

SDDC	Surface and Distribution Command
SGT	Sergeant
SOUTHCOM	South America Command
SSA	Supply Support Activity
TOE	Table of Organization and Equipment
TRANSCOM	Transportation Command
TTPs	Tactics, Techniques, and Procedures
UAE	United Arab Emirates
UIC	Unit Identification Code
U.S.	United States
USA	United States Army
USAF	United States Air Force

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I. INTRODUCTION

A. BACKGROUND

The Department of Defense (DOD) uses lumber in many of its operations and construction activities around the world. Class IV (lumber) is critical to the operational success of forward units. Lumber provides the basics of infrastructure for living, mission command, and force protection. The Defense Logistics Agency provides lumber to the DOD. As defined by the agency's mission statement, "The Defense Logistics Agency is the Department of Defense's largest logistics combat support agency, providing worldwide logistics support in both peacetime and wartime to the military services as well as several civilian agencies and foreign countries" (DLA, 2013, para. 1).

The DOD's lumber supply chain is a complex system, which utilizes several government organizations, contractors, and transportation networks to deliver wood products to customers worldwide. DLA provides 1,024 different lumber and wood products for all appropriate applications (DLA, 2015c). DLA's wood products include: hardwood, softwood, plywood, and all other related wood products.

DLA suspects that problems exist within the Class IV (lumber) supply chain at the customer interface level. DLA has recognized a pattern of continuous ordering of lumber by units around the world. DLA believes that issues with this supply chain are occurring at the end of the supply chain, specifically, at the user interface level colloquially known as "the last tactical mile." The last tactical mile is the last leg in the supply chain where national distribution assets end and the tactical transportation and distribution occur to deliver the item to an end user. This often occurs in an austere or remote location with uncertain infrastructure. DLA has yet to prove empirically that supply interruptions are occurring, but it suspects this based on ordering trends. DLA requested assistance from the Naval Postgraduate School (NPS) to research this problem.

This issue is critical to DOD operations as lumber is a weight- and space-intensive commodity requiring large amounts of limited transportation assets. The optimization and improvement of the lumber supply chain can provide value added to the

warfighter. Ensuring the timely and accurate fulfillment of orders the first time, making duplicate orders unnecessary, will free up needed resources (Grajewski & Berney, 2007). The unrealized opportunity cost lost to duplicate orders can be detrimental to accomplishing other missions.

B. PURPOSE

The purpose of this research is twofold: first, to determine if DLA has any quantifiable problems with the lumber supply chain at the customer interface level and, second, to make recommendations for improvement. Lumber is a critical class of supply to the DOD and any interruptions in delivery can have significant operational impacts. Identification of these problems is an important step in supply chain management (SCM) improvement. Recommendations for improvements in the lumber supply chain would allow DLA to implement new policies and procedures to improve conditions for the warfighter.

C. RESEARCH QUESTION

This research addresses these questions:

1. Does DLA have any quantifiable problems with the lumber supply chain at the customer interface level?
2. What problems, if any, are present and what can be done to rectify them?
3. What recommendations for improvements in the lumber supply chain would allow DLA to implement new policies and procedures to improve conditions for the warfighter?

D. BENEFITS OF RESEARCH

This research provides analysis based on historical Class IV orders from DLA. It intends to identify and quantify trends using existing DLA lumber order data. These trends may lead to insight and confirm or deny DLA's suspicions of problems with the DOD lumber supply chain, explicitly focusing on the customer interface level. Other benefits of this research include recommendations of best practices and improvements to

the supply chain from root-cause analysis. It offers insight into customer interactions in nebulous forward locations, where there are austere conditions and poor infrastructure.

E. LIMITATIONS OF RESEARCH

The research does not explore the full lumber supply chain from contracting purchase to delivery, but, rather, it focuses solely on the final steps of the process. This limitation allows the research team to concentrate its efforts on a very specific period of time in the supply chain, the distribution point and issue to the end user.

Currently, the research team has full access to DLA's databases and ordering data, which can reveal many things about lumber within the supply chain. Data about the demand side of the lumber supply chain, however, proved challenging to collect because of the inability to readily access a forward unit's forecast for lumber usage.

Previous literature and lessons learned from prior DOD operations are limited to lumber as it relates to the customer interface level. No system is in place to measure quantitatively customer interaction and satisfaction in regard to lumber. Furthermore, this research does not include any classified data, which may or may not show a different set of data associated with the focus of this project.

F. SCOPE AND RESEARCH METHOD

To show trends in lumber orders—and duplicate orders—the researchers conducted a statistical analysis focused on the major DOD Combatant Commands, which are subject to different variables. Trends were then either present or not present and shown to be more or less significant due to controllable and uncontrollable circumstances. The researchers also conducted a ratio analysis of regular orders to duplicates orders. This revealed relationships between perceived problems in customers not receiving their lumber and the distribution method of lumber.

G. ORGANIZATION OF THE RESEARCH

Chapter II, Literature Review, describes the conceptual process of what the DLA lumber supply chain system is and how it works under ideal conditions. Conversely,

functioning in a contingency-forward environment does not take place under ideal conditions. To better understand how to improve the lumber supply chain at the customer interface level in an austere environment, noting what an ideal customer interface looks like is important.

Chapter III, Methodology, examines the data collection methods and analytical methods used to derive results. It offers insight through analysis of known data to answer the research questions. More succinctly, this research does not attempt to change processes, but it rather identifies if a problem in ordering exists and opportunities for improvement in the current system.

Chapter IV, Findings, examines the results of the data. It shows there is a duplicate ordering problem prevalent within DLA. It shows how several variables, such as quantity, date, unit, and item type, all contribute to duplicate orders differently. It shows the results of the data within each COCOM, presenting unique trends and analysis.

Chapter V, Conclusion and Recommendations, gives clear thought to the reason why there is a duplicate ordering problem. This research gives analytical data to outside users to formulate their own conclusions. It is not meant to offer one solution, however, but rather to look at a host of solutions that could solve this duplicate ordering problem. Such solutions include better training at ordering points, greater collaboration, refinement of requirements, and instituting mechanisms within the ordering system to identify duplicate orders.

Chapter VI, Case Study of Operation United Assistance. This research uses a case study of Operation United Assistance (OUA) in Liberia and other parts of Western Africa to understand the supply chain from both the supply and demand side. This case study offers a modern example of lumber supply in a forward environment and how it is interrelated with users at the customer interface level. OUA specifically dealt with containing the outbreak of Ebola in Western Africa; lumber was pivotal in providing rapid infrastructure buildup in support of this humanitarian effort. This case analyzes the rapid shipment and distribution of lumber.

H. SUMMARY

The overall supply chain network of lumber is long and complex. Various enterprise resource planning (ERP) and SCM systems govern lumber shipping and distribution. Shipping lumber around the world takes much work, time, and effort; often, however, avoidable issues creep in and hinder the process (Barber, Werneke, & Duffy, 2009). Focusing on the customer interface level, the researchers attempt to identify opportunities for network improvement at this level.

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II. BACKGROUND AND LITERATURE REVIEW

A. INTRODUCTION

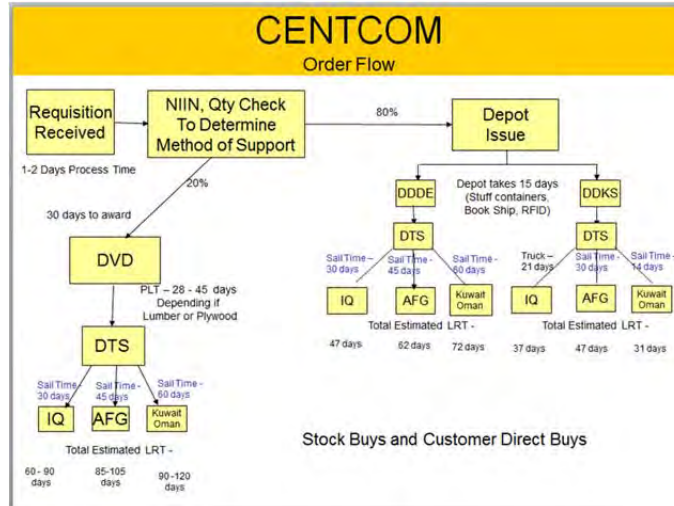
This chapter provides background on the modern DOD lumber supply chain. It explores existing research, DLA publications and procedures, and other relevant data to understand the DOD lumber supply chain. First, we outline the entire lumber supply chain process from a customer placing an order, through lumber harvest, to transportation, and to delivery. Second, we review the operations process associated with the DOD lumber supply chain. Third, we review the DOD policy on lumber standards for DOD use. Fourth, we review the current inventory holding procedures used by the DOD. Lastly, we look at the DOD delivery procedures and common practices in use at the customer interface level.

B. THE DOD LUMBER ORDER FLOW AND SUPPLY CHAIN

The lumber supply chain in the DOD is a complex and multi-step operation involving multiple commands, organizations, contractors, and transporters. The DOD lumber order flow process and supply chain is dependent on each major Combatant Command (COCOM) (Joint Chiefs of Staff, 2013). Specifically, the way a DOD unit orders and receives lumber is dependent on the geographically aligned COCOM to which the unit is assigned. According to DLA, at the macro level, each command orders and receives lumber using the steps in Figures 1–5; DLA COCOM process flow charts for lumber. According to DLA, each COCOM follows a similar protocol for ordering lumber (DLA, 2015a). After DOD inventories and depots are exhausted, required lumber quantities are contracted for using prime vendors. The vendors may deliver either directly to the customer or through the Defense Travel System (DTS) (DLA, 2015a). DTS may use a mixture of military or contracted commercial assets to transport lumber to the customer. As listed in Table 1, each COCOM has a slightly different process and timeline depending on the geography and depot distribution of the COCOM (TRANSCOM, 2014).

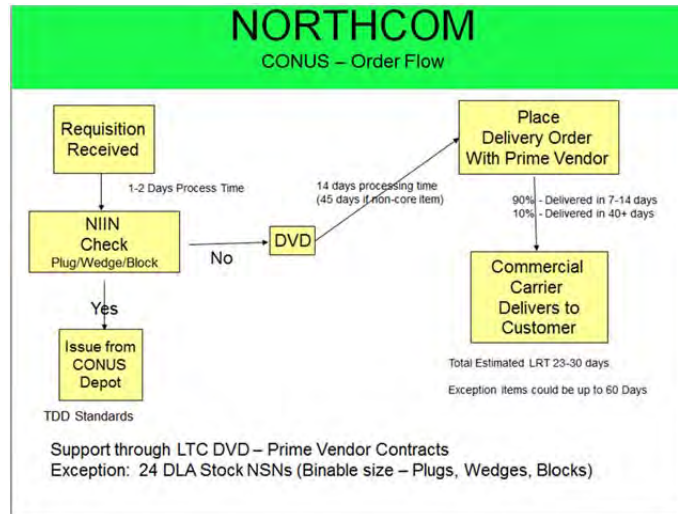
The slide listed describes in generic form a lumber order processed from order placement to product delivery according to DLA.

Figure 1. CENTCOM Order Flow Chart Lumber



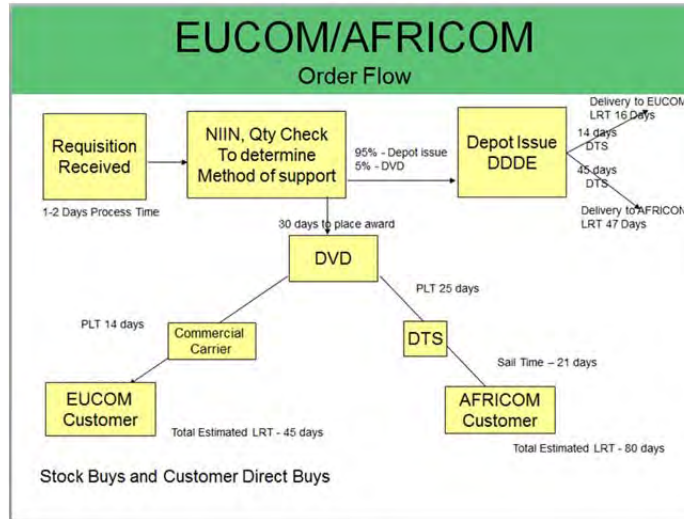
Source: Defense Logistics Agency. (2015a). *COCOM order flow charts for lumber* (Unpublished manuscript). Philadelphia, PA: Author.

Figure 2. NORTHCOM Order Flow Chart Lumber



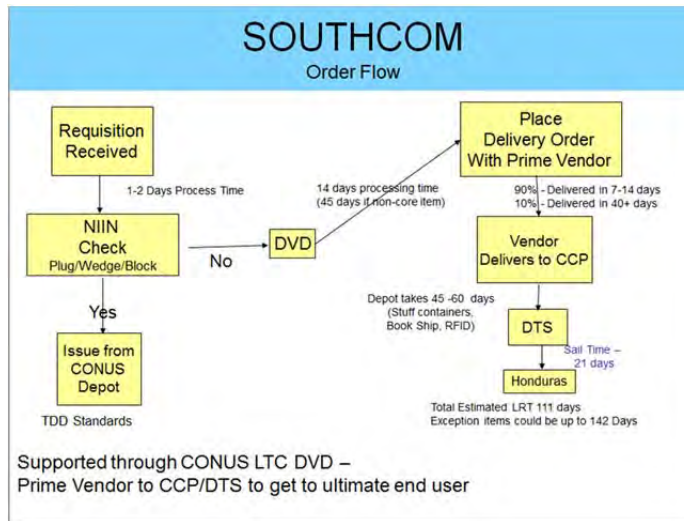
Source: Defense Logistics Agency. (2015a). *COCOM order flow charts for lumber* (Unpublished manuscript). Philadelphia, PA: Author

Figure 3. EUCOM/AFRICOM Order Flow Chart Lumber



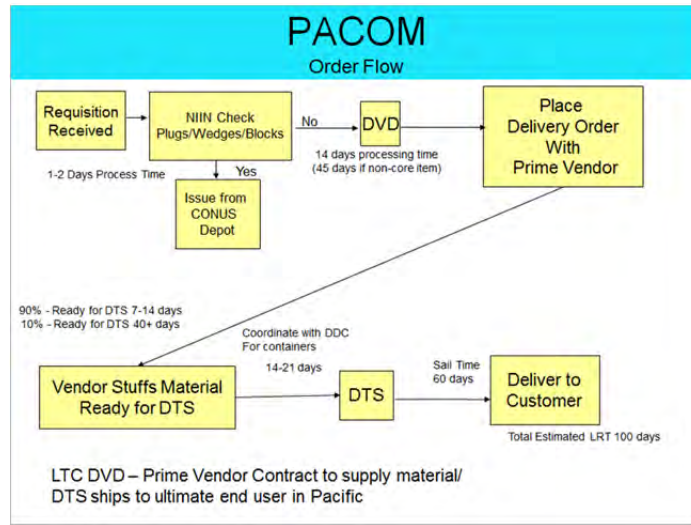
Source: Defense Logistics Agency. (2015a). *COCOM order flow charts for lumber* (Unpublished manuscript). Philadelphia, PA: Author

Figure 4. SOUTHCOM Order Flow Chart Lumber



Source: Defense Logistics Agency. (2015a). *COCOM order flow charts for lumber* (Unpublished manuscript). Philadelphia, PA: Author

Figure 5. PACOM order flow chart lumber



Source: Defense Logistics Agency. (2015a). *COCOM order flow charts for lumber* (Unpublished manuscript). Philadelphia, PA: Author

Table 1. Lumber Ordering Process.

Customer input [sic]; Document order into SSA (SARRS I)
Document goes into SARRS II and AJ2 for available stock
If there is no Army stock available, document becomes requisition (RON)
Requisition [sic] comes into our EBS (Enterprise Business System) for processing
Currently all lumber and plywood requisitions going to Afghanistan are processed direct delivery
Direct delivery means the vendor ships directly to the customer (CONUS); no stock in CONUS
Basic lumber and plywood items are stocked at DDDE and are issued for requisitions going to CENTCOM/EUCOM/AFRICOM. Stock is replenished via OCONUS LTC. Items not stocked are shipped from CONUS. PACOM requisitions shipped from CONUS.
Requisition is released once validated by CAS.
CENTCOM/EUCOM/AFRICOM: If available, stock released immediately; if not, backordered against incoming material or obtained via separate order against OCONUS LTC
CONUS: Solicitation/award process is about two weeks, with standard delivery of 10 days
CENTCOM/EUCOM/AFRICOM: After the material is released from [sic] at DDDE, transportation is handled by DTS; shipping is via truck and ocean vessel; air shipment is almost never authorized

Source: Defense Logistics Agency. (2015b). *COCOM order flow charts for lumber* (Unpublished manuscript). Philadelphia, PA: Author

To understand this complex system, a vignette from a fictional U.S. Army Supply Sergeant (SGT) is used. The SGT places an order for lumber in a forward austere location. In this vignette, the assumption is that all processes occur as they are designed with no variability, and that all lumber supply stocks have been exhausted in the entire supply chain system. Due to this example's location, all steps after Step 5 are derived from CENTCOM's process flow chart lumber (Figure 1) (DLA, 2015b, para. 1).

Step 1: The Class IV lumber order flow and supply chain begins with a supply SGT receiving a request from a platoon in a combat outpost (COP) in Afghanistan. This supply SGT is co-located on a small company-sized COP in a remote part of Afghanistan. The Supply SGT, SGT Doe, receives a request for 24 pieces of 2" x 4" x 12' lumber and 10 sheets of 4'

x 8' x 1/2" plywood for guard tower improvement at the outpost. (DLA, 2015a and DLA, 2015b)

Step 2: SGT Doe enters this supply request into the company's Army property book unit supply enhanced (PBUSE) web-based application. According to Lockhart (2008, p 32), PBUSE "is the Army's web-based, state-of-the-art, force-sustainment property accountability system." PBUSE is also the main program used to order various other classes of supply. (DLA, 2015a, 2015b)

Step 3: SGT Doe's order is given a requisition, also known as a document number, and the order is then sent to the next level of Army sustainment in the Supply Support Activity (SSA). The SSA, which services SGT Doe in this particular order, is located on another forward operating base in Afghanistan approximately 100 miles away. (DLA, 2015a, 2015b)

Step 4: Once SGT Doe's order is received, the SSA will attempt to fill this request with inventory already available. If inventory is available, then SGT Doe, or a designated command representative, can pick up the lumber at the SSA using a manual paper form, conducting a process colloquially known as a "walk through." (DLA, 2015a, 2015b)

Step 5: If the supplies are not available, then the order is uploaded into the Standard Army Retail Supply System - Level 1 (SAARS 1) by SSA personnel. According to the Department of the Army (DA), as of 2013 a new system, the Global Combat Support System (GCSS), replaced the SSARS and PBUSE systems. (DLA, 2015a, 2015b)

Step 6: According to DLA procedures, the document for SGT Doe's lumber is input into SAARS 1 (now GCSS) and then migrated to SAARS Level 2 (now GCSS). (DLA, 2015a, 2015b)

Step 7: As described by DLA procedures, the SAARS Level 2 (now GCSS) system attempts to locate SGT Doe's required lumber and plywood order throughout the Army and, if no stock is available, the order becomes a requisition on order (RON). (DLA, 2015a, 2015b)

Step 8: DLA procedures dictate that SGT Doe's lumber order is then placed into the DLA Enterprise Business System for processing. Since this particular lumber order could not be sourced in existing theater inventories, DLA then takes over the request. (DLA, 2015a, 2015b)

Step 9: According to DLA, SGT Doe's items are typical lumber items normally stocked at the depot level. As such, DLA would attempt to source these items from the Defense Distribution Depot Europe (DDDE) or the Defense Distribution Depot Kuwait Southwest Asia (DDKS).

According to DLA, typically 80% of lumber orders are filled using the Depot system. (DLA, 2015a, 2015b)

Step 10: Following DLA procedures, if the DDDE facility can fill SGT Doe's lumber order, then the requisition ships to Afghanistan using the Defense Transportation System (DTS). DTS for Afghanistan uses a combination of contracted transportation companies to move lumber via truck, ship, and local national trucks to deliver directly to the customer. (DLA, 2015a, 2015b)

Step 11: In accordance with DLA standard operating procedures (SOPs), if either depot facility could not fill SGT Doe's order, items are replenished from the Continental United States (CONUS) stocks. If available in the U.S., the lumber order is shipped using DTS to theater. Normally only 20% of the lumber orders in the CENTCOM Area of Operations (AOR) require reaching back to CONUS. (DLA, 2015a, 2015b)

Step 12: Furthermore, using DLA procedures, if SGT Doe's order could not be filled immediately and released to theater using the CONUS inventory, then this order is placed on backorder against incoming lumber. When available, the lumber is also shipped using DTS to its destination. (DLA, 2015a, 2015b)

Step 13: If SGT Doe's lumber order could not be sourced against backordered items, DLA will leverage Operation Enduring Freedom (OEF) long-term contracts (LTCs) to fill this order. (DLA, 2015a, 2015b)

Step 14: If long-term contracts do not cover the lumber requested by SGT Doe's order, then a new government contract is solicited after the designated contract administration service (CAS) approves the request. (DLA, 2015a, 2015b)

Step 15: The DLA contract solicitation and award process takes approximately two weeks, with standard delivery of 10 days using federal business operations. (DLA, 2015a, 2015b)

Step 16: Upon award of the DLA contract, vendors are directed to use the direct delivery method. This entails that, when the order is ready, the contractors will ship directly to the customer. (DLA, 2015a, 2015b)

Step 17: The timber harvesting company harvests lumber from appropriate woodland to meet the market demand at the saw mill. (DLA, 2015a, 2015b)

Step 18: The saw mill cuts and dries timber into lumber products and treats lumber using heat treatment to kill off parasites. The mill places

appropriate markings and packaging on the lumber products (American Pole & Timber, n.d.). (DLA, 2015a, 2015b)

Step 19: The contractor purchases the lumber from the saw mill, or other wholesalers, and prepares lumber for shipment to fulfill a government contract. (DLA, 2015a, 2015b)

Step 20: The contractor places the contracted lumber in a 20-foot shipping container and attaches a radio-frequency identification (RFID) tag. (DLA, 2015a, 2015b)

Step 21: Containers are shipped using either DTS or private cargo shipping companies direct from vendors, and they can arrive at various sea ports of entry (POE) inside its destination's theatre. For example, in this case, it could be Pakistan, Kuwait, Oman, United Arab Emirates (UAE), or somewhere else that allows access to other over land intermodal transportation networks. (DLA, 2015a, 2015b)

Step 22: Containers are downloaded at the POE and are loaded into contracted trucks for onward movement to their final destination. (DLA, 2015a, 2015b)

Step 23: Contracted local national trucks may take a variety of routes into Afghanistan, as in this example. These routes are subject to conditions such as weather, enemy activity, and other unforeseen variables that can impact delivery time. (DLA, 2015a, 2015b)

Step 24: Along these various routes, local national trucks may cross international borders, and their loads can be inspected or pilfered. The drivers may face other hazards such as illegal checkpoints operated by the enemy or rogue elements of a country. The lumber on boards may be pilfered, destroyed, or stolen in route. (DLA, 2015a, 2015b)

Step 25: Upon arrival at the destination, the truck is subject to search. After appropriate searches, the lumber contents may be downloaded into a centralized receiving and shipping point (CRSP) yard or downloaded by any other unit on the base subject to force protection procedures. If all has gone well for Sgt. Doe's lumber order, it will arrive at the SSA intact. (DLA, 2015a, 2015b)

Step 26: Depending on standard operating procedures at the SSA, the container will be cross-loaded onto another local national truck and sent directly to its final destination. (DLA, 2015a, 2015b)

Step 27: If not sent using local national trucks, the container may be staged at the SSA until the ordering unit's headquarters picks up the

container or the forward support company transports it using military trucks. (DLA, 2015a, 2015b)

Step 28: If the local SOP requires the container to be downloaded, then the lumber could potentially be broken down by the SSA and placed into the bins of the ordering unit at which time it may be subject to potential pilferage. (DLA, 2015a, 2015b)

Step 29: Sgt. Doe picks up his lumber at the SSA or receives it after it arrives at its location. (DLA, 2015a, 2015b)

According to DLA, 80% of the time lumber that is bound for Afghanistan needs to be sourced from outside of theater at the depot level. This means that the order should arrive into Afghanistan within 47–62 days. 20% of the time, lumber needs to be sourced from CONUS. When this occurs, lumber should arrive in Afghanistan within 85–105 days (DLA, 2015a).

The aforementioned vignette was designed to help explain via one example in the Central Command AOR how the lumber order process and supply chain works. This vignette represents one transaction from order to delivery at the absolute worst-case scenario, in which all sources along the supply chain are exhausted. Every order for lumber placed may have a different path along the supply chain with variations depending on COCOM. One can see how detailed and controllable the process is when under the direct supervision of DLA. The more forward lumber is shipped, the more variation occurs in the supply chain, which can constrain its successful arrival (Peltz & Robbins, 2012).

C. LUMBER STANDARDS

Lumber, as defined by Merriam-Webster’s online dictionary (2015), is “timber or logs especially when dressed for use.” DLA includes 1,024 different lumber and wood type products in its catalog. These 1,024 different lumber and wood products are grouped into 18 specifications, each with a unique code (DLA, 2015c). For the purposes of this research, focus is on standard dimension lumber and plywood materials most commonly used in building and barrier construction in the contingency environment.

According to the DLA website, DLA and the DOD used the American Lumber Standards Committee PS-20 commercial grade standards for all dimensional lumber and plywood material (DLA, 2015f). The product standard PS-20 commercial standards come from the U.S. Department of Commerce and are codified in the American Softwood Lumber Standards green book (U.S. Chamber of Commerce, 2015). The green book establishes standards for dimensions, grading, and grade marking. This standard is voluntarily used by the commercial lumber industry in the United States, and it is written into DLA contracts for lumber.

In addition to the PS-20 commercial grading standards, the DLA website states that packaging and marking of lumber is done according to Mil-Standard 129 and MIL L 14362 (DLA, 2015e). These standards govern the packaging and marking of lumber for use in DOD and are written into DLA contracts or lumber requisitions.

According to DLA, all commercial grade lumber is heat treated. Lumber heat treatment (HT) requires heating wood products to a designated core temperature, typically above 133° F for a period of time, generally around 30 minutes. This process kills wood boring parasites and insects which may inhabit the lumber. A marking of kiln dried KD-19 and HT are placed on lumber in accordance with standards set forth by the American Lumber Standards Committee (Espinoza, Bond, & Kline, 2010). All lumber and wood products which DLA requisitions specifically address the standards required for each type of lumber. DLA states that lumber product standards are directed by the contract and are marked accordingly” (DLA, 2015e).

D. INVENTORY HOLDING PROCEDURES

Inventory holdings are essential control mechanisms and procedures that can prove beneficial or disastrous for a commodity, such as lumber. Class IV is a large cumbersome item that is often shipped in bulk, resulting in large quantities of small individual items, which leads to difficult inventory holdings. Class IV inventory holdings are essential to the end user. Inventory holding is usually the last step in a supply chain management process. Therefore, great attention must be given to this step to ensure all the efforts to get lumber to the requester is not wasted at the final step (Budhiraj & de la

Torre Castro, 2010). Depending on the procedures in place, holding inventory, particularly lumber, can become problematic. Lumber, especially within the DOD, is a highly sought after commodity and tends to be easily pilfered. Furthermore, if lumber is held properly, the many requesting users will need to have their orders filled very quickly so that pilferage does not impact the mission (Bajgiran, Zanjani, & Nourelfath, 2014).

RFID (radio-frequency identification) are commercially available tags that can be attached to an asset to track shipments. RFID tags are light weight and come in many sizes. Gates fitted with RFID readers at POEs and along shipping routes serve as control points. The RFID tag exchanges a signal with the control points to report exactly when the tag (and the asset with it) passes through each point, thus tracking the shipment (Apte, Ferrer & Dew, 2006). Traditionally, RFID tags associated with transporting lumber are relatively small, inexpensive, and very light weight (Clark & Hozven, 2003).

However, lumber's unique nature does not allow for an RFID tag to be placed on each individual piece. Lumber, shipped in bulk, is subject to like dimensional requirements to be shipped efficiently (Swedberg, 2014.) Therefore, lumber is often stacked, bounded, and placed inside large shipping containers. RFID tags are then only strapped to each container of lumber. This way shipping containers, with lumber on the inside and RFID tags on the outside, are tracked to their final destination. There is no tracking device associated with lumber, once lumber is removed from the container (Davis & Jones, 2004).

Inventory holding of lumber at its final destination is subject to on-site procedures and policies to ensure proper accountability and holding. Often, lumber arrives at a forward area in a remote part of the world. These austere conditions associated with these forward areas often lack infrastructure and protective measures to safeguard inventory. Such measures might be security cameras, fences, regular inventory counts, and procedures to check in and out all inventory. Since the DOD is not providing lumber to a paying customer, but rather to a mission-oriented customer, many customers understand that they can take more than their requesting amount of lumber. This can be problematic, especially when lumber is a highly sought after commodity and when a new operation is

opened up in a foreign country. Over time this can lead to shortages for other requesting units with impact to mission requirements (Wright, Smith, & Wright, 2007).

Proper inventory procedures possess many robust technological methods and easy to conduct physical routines. Proper inventory holding will ensure that inventory is always accounted, whether it is arriving, being stored, or being issued. (de Santa-Eulalia, D'Amours, Frayret, Menegusso, & Azevedo, 2011).

RFID tags and barcodes are also another means of controlling inventory. These practices tend to be expensive but effective. These technologies, coupled with human routines, can provide the most comprehensive protection of inventory. Habitually checking inventory multiple times a day, as well as having a system of control logs into and out of the holding area, lowers losses associated with inventory (Fernandez, 2004). However, these controls can be difficult for an organization that is standing up an inventory holding area rapidly with the intent to distribute soon after, as it occurs in any forward DOD location.

Property inventory within DOD forward lumber yards has a much higher degree of unaccountability, pilferage, and lost inventory (Barker, 2008). Forward lumber yards are created at the onset of a mission. Lumber yards are often large as they must provide materials and field requests for hundreds or thousands of soldiers. Due to this unique nature, these lumber yards do not have the luxury of security cameras, barcoding, and manpower that can contribute towards physical accountability measures. Though actions are taken, opportunity costs often dictate other pressing priorities, which can overcome the need to police a lumber yard. Due to this, fielding unforeseen customer requests can create inaccurate order fulfillment. An example might be customers unknowingly taking 10% more than their lumber orders. There is no intent of negligence, per se, but rather an impact on the design of standing up lumber yards hastily without the requisite inventory holding procedures already in place. Proper holding procedures of inventory would address these matters and rectify them.

E. INVENTORY SYSTEMS

There are numerous approaches to account for inventory, whether physical or technological. Tracking Class IV items successfully requires being able to track each individual piece of lumber. If one were to track only batches, such as like pieces of lumber from an open container that has arrived from a ship, there would be issues in accountability once that batch is broken up. In other words, if 100 pieces of 2x4s are tracked since they were bound together, and then a requestor wants 40 pieces, then the remaining 60 pieces would be unaccounted for in the system (Vila, Beauregard, Martel, 2009). Efforts must be made to account each individual piece. As such, proper inventory systems will account for all items of inventory and know with accuracy the exact number of all inventory at any time, forecast future consumption, and account for lost or obsolete inventory (Parlar, Perry, & Stadge, 2011).

Inventory accountability must be robust, easy to use, and accurate. Barcoding is a great example of this. Barcoding takes an individual code assigned to an individual piece of inventory and, as it comes in or out, tracks it. Barcodes are a cheap and effective way of accounting all inventories and knowing the incoming and outgoing rates of deliveries and distribution. Barcodes tend to be successful when they are placed on inventory prior to their final destination's arrival. This ensures that a scanner at the destination is used to input accurately all inventory into the system. Oppositely, barcodes scan inventory as it leaves the holding area, resulting in accountability from reception to distribution (Vike, 2007).

If an organization conducts this properly, inventory accountability can help forecasting demand. Good forecasting, especially with Class IV in a forward environment, can prove decisive to a mission. Lumber serves as a linchpin to infrastructure in a forward environment. As such, units constantly generate requests for more lumber, driven by mission requirements. Having inventory systems in place that can account for all lumber at all times in holding will produce an accurate picture as to what resources are actually available. This can drive mission requirements and forecast additional orders to meet mission requirements.

Accounting for lost or obsolete inventory is also important to proper accountability. It is unrealistic, however, to think that all Class IV will arrive unscathed to distribute to forward units. It is realistic to account for inventory errors, whether they are damaged products, accountability errors, or wrong shipments. Dealing with lost or obsolete inventory can be time-consuming if proper accountability measures are not already in place.

F. CUSTOMER INTERFACE

Customer interface is a unique relationship between all of a business's efforts to bring a product to sale and how the customer arrives to purchase this product. Often hidden to the customer is the operation's process that a company uses to bring forward an end item. Once this product is ready for sale, a unique relationship is built with the customer. Companies vie for trust and repeat customers when selling their products (Bonacich & Wilson, 2005). When it comes to shipping lumber, customers within the DOD and DLA are no different. A special relationship exists between forward requesting units in austere environments and the DLA. Unbeknownst to most requesting units is the sheer operational process and volume of lumber DLA ships around the world (Guide, Jayaraman, & Linton, 2002). This is particularly important, however, when dealing with the lumber actually being handed off to a requesting unit.

Lumber is a highly sought after commodity item in the DOD and requesting units' mission requirements are tied to it. In short, lumber provides the basics of infrastructure that support force protection, command and control, and sustainment, which are three critical war fighting functions for units in the DOD. The better the relationship can be between DLA and a requestor, the better order fulfillments will accomplish mission requirements. Conversely, however, when this relationship breaks down, requesting units tend to get orders fulfilled late. This drives mistrust and can result in units placing expedited orders and duplicate orders. This is commonly known as the bullwhip effect, which is a negative event that drives forecast driven supply chain management systems (Bray & Mendleson, 2012). This could be due to many factors. Attributing to the problem are mistakes in inventory that result in misrepresenting what is on hand versus what has

already been issued. Further, this creates second order effects that drive requestors to order more and expedite their orders, creating high costs and tying up more DOD assets to ship superfluous orders (Risbrudt, Ross, Blankenburg, & Nelson 2007).

Customer interface is pivotal to the last tactical mile. In essence, it is the first step in the last major facet of the giant operational process of bringing lumber from a forest in North America to a forward deployed unit halfway around the world. Customer interface is a make or break concept for DLA and requesting units of lumber. The better this interface can manage and fulfill requests, the better units will be at accomplishing their mission.

G. SUPPLY SUPPORT ACTIVITY

According to the Army Techniques Publication No. 4–42.4 (ATP 4–42.4) Supply Support Activity Operations within the DOD specifically the Army, supply operations are conducted using supply points or supply support activities (SSA). SSAs are distribution centers that handle eight of the ten of the DOD classes of supplies. According to ATP 4–42.4, supply support activities include: “the receipt, storage, safeguarding, turn-in and issue of the various commodities referred to as classes of supply” (Army, 2014, p 1–1). Reference Table 2 for a description of all of the major classes of supply:

Table 2. Classes of Supply

Class I	Subsistence
Class II	Clothing, Individual Equipment, Tools, Administrative Supplies
Class III	Petroleum, Oils, Lubricants
Class IV	Construction Material
Class V	Ammunition and Explosives
Class VI	Personal Demand Items
Class VII	Major End Items
Class VIII	Medical Materials
Class IX	Repair Parts
Class X	Material for Nonmilitary Programs

From ATP 4–42.4 United States Army (2014a). *Supply support activity operations* (Unpublished manuscript). Washington, DC: Author

All classes of supplies are requisitioned from national level supply centers, arsenals, depots, major commands, sister services, government organizations, and in some cases vendors directly. SSAs typically do not handle class V ammunition and class VIII medical materials. According ATP 4-42.4, SSAs are required to “maintain accountability and inventories of supplies required to support the readiness of supported units. [While] SSA management [is concerned with] stocking items needed for customer readiness, monitoring performance metrics, and conducting inventories.” (U.S. Army, 2014a).

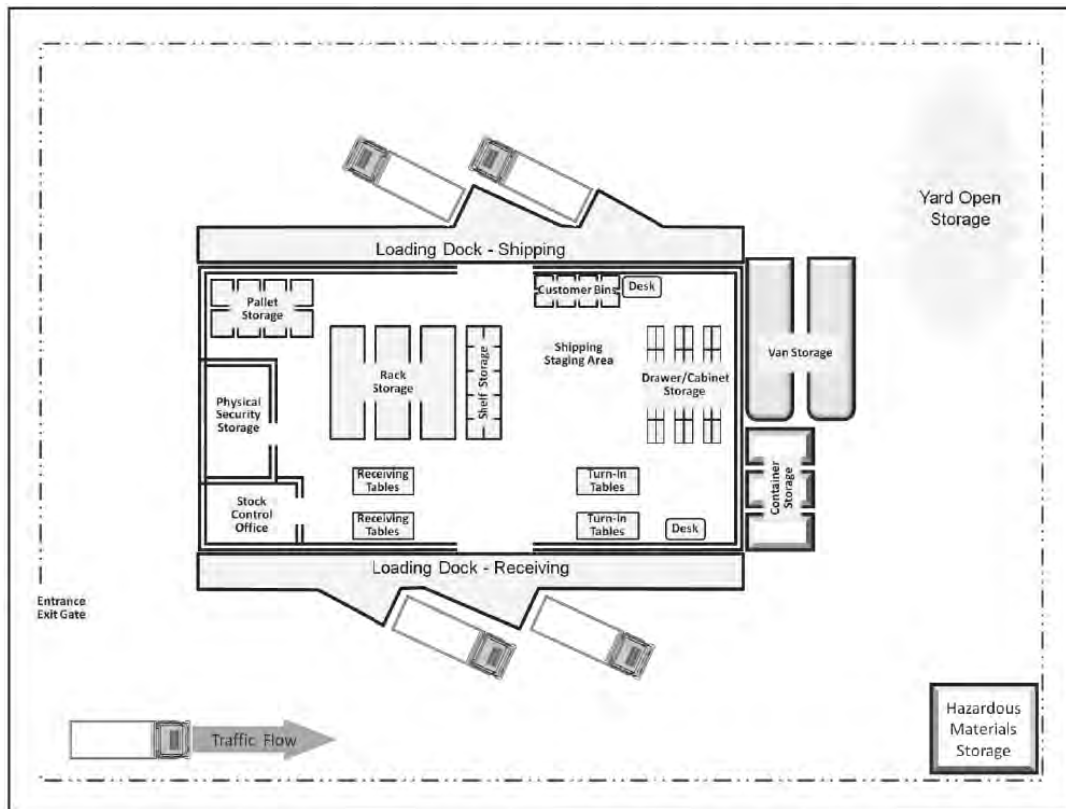
The SSA is considered the storage location of the Army’s wider single logistics enterprise system. The Army’s logistics enterprise system includes “forecasting, planning, and scheduling tools [which] integrate supply support functions across the Army to link customers and suppliers for more efficient supply chain management. [This system allows]...a transaction to flow seamlessly from the customers and suppliers thereby providing timely, accurate, and accessible information for all users...and access to logistics information that originates with the customers unit’s supply request through the entire supply chain until the customer received his requested items” (U.S. Army, 2014a, p. 1-2).

Operations within the SSA can involve inventories of supplies often in the hundreds or thousands of line item numbers. All of these supplies are required to be stored safely and securely and make up an authorized stock list (ASL). ASLs are tailored to the type of unit an SSA is supporting, in order to reduce inventory size to essential items only. A key component of SSA operations include the use of Department of Defense activity address codes or (DODAAC). DODAACs, as mentioned in ATP 4-42.4, are: “a unique six position alpha-numeric code designating the activity/organization of ownership, contains a set of in-the-clear and electronic routing addresses, and includes embedded intelligence used by the various automated systems...these codes identify unit location, mission, and support requirements used by the defense transportation and supply systems” (U.S. Army, 2014a, p. 1-5). Effective DODAAC management is critical to SSA operations as the DODAAC will identify the customer requisition, shipping, and billing documents. DODAAC management at the SSA includes: scrubbing, research,

updating and changing DODAAC information, and associated unit identification code (UIC) information as needed.

The physical flow of supplies into SSAs may either be processed or loaded onward to customers. Figure 6 displays what a notional SSA could look like with operations including shipping, receiving, and storage.

Figure 6. Notional SSA Storage



From ATP 4-42.4 United States Army (2014a). *Supply support activity operations* (Unpublished manuscript). Washington, DC: Author

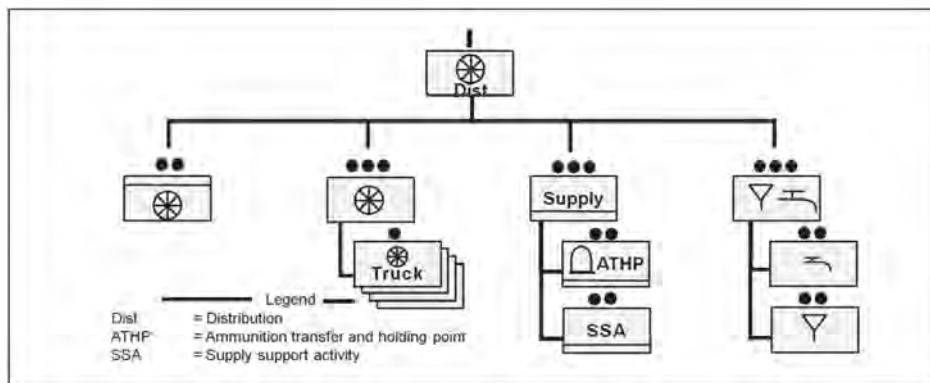
SSAs conducts several unique functions as the focal point for receiving and issuing lumber. These include receiving loading, shipping loading, and customer holding bins, various storage areas, and administrative office actions. All of these activities revolve around stock control of items. Stock control as defined by ATP 4-42.4 “is the process of maintaining inventory data on the quantity, location, and condition of

supplies...monitor expiration dates...rotate stock...issue the oldest stock first... the first in, first out rule” (U.S. Army, 2014a, p. 1-3). SSA items are also stored in a systematic manner according to enterprise stock control measures.

SSAs are staffed by supply personnel Soldiers who will eventually require specialized training to operate the enterprise system. According to ATP 4–42.4, “Soldiers may arrive without experience or in-depth knowledge of the enterprise system. Untrained Soldiers will have a direct impact on the supply support activities (SSA) ability to provide effective and efficient customer service” (U.S. Army, 2014a, p. 1-2).

In U.S. Army formations, SSAs are organized as a section sized element as part of a larger distribution Company within the Brigade Support Battalion. This section-sized unit of 15 personnel consists of Officers, Warrant Officers, NCOs, and Soldiers. Below is an organizational diagram which describes the location of the SSA as part of the larger distribution Company within a Brigade Support Battalion in Figure 7.

Figure 7. Distribution Company



From ATP 4–90 United States Army (2014b). *Brigade support battalion* (Unpublished manuscript). Washington, DC: Author

According to the U.S. Army doctrine, a modified table of organization and equipment (MTOE) is a document which describes what type of personnel and equipment are authorized within a particular army unit. Just like all units within the Army, the SSA has an MTOE authorization for personnel. The SSA Section consists of the following

authorized personnel according to ATP 4-42.4 and the corresponding MTOE authorization from the FY 2016 MTOE for a Brigade Support Battalion formation:

SSA accountable officer: “Responsible for all SSA operations with direct responsibility for all assets and inventory at the SSA. This duty position according to FY 2016 MTOE is held by a Chief Warrant Officer 2 (CW2)” (U. S. Army, 2014a, p. 1-8).

SSA Stock control manager: “Coordinates the functions of the stock control section and manages inventories. According to the FY 2016 MTOE this position is held by a Staff Sergeant E-6” (U. S. Army, 2014a, p. 1-8).

Storage manager: “Responsible for the uninterrupted flow of inventory through the SSA. This position according to the FY 2016 MTOE is held by a Sergeant E-5” (U. S. Army, 2014a, p. 1-8).

Storage control clerks: “Load and unload inventory throughout the SSA and process associated SSA documents. According to the FY 2016 MTOE these positions are held by Soldiers in the ranks of Private First Class E-3-E-4 and Specialist” (U. S. Army, 2014a, p. 1-8).

SSA Non Commissioned Officer in Charge (NCOIC): “Responsible for the day to day supervision and mission accomplishment of the SSA. According to the FY 2016 MTOE this position is held by a Staff Sergeant E-6” (U. S. Army, 2014a, p. 1-8).

Warehouse supervisor: “Assists the SSA NCOIC in implementing policies, procedures and setting priorities for SSA operations. According to the FY 2016 MTOE this position is held by an Army Sergeant E-5” (U. S. Army, 2014a, p. 1-9).

Section NCOIC: “Supports the warehouse supervisor and SSA NCOIC with the implementation of policies, procedures, and assists in setting priorities and maintaining unit desktop standard operating procedures. According to the FY 2016 MTOE this position is held by an Army Sergeant E-5 “(U. S. Army, 2014a, p. 1-9).

Platoon Sergeant: “Serves as the primary liaison between the distribution Company and the SSA section, and is responsible for the training maintenance and accountability of all SSA personnel and equipment. According to the FY 2016 MTOE this position is held by an Army Sergeant First Class E-7 “(U. S. Army, 2014a, p. 1-9).

Platoon Leader: “Has overall responsibility for the SSA Platoon personnel and equipment and leads the Platoon with responsibility for the overall mission success of the SSA Platoon. According to the FY 2016 MTOE this position is held by an Army First Lieutenant (O-2). Other key Platoon Leaders duties according to ATP 4–42.4 include:

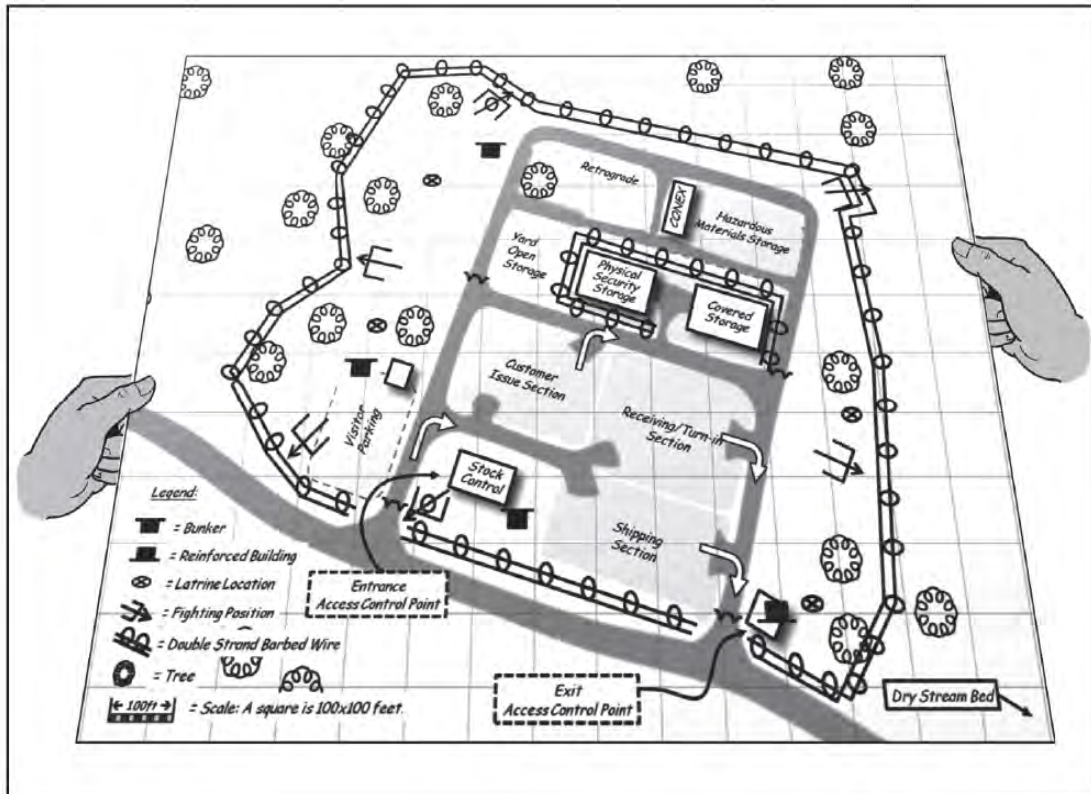
- SSA site selection in accordance with the current operations order.
- Site occupation
- Establishment of SSA Operations
- Site security and defense
- Establishment of SSA communications” (U. S. Army, 2014a, p. 1-9).

SSA functions are part of tactical level logistics, which, focus on “arming, fixing, moving, and supplying of supported units” (U.S. Army, 2014a). SSAs are established to allow “Supported units [to] request...turn in supplies, [which allow units] to: train, mobilize, deploy, support, sustain, and reconstitute forces in theater” (U.S. Army, 2014a, p. 1-5). SSAs are positioned to best support the forward units. According to Army doctrine SSAs are “positioned according to mission, enemy, terrain and weather, troops and support available, time available, and civil considerations (METT-TC) to provide the most efficient and expedient support across their supported area of operations” (U.S. Army, 2014a, p. 1-4). Because SSA layouts and positioning are METT-TC dependent, SSA functionality and design are customized depending on the mission. The variability of SSA configurations can affect inventory operations. Additionally, the following considerations are taken when planning SSA layouts according to Army doctrine:

- “A way to secure the site and establish safe and efficient traffic flow. This includes entrance and exit control points and parking areas.
- Storage for all commodities including storage areas for large equipment, such as generators and vehicles, susceptible to pilfering items, and items requiring controlled climate.
- Potential to integrate existing structures into SSA design.
- Thoroughly review the terrain; look for swampy or wet areas, potential flood sites, presence of animal or insect infestations and ability to expand the site” (U.S. Army, 2014a, p. 2-1).

SSAs can be established in developed and undeveloped locations with no two layouts or designs being alike. Figure 8 is a sample SSA field storage layout design.

Figure 8. SSA Configuration in Contingency Conditions



From ATP 4-42.4 Figure 2-2 United States Army (2014a). *Supply support activity operations* (Unpublished manuscript). Washington, DC: Author

The distribution Company, which is the parent organization of the SSA, conducts operations from the SSA using two distinct methods. Supply point distribution, previously known as service station resupply, and unit distribution, previously known as tailgate resupply. Supply point distribution involves supported units arriving at the SSA or supply point to pick up supplies. Distribution services involve direct delivery by the distribution Company to the supported customer unit.

The SSA is critical to mission success of any Army formation and serves as the multiclass supply distribution, turn in, and warehouse center. All of the aforementioned components interact to provide a functioning SSA within Army formations.

III. METHODOLOGY

The DOD, specifically DLA, has vested interests in streamlining the lumber supply chain process as efficiently as possible, increasing rates of on-time delivery and keeping costs minimized. In this project, multiple analysis methods of DLA's lumber process are used to understand whether a problem exists in this process. Though the process of acquiring, treating, shipping, and issuing lumber is detailed and extensive, focusing on the destination points, where a perceived problem may be, is the center of this research. Analyzing the process from start to finish is important as well, but greater attention on ordering accurately the first time aims to focus on a wide variety of issues that could plague lumber at its ultimate destination. Such factors lend to lost orders, higher costs associated with duplicate orders, and transportation resources being wasted, resulting in the mission faltering due to lack of Class IV.

Supply chain management systems are very prevalent in today's business world. There is plenty of literature on the topic. We reviewed several articles, such as scholarly, professional, academia, and business management. These sources were collected from NPS, the U.S. Army War College, the Defense Technical Information Center (DTIC), Center for Army Lessons Learned (CALL), the U.S. Army's Surface and Distribution Command (SDDC), DLA, and DLA Office of Operations Research and Resource Analysis (DORRA).

Specifically, this research used data provided by numerous points of contact within DLA and the DORRA. DORRA is a focal point for all strategic issues related to transportation and logistics within the DOD. They possess data on all Class IV orders, requestors, shipping details, priority of orders, types of orders, quantity of orders, unit ordering, and numerous other details pertinent to worldwide Class IV distribution. The data provided by DORRA painted the picture of the entire lumber ordering system. Perceived issues of irregularity and orders processed untimely emerged. Trends can be seen from DORRA's point of view as well as contrasting points of view from a forward unit requesting and receiving Class IV orders. DORRA formulated this data from the "Magellan Fusion Center."

Limited research on the actual data associated with Class IV orders resulted in a quantitative approach. Numerous data on orders placed is present; however, data that shows receipt of order does not necessarily mean the end user or the requestor received the order. This research uses statistical analysis to determine trends in orders and duplicate orders. Ratios that include total duplicates to total orders to show trends, if prevalent, in problems associated with the lumber supply chain at the customer interface level. Further, it factors in military units requesting the same Class IV orders.

Statistical analysis can show trends in orders and duplicate orders. An analysis would show if these environments tend to be more or less problematic than already built up logistical hubs. Often, Class IV orders are needed in environments where no infrastructure exists to receive the orders. Such an environment might be an earthquake relief zone, a forward-deployed area, or humanitarian response to a disease outbreak. Austere conditions bring forth a slew of unpredictable variables in regard to receiving lumber. Statistical analysis can show trends and correlations between these variables such as duplicate orders.

Throughout this research, several statistical models are present. The data provided by DORRA lead to 74,021 items of lumber being ordered over a three year period throughout six Combatant Commands (COCOM) and one unknown category. From this data, each order was divided into each COCOM or an unknown category. From this, data trends emerged in the categories of unit ordering (DODAAC), quantity of orders, type of order (NIIN), and finally date of order. From these variables, one can tell where there are trends in duplicates. Further, a Pareto curve was used to show the significance of duplicate orders. A Pareto curve is especially important in this regard since there might be over 200 NIINs ordered in duplicate, however, only 16 NIINs represent nearly 90% of all duplicates for a COCOM. A Pareto curve is decisive in identifying where efforts should be used to make changes.

Researchers of this thesis use root cause analysis. Root cause analysis identifies problems and dissects the problem into various degrees of significance. One problem might lead to second and third order effects that were previously unseen, thus resulting in a larger systemic problem. This analysis offers to provide more value to the end user as

well as determine where no value is added. As a result of this analysis, unnecessary steps in a process can be eliminated or steps may be changed to cope with unforeseen problems.

Of important note, the term duplicate order is significant in meaning as it relates to this research. In short, a duplicate order is the same order as defined by criteria set forth in this research, of an original order. For example, if X-unit, on an X-date, orders an X-quantity of an X-NIIN, then that is one order. If that order, meeting all those X-criteria equally is placed within a certain time window again, it is considered to be a duplicate order. In general, we use a time frame of seven sliding days to determine periods of duplicate orders. The model built in excel allows for a user to select the days between orders to see different trends in duplicates, using length time as an independent variable. When charts show the amount of orders and duplicate orders, normal orders are in blue and duplicate orders are in red. The more red on blue, then the higher the duplicate trend for that data set, such as quantity of NIIN or DODAAC.

Excel spreadsheets are used extensively in this research. This allows for a model to be created in order to filter through 344,005 lines of Class IV data and produce 74,021 lines of purely lumber orders. Each line represents one order. The excel model looks for and counts the frequency of orders possessing the same unit, date, quantity, and NIIN. Each count resulted in knowing the total number of duplicate orders, which varied per COCOM and changing the value of time between orders. The model was tailored to allow for changing the time window from zero to seven day sliding windows to see if orders were more of a problem in day to day operations versus a seven day period between duplicate orders.

Lastly, this thesis provides a case study of what Class IV shipments look like in a forward contingency environment. This particular case was provided by DORRA and focuses on OUA, a U.S. and international mission to contain the spread of Ebola in Western Africa. The conditions in the case show the rapid need for lumber to build infrastructure to support mission requirements. It additionally shows how lumber was a highly sought after commodity and that its proper management can lead to early mission

success or failure. This case analysis reinforces the importance of understanding interagency collaboration and requirements to meet mission demand.

IV. FINDINGS

This chapter is broken down into findings based on Combatant Commands (COCOMs). It leads with a section showing overall ordering trends within the Defense Logistics Agency (DLA). It then further analyzes the ordering data in each individual COCOM, focusing primarily on NORTHCOM due to its large size. The other COCOMs and further NORTHCOM data and analysis can be found in Section A of the Appendix. This allows for macro and micro observations to emerge. Unique reasons for duplicate orders emerge differently within each COCOM. The data was dissected by looking at orders based on quantity, DODAAC, date, and NIIN. Each category produced different results, which may or may not be construed as detrimental to the lumber ordering system based on the percentage of duplicate orders.

A. OVERALL TRENDS OF ALL COCOMS

From July 2012 to July 2015, across all of the major geographically aligned COCOMs, there were 344,005 orders of Class IV materials. Of this amount, 74,021 were orders for lumber. Lumber includes all wood and lumber products, many of which can be found in the DLA wood products catalog. All data includes an unknown category which is unknown because the associated COCOM was not listed in the provided DLA lumber order data. The unknown order data has not been removed because the data appears as a valid order just without the associated COCOM. The unknown category of data was also retained because this category serves as a sample of the total lumber order data and the properties exhibited by the unknown category are similar to the other COCOMs. As such, logical conclusions can be made from this unknown COCOM data since all other relevant measures are present including DODAAC, NIINs, quantity, etc. Table 3 lists the values of all Class IV and lumber orders during the period of study.

Table 3. All COCOM Class IV orders broken down into lumber

Master Class IV Data	
	Total
Total CLS IV Orders	344005
Lumber Orders	74021
% Lumber	21.52%

(1) Overall trends of all COCOMs by orders

The lumber orders in Table 3 represent 21.52% of all of the Class IV items ordered. Tables 4 and 5 detail all of the Class IV lumber and duplicate orders placed during a seven day sliding window. When using a one day sliding window, the total duplicate order rate was 8.76%. This grows tremendously when you use a more realistic seven day sliding window. In total, using a seven day sliding window for duplicate orders, 49.83% of the lumber orders placed were duplicate orders, as described in Table 5. Further, each COCOM displayed a similar trend as depicted in Table 5.

Table 4. All COCOM Class IV Duplicate Orders within a one day sliding window

Combatant Command Class IV Data								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	total
Lumber Orders	42853	8129	6459	3370	814	46	12350	74021
% Lumber	57.89%	10.98%	8.73%	4.55%	1.10%	0.06%	16.68%	100%
tot duplicates	8359	1434	723	587	64	6	1789	12962
% duplicates	19.51%	17.64%	11.19%	17.42%	7.86%	13.04%	14.49%	17.51%
% tot duplicates	64.49%	11.06%	5.58%	4.53%	0.49%	0.05%	13.80%	100.00%

Table 5. All COCOM Class IV orders broken down into lumber within a seven day sliding window

Combatant Command Class IV Data								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	total
Lumber Orders	42853	8129	6459	3370	814	46	12350	74021
% Lumber	57.89%	10.98%	8.73%	4.55%	1.10%	0.06%	16.68%	100%
tot duplicates	23673	4007	2790	1562	306	6	4544	36888
% duplicates	55.24%	49.29%	43.20%	46.35%	37.59%	13.04%	36.79%	49.83%
% tot duplicates	64.18%	10.86%	7.56%	4.23%	0.83%	0.02%	12.32%	100.00%

Figure 9 describes the lumber duplicate order phenomena in terms of geographical COCOMs within a seven day sliding window. There are minor fluctuations between the COCOMs executing duplicate orders between one day and seven days as an ordering

period. NORTHCOM is the only COCOM that grows as a percentage of duplicate orders and is responsible for the majority of the lumber duplicate orders. The reason for the larger percentage within NORTHCOM is associated with the number of military units assigned to NORTHCOM. NORTHCOM has the largest number of units which placed orders for lumber during the period of study.

While all COCOMs can improve, NORTHCOM stands to gain the most from improving the lumber ordering system. Further, NORTHCOM can be used as a test bed for making improvements to the supply chain management systems for lumber since it is not subject to forward operating constraints.

Figure 9. All COCOM percentage of lumber duplicate orders within a one day sliding window

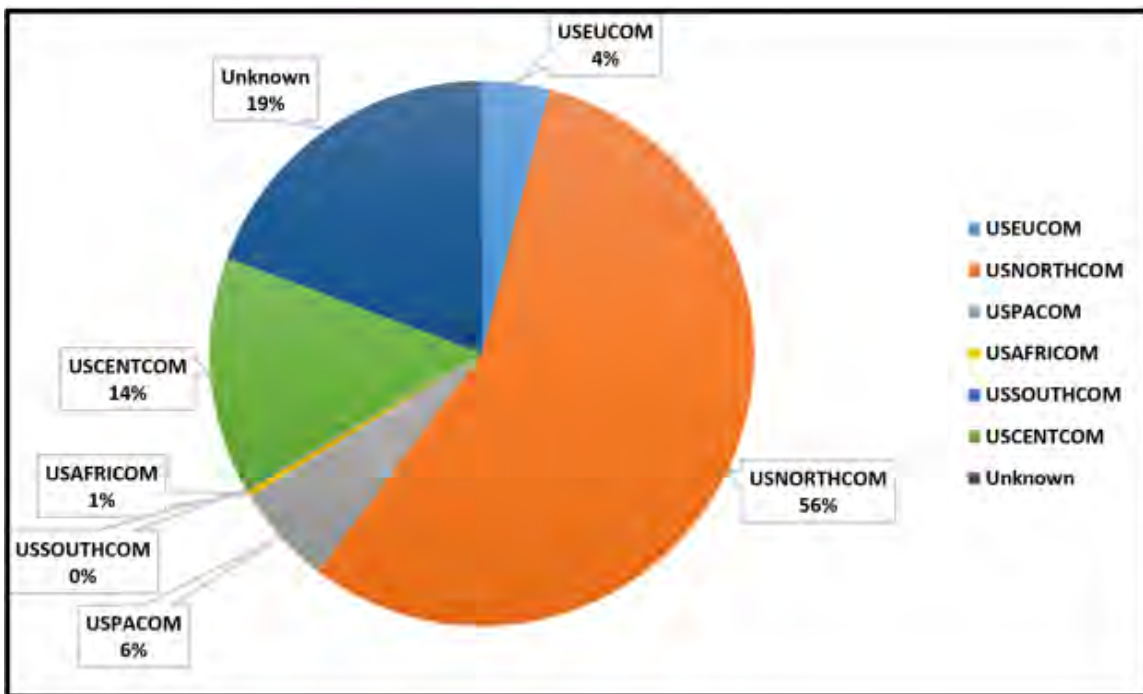


Figure 10. All COCOMs percentage of lumber duplicate orders within seven day sliding window

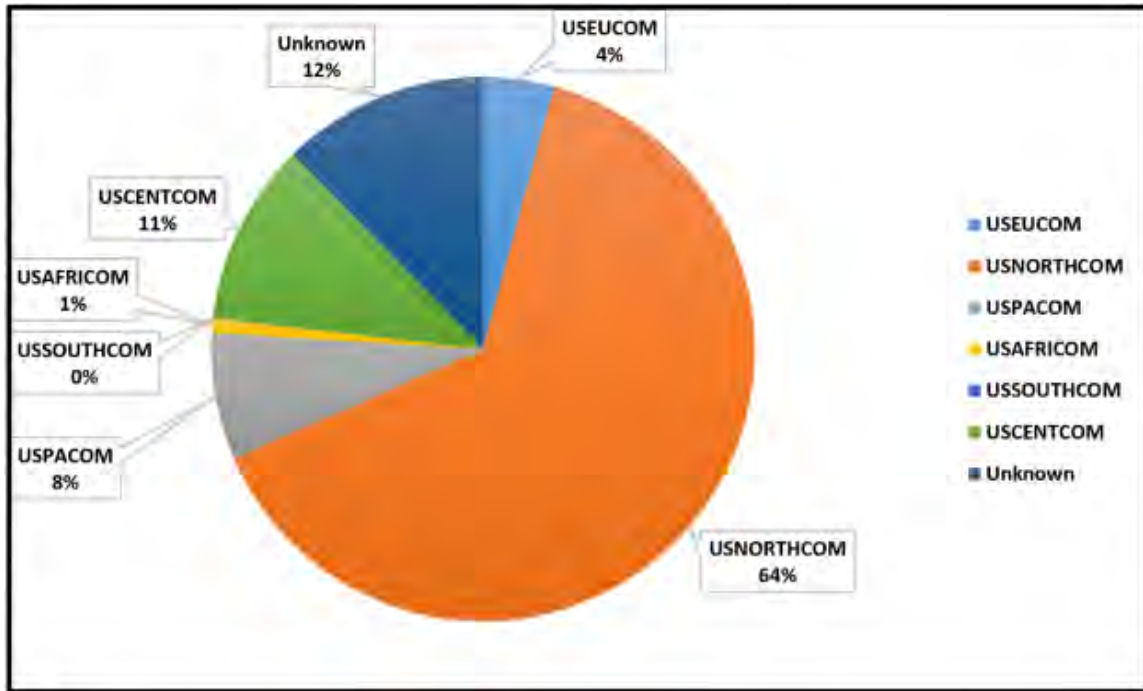


Figure 11 describes the COCOM lumber and duplicate orders placed during the period of study using the seven day sliding window. The one day sliding window displays a low duplicate order rate. This in turn can be seen as a baseline. When using a seven day sliding window, a large growth across all COCOMs is prevalent. Using a seven day sliding window, an average duplication rate of 49.83% is observed. Conversely, using a one day window, the rate is 8.76%. These order trends indicate that a high demand for lumber is also accompanied by a high duplicate order rate. As orders are placed in duplicate, the frequency of a duplicate order increases throughout the seven day sliding window. By day seven of the order window, the number of duplicate orders increases and accounts for nearly 50% of all lumber orders placed during the three year period of study.

Table 6 shows the total amount of NIINs per COCOM as well as the rate of order duplication. Overall, there were 556 different NIINs ordered throughout all COCOMs. Of these 556 NIINs, 270 NIINs were ordered as duplicates, or 48.56%

Table 6. All COCOM NIIN totals, duplicates, and rate per COCOM

NIIN duplicate rate per COCOM								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	ALL
Total NIINs	449	212	272	111	51	13	208	556
NIINs duplicated	217	114	97	57	21	2	108	270
% Duplicate	48.33%	53.77%	35.66%	51.35%	41.18%	15.38%	51.92%	48.56%

(2) Overall trends of all COCOMs by DODAAC

Understanding the duplicate ordering trend at the COCOM level is important. Pinpointing whether this trend is associated with a unit ordering at the user level or a systemic problem is just as important. Looking at the ordering trends by DODAAC allows understanding of unit behavior and determining if all units, or just select units, had problems ordering lumber. When looking at all duplicate-ordering DODAACs, NORTHCOM emerges as the largest perpetrator. 52% of all DODAACs within NORTHCOM placed duplicate orders during the period of study. This duplicate order phenomenon exists at the user level of ordering. Figure 11 shows the analysis for the percentage of duplicate ordering DODAACs per COCOM.

Figure 11. All COCOMs percentage of DODAACs that make duplicate orders

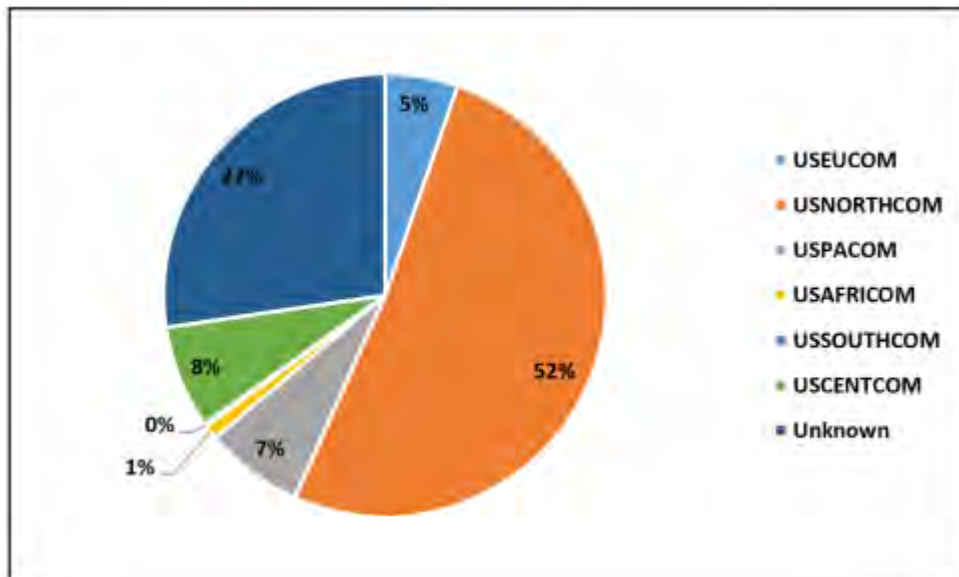
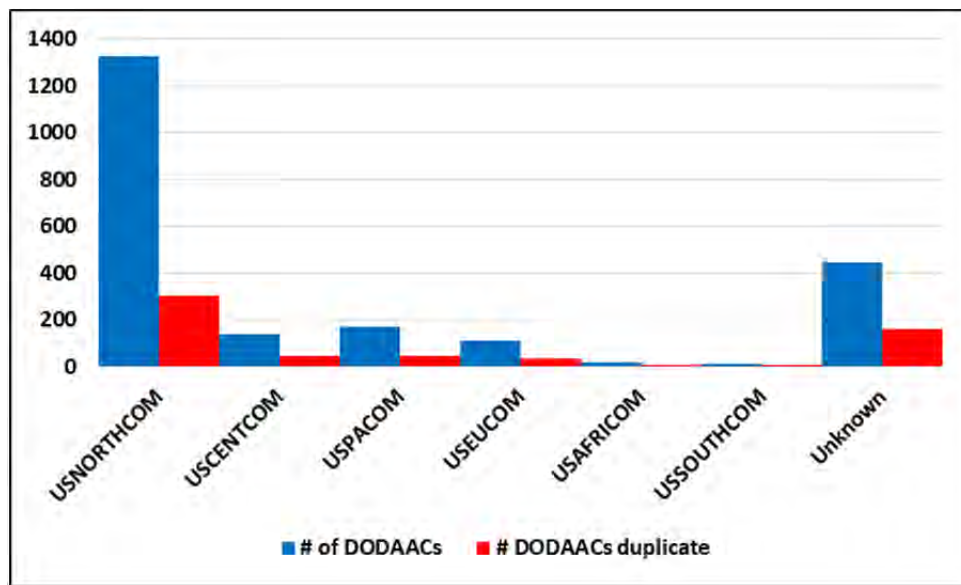


Figure 12 displays the number of DODAACs per COCOM which placed regular and duplicate orders. The blue represents the frequency of DODAACs that placed regular orders and the red represents the frequency of DODAACs that ordered in duplicate. The more red on blue, the higher the frequency of duplicate orders. When viewing duplicate orders rates through the lens of the DODAAC, the duplicate order rate drops considerably as compared to total duplicate orders. This shows that if resources are put into correcting the duplicate order placement at the user interface level, the duplicate-ordering trend would be greatly reduced. This is a common theme throughout all COCOMs, regardless of duplicate order sizes.

Figure 12. All COCOMs total DODAACs that order correctly and incorrectly within a seven day ordering window



(3) Overall trends statistically of all COCOMs

Viewing each order and its frequency of duplication can lead to an understanding of at what level this problem exists. Figures 13 and 14 show the difference in orders using a one day vs seven day sliding window. This is significant in the fact that duplicate orders by NIIN rise drastically from one day to seven days. This means that the same DOD units are ordering the exact same quantity and lumber items, all within a small period of time. The red-bar on blue-bar increase in duplicates between Figures 14 and 15,

because of the seven day sliding window which represents a total percentage of duplicate orders for that COCOM.

Figure 13. COCOM lumber orders using a one day sliding window

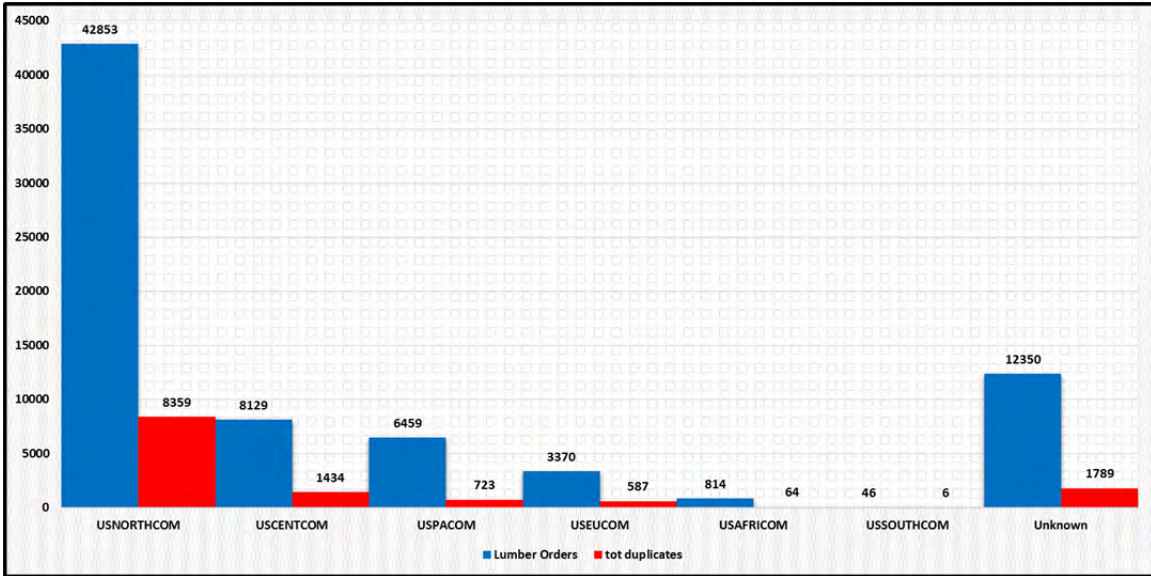


Figure 14. COCOM lumber orders using a seven day sliding window

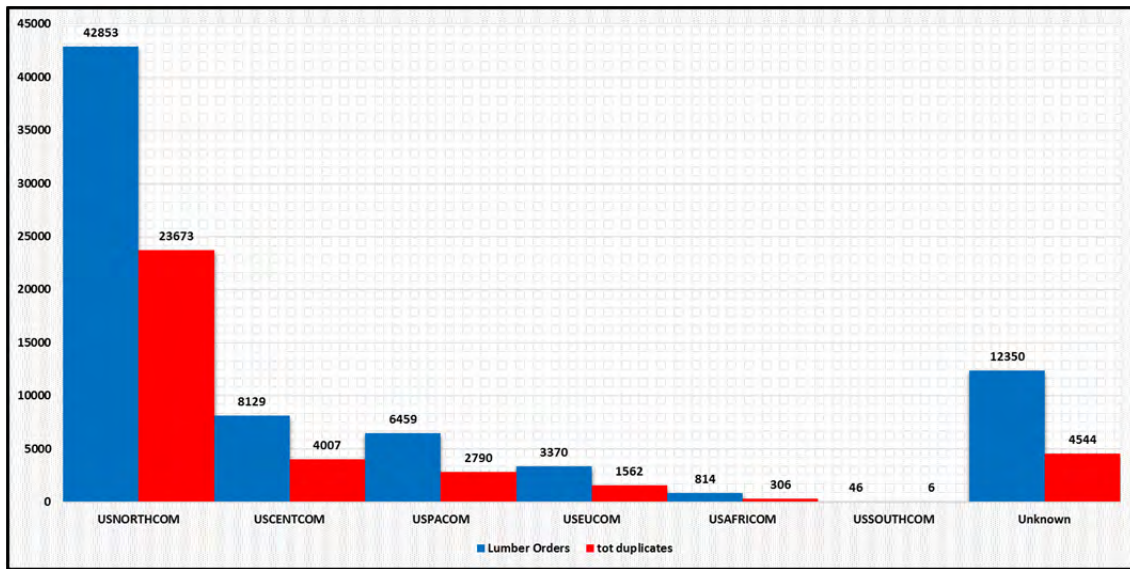


Table 7 and Figure 14 describe the average lumber and duplicate orders placed by date, order, DODAAC, item, and quantity. These numbers reinforce previous data about each COCOM's pattern of placing lumber orders in duplicate.

Table 7. All COCOM statistics of Duplicate Orders using a seven day sliding window

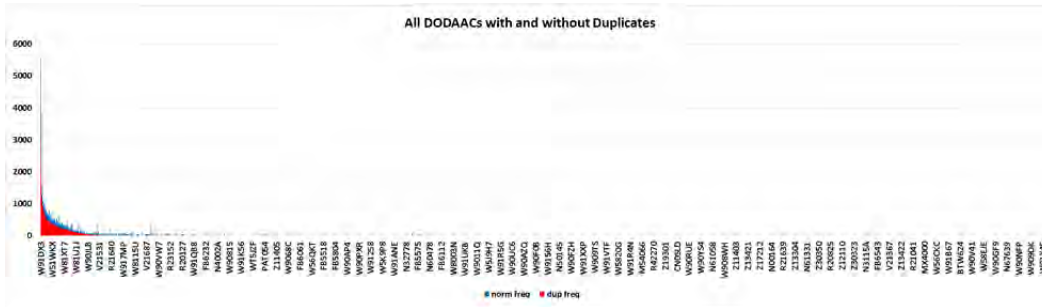
Average Order rate per Day (7 day sliding window)								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	ALL
Normal Orders	42.18	8.80	7.82	4.90	2.22	3.54	12.99	77.11
Duplicate Orders	23.30	4.34	3.38	2.27	0.84	0.46	4.78	40.11
% Duplicate	55.24%	49.29%	43.20%	46.35%	37.59%	13.04%	36.79%	52.01%
% of total duplicates	58.09%	10.81%	8.42%	5.66%	2.08%	1.15%	11.91%	100.00%
Average Order rate per DODAAC (7 day sliding window)								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	ALL
# of DODAACs	1329	136	168	108	19	9	442	2211
# DODAACs duplicate	299	44	42	31	6	1	159	586
% of duplicate DODAACs	22.50%	32.35%	25.00%	28.70%	31.58%	11.11%	35.97%	26.50%
% of tot duplicate DODAACs	51.02%	7.51%	7.17%	5.29%	1.02%	0.17%	27.13%	100.00%
Normal Orders	32.24	59.77	38.45	31.20	42.84	5.11	27.94	33.48
Duplicate Orders	17.81	29.46	16.61	14.46	16.05	0.67	10.28	16.68
% Duplicate	55.24%	49.29%	43.20%	46.35%	37.47%	13.04%	36.79%	49.83%
% of total duplicates	16.91%	27.97%	15.76%	13.73%	15.24%	0.63%	9.76%	100.00%
Average Lumber Items per Day (7 day sliding window)								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	ALL
Normal Orders	47214.86	12070.04	9638.03	3672.47	1460.95	4.79	7395.49	81456.63
Duplicate Orders	17644.46	3833.20	3461.07	426.57	189.63	0.01	2130.32	27723.68
% Duplicate	37.37%	31.76%	35.91%	11.62%	12.98%	0.23%	28.81%	34.03%
% of total duplicates	63.73%	13.85%	12.50%	1.54%	0.68%	0.00%	7.69%	100.00%
Average Quantity of Orders per Day (7 day sliding window)								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	ALL
Normal Orders	1206.48	1625.87	1633.94	1193.63	1965.28	114.02	655.71	1205.03
Duplicate Orders	817.95	1047.50	1358.38	299.04	678.59	3.67	513.36	822.98
% Duplicate	67.80%	64.43%	83.13%	25.05%	34.53%	3.22%	78.29%	68.30%
% of total duplicates	17.33%	22.20%	28.79%	6.34%	14.38%	0.08%	10.88%	100.00%
NIIN duplicate rate per COCOM								
	USNORTHCOM	USCENTCOM	USPACOM	USEUCOM	USAFRICOM	USSOUTHCOM	Unknown	ALL
Total NIINs	449	212	272	111	51	13	208	556
NIINs duplicated	217	114	97	57	21	2	108	270
% Duplicate	48.33%	53.77%	35.66%	51.35%	41.18%	15.38%	51.92%	48.56%

(4) Overall trends of all COCOMs by quantity of orders

Figure 15 represents all orders across all COCOMs as viewed solely from the quantity amount. This shows a trend in high duplicate order placement based on quantity. For example, the largest spike on the far left represents 17,879 duplicate orders out of 21,825 orders of the same NIIN. Significance to this spike is that each duplicate order is for exactly 1,000 pieces of lumber. Further, there are approximately 10 quantity orders of various NIINs that represent whole numbers such as 5, 25, 50, and 100. This indicates that duplicate orders are not tailored to specific projects, but rather are untied to

requirements. This is significant because this trend indicates improper use of supply ordering systems and failure to properly define requirement before placing lumber orders.

Figure 15. All COCOMs lumber order frequency by legitimate orders and duplicate orders by quantity



In total, there are 2,687 different quantities of lumber ordered, of which, 457 were duplicates. On average, each quantity by NIIN ordered in duplicate represents 81 lumber items. Just because a NIIN is a duplicate once, does not necessarily mean that it is a low measurement of duplicate ordering. One NIIN could represent 1,000 pieces of lumber as part of a larger duplicate order.

(5) Overall trends of all COCOMs by averages of orders based on date, DODAAC, quantity of NIINs, and quantity of orders

Figures 16–19 represent various statistical measures of each COCOM. These Figures reveal the prevalence of duplicate orders when viewed solely by either DODAAC, date of order, quantity of order, or NIIN. Trends emerge to show that duplicate orders are different when viewed with different criteria. In short, nearly all COCOMs have a duplicating problem that lends itself to duplicate orders being placed at the user level.

Overall, many different trends emerge when viewing duplicate orders by averages per day. The average duplicate orders placed per day across all COCOMs was 52%. The average percentage of DODAACs conducting duplicated orders across all COCOMs is only 26.5%; however, the average percentage of duplicate-ordering DODAACs per day across all COCOMs is 50%. The average quantity of actual lumber items in the supply chain is 81,456 pieces of lumber per day, of which, 27,723 pieces are duplicate ordered

items, or 34% of all lumber items in the supply chain are duplicate orders. Lastly, the average quantity of lumber orders placed per day is 1,205 orders, of which, 823 are duplicates, or 68.3%. From these averages, honing in on the smaller percentage numbers can yield the biggest results when finding solutions to the duplicate order problem. In this case, looking at each individual DODAAC and how they conduct their lumber orders can allow for the identification of the biggest duplicate order placing units.

Figure 16. All COCOMs average order rate per day using a seven day sliding window

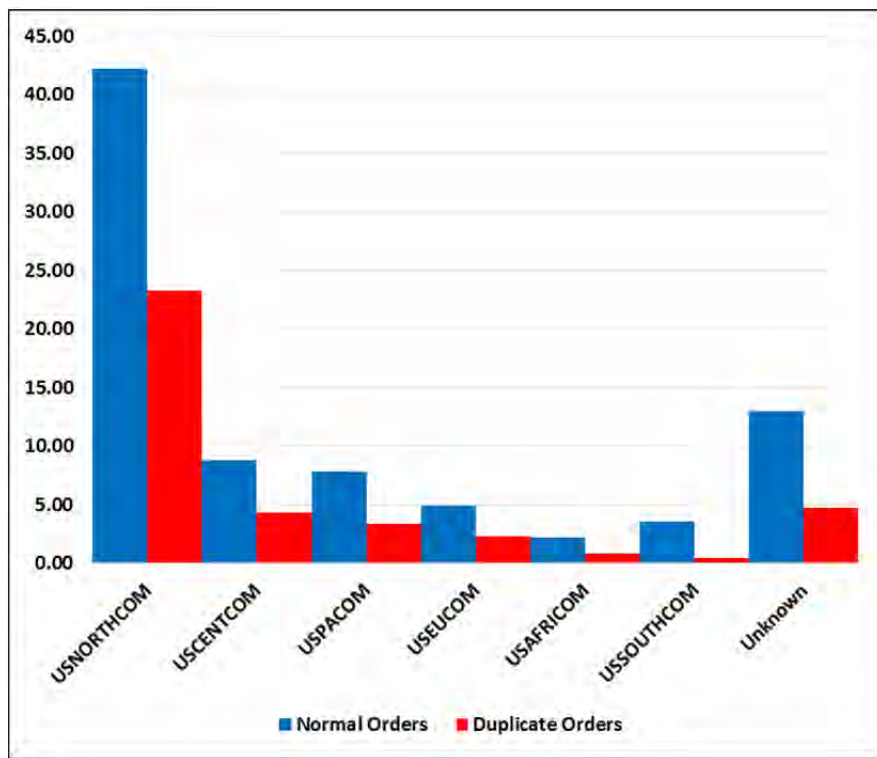


Figure 17. All COCOMs average order rate per DODAAC using a seven day sliding window.

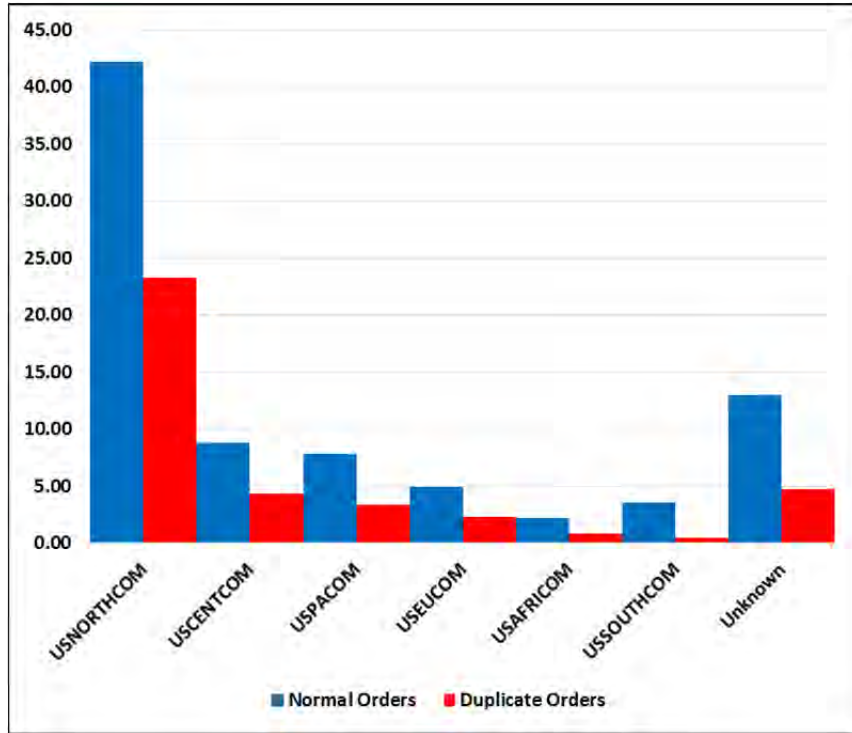


Figure 18. All COCOMs average lumber items per day using a seven day sliding window.

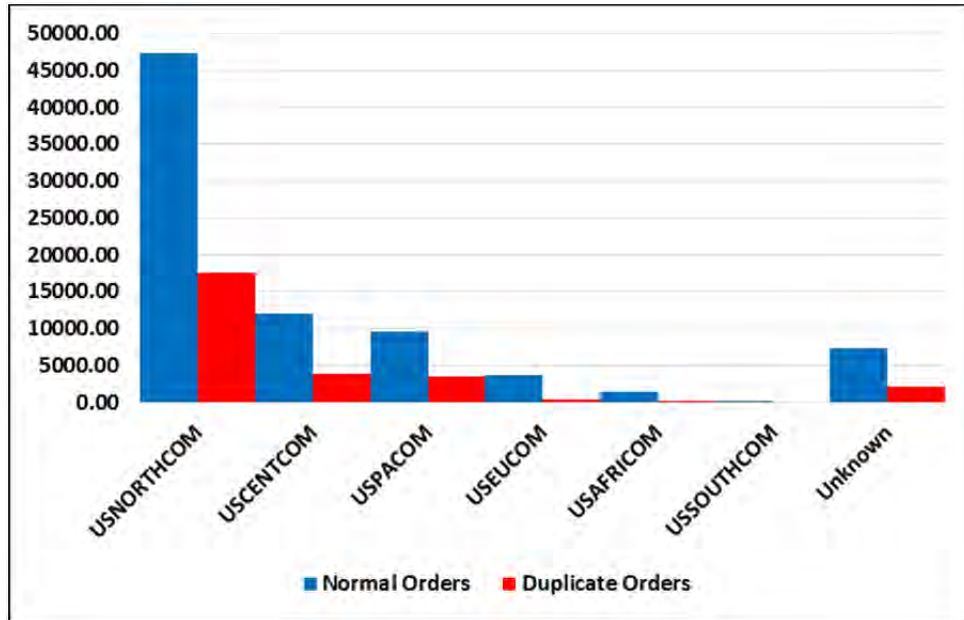
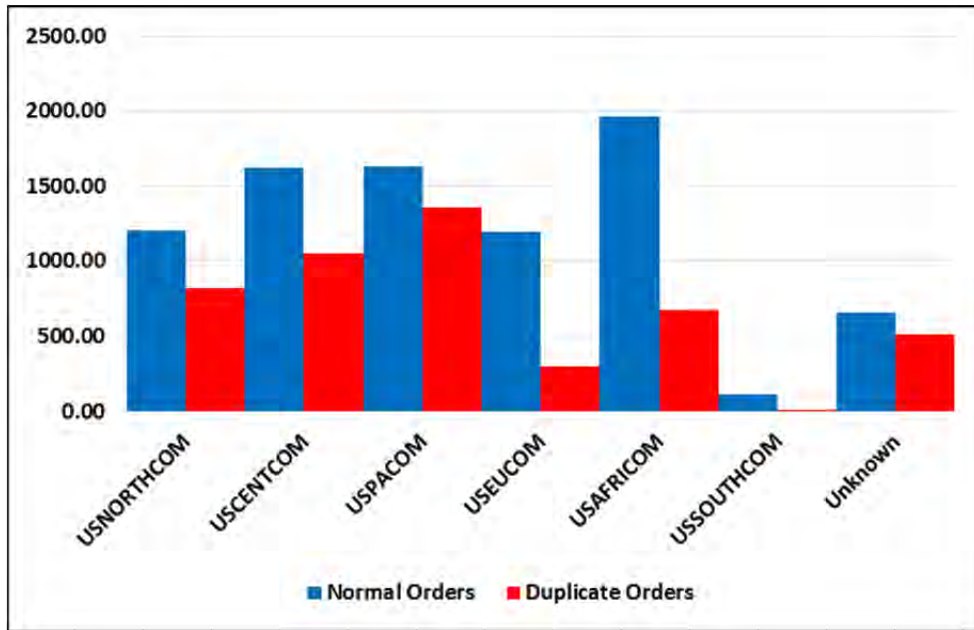


Figure 19. All COCOMs average quantity in an orders using a seven day sliding window.



In summary all COCOMs, including the unknown, display similar trends in demand for lumber with an associated pattern of placing duplicate orders. Some COCOMs have an increasing tendency to place duplicate orders; however, the disposition of forces affects the demand for lumber and associated duplicate order placing behavior. Further analysis of each COCOM has been conducted, each revealing unique patterns of ordering behavior.

Table 8. All COCOM average order rate per day

ALL	
Normal Orders	77.11
Duplicate Orders	40.11
% Duplicate	52.01%
% of total duplicates	100.00%

Table 9. All COCOM average order rate per DODAAC

ALL	
# of DODAACs	2211
# DODAACs duplicate	586
% of duplicate DODAACs	26.50%
% of tot duplicate DODAACs	100.00%
Normal Orders	33.48
Duplicate Orders	16.68
% Duplicate	49.83%
% of total duplicates	100.00%

Table 10. All COCOM average lumber items per day

ALL	
Normal Orders	81456.63
Duplicate Orders	27723.68
% Duplicate	34.03%
% of total duplicates	100.00%

Table 11. All COCOM average quantity of orders per day

ALL	
Normal Orders	1205.03
Duplicate Orders	822.98
% Duplicate	68.30%
% of total duplicates	100.00%

B. NORTHCOM

(1) Overall trends of NORTHCOM by top lumber Items

NORTHCOM is the largest COCOM which placed duplicate orders during the period of study, for this reason further analysis of this COCOM has been conducted. Between 1 July 2012 and 1 July 2015, NORTHCOM was the largest COCOM that placed duplicate orders and stands to gain the most from a change in ordering procedures. NORTHCOM had 42,853 total orders placed, of which, 23,673 were classified as duplicates, or 55.24%. Not only is this the highest in terms of quantity, but also it is the highest duplicate order rate of all the COCOMs. Table 12 describes the lumber type and dimensions which were ordered in duplicate.

Table 12. NORTHCOM types of duplicate lumber

NORTHCOM		
NIIN	Nomenclature	Wood Type
6186958	1/2" x 48" x 96"	Veneer Plywood
14334200	2" x 4" x 8'	Lumber
14451016	4" x 4" x 8'	Lumber
1676855	2" x 4" x 8'	Lumber
16079434	4" x 4" x 16'	Lumber
2206198	2" x 8" x 6'	Lumber
1297777	1/2" x 48" x 96"	Plywood
14331244	2" x 4" x 16'	Lumber
2206178	4" x 4" x 8'	Lumber
16079431	2" x 12" x 16'	Lumber
2206194	2" x 4" x 6'	Lumber
14334221	4" x 4" x 16'	Lumber
220680	Wood packaging	Wood
14338589	1" x 4" x 12'	Lumber
14331216	2" x 4" x 8'	Lumber
14338603	1" x 6" x 12'	Lumber

The listed lumber items range from plywood to lumber boards and vary in dimension and type. Many of the types of lumber are sheets of plywood and lumber with varying dimensions. These types of lumber are suitable for construction purposes including both interior and exterior surfaces. The listed lumber is also useful for building wall frames, flooring, structural support posts, and bracing cargo inside of military shipping containers.

(2) Overall trends of NORTHCOM by NIIN

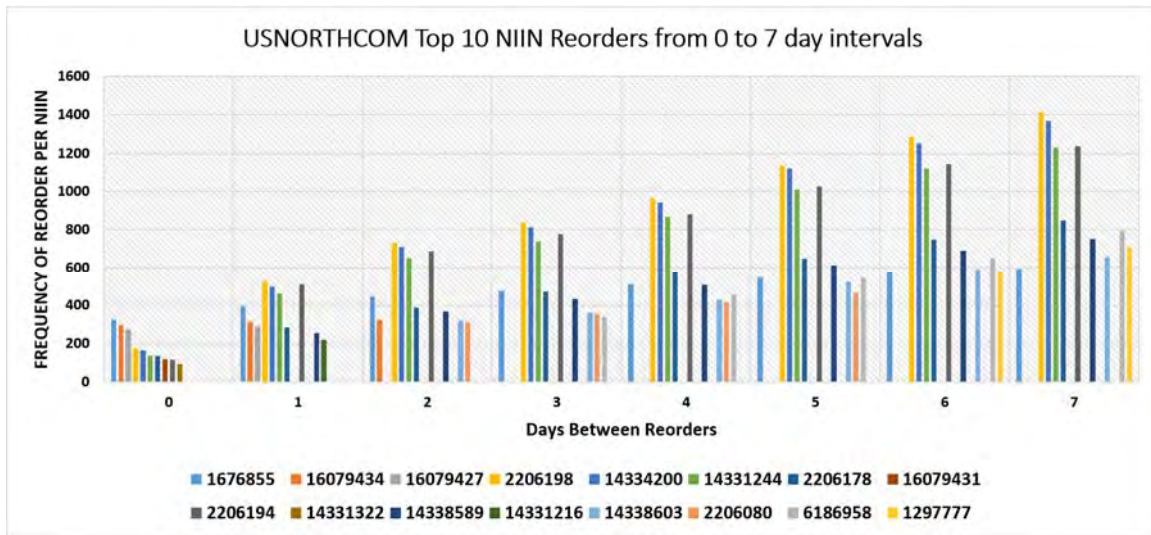
Table 13 depicts the exact number of NIINs within NORTHCOM. 449 different NIINs were ordered, of which, 217 were duplicate orders. This represents a 48.33% duplicate rate by NIIN, which is slightly below the overall average of 48.46%. NORTHCOM represents the largest COCOM in terms of total NIINs ordered and ordered in duplicate.

Table 13. NORTHCOM NIIN order total, duplicates, and percentage rate

USNORTHCOM	
Total NIINs	449
NIINs duplicated	217
% Duplicate	48.33%

Figure 20 and Table 14 represent the top 10 NIINs lumber items ordered during the period of study. The top 10 duplicate orders vary from day to day and represent 16 individual NIINs, depending on the day within the seven day sliding window.

Figure 20. NORTHCOM top ten NIIN duplicates from zero to seven days



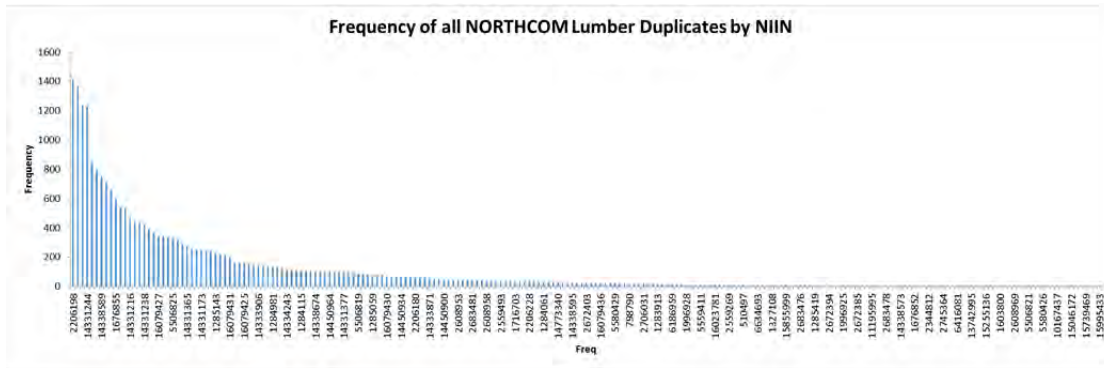
The top 10 duplicate orders vary from day to day and represent 16 individual NIIN items depending on the day within the seven day sliding window. The number one item placed in duplicate for NORTHCOM was NIIN 2206198, which is the 2" x 8"x 6' lumber board. This board was placed in duplicate 7,071 times during the three year period of study by various units within NORTHCOM. Table 14 data applies to Figure 20 and shows the quantity of all NIINs placed on in duplicate by day.

Table 14. NORTHCOM quantity of duplicate NIINs per day of duplicate

		Number of days in ordering period							
		0	1	2	3	4	5	6	7
NIINs	1676855	327	395	448	477	510	546	574	594
	16079434	299	315	325					
	16079427	275	292						
	2206198	178	526	731	839	966	1137	1283	1411
	14334200	166	499	710	814	943	1122	1251	1367
	14331244	138	464	650	738	867	1011	1121	1231
	2206178	134	286	388	474	573	649	749	849
	16079431	120							
	2206194	116	510	686	776	880	1028	1144	1236
	14331322	94							
	14338589		255	369	433	508	611	690	752
	14331216		220						
	14338603			319	363	431	523	589	656
	2206080			309	355	419	466		
	6186958				339	455	548	652	795
1297777							579	710	
		Number of times duplicate NIIN occurred in each day							

Figure 21, illustrates the types of lumber placed on order and in duplicate within the seven day sliding window. Each NIIN represents an individual type of lumber placed on order during the three year period of study. The vast majority of NIINs were ordered correctly; however, NIINs ordered in duplicate represent nearly 50% of all NIINs ordered in NORTHCOM. If we use Day 0 as a baseline, which represents an original order that won't be duplicated later in the seven day sliding window, NORTHCOM's duplicate order rate is only 8.51%, or 56.28% of all DLA duplicate orders. This means that units place about 8.5% duplicate orders in any one day. Within the seven day sliding window, this number grows tremendously. In NORTHCOM's case, the percentage grew to a 55.24% duplicate rate within the seven day sliding window. This represents nearly 65% of all of DLA's total duplicate orders. The top ten NIINs from Figure 22 represent nearly 50% of the duplicate ordered NIINs.

Figure 21. NORTHCOM total duplicate orders by NIIN



The NIIN changes in type and frequency throughout the duration of the seven day sliding window. At day seven the frequency of the type of lumber ordered in duplicate has changed along with the rank order of frequency. For example, NIIN 2206178, which is a 4" x 4" x 8' lumber board, on day one was observed as being 4th in rank order of the most frequently ordered NIIN in duplicate. By day seven of the seven day sliding window, this same item moved to the 1st rank order. The type of lumber item being ordered in duplicate changes during the seven day sliding window. Certain lumber items have a varying degree of demand throughout the duplicate order period.

In summary, units appear to experience a sliding demand scale for different types of lumber items depending on how long they wait to order in duplicate. This data could prove useful because it reinforces the top 16 high demand NIINs and supports the idea that items placed in duplicate are also in high demand.

(3) Overall trends of NORTHCOM by date

Figures 22–25, represent the frequency of Class IV lumber items placed in either normal or duplicate order by date. Each Figure represents lumber orders placed throughout NORTHCOM. The more the red-bar is stacked on the blue-bar, then the more prevalent the duplicate order is. Significant to this is the Y-axis. The variability in total orders, whether normal or duplicate, changes each year, sometimes drastically. More variance can contribute to unexpected ordering and shipment of lumber. This, in turn, can lead to greater shipping costs and larger holding costs. It further clogs the supply chain pipeline with extra lumber. When viewing duplicate orders by day, there is on average 23.3 duplicate orders in process within NORTHCOM during the period of study.

Figure 22. NORTHCOM frequency of orders by date in 2012

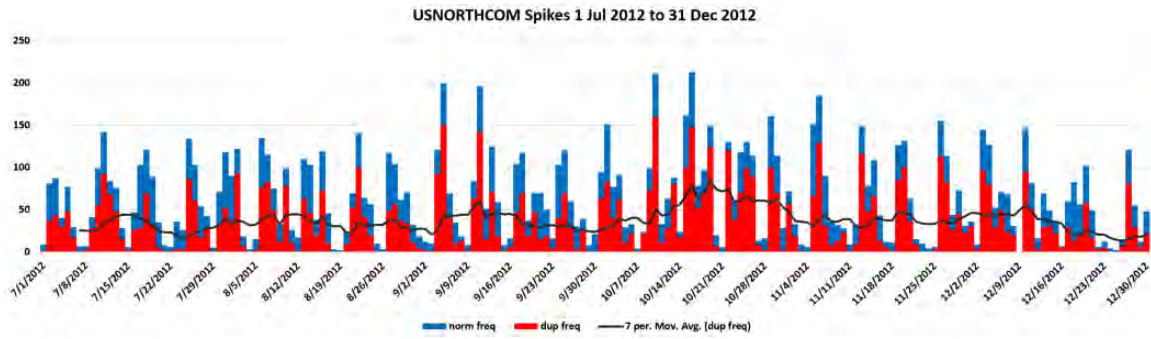


Figure 23. NORTHCOM frequency of orders by date in 2013

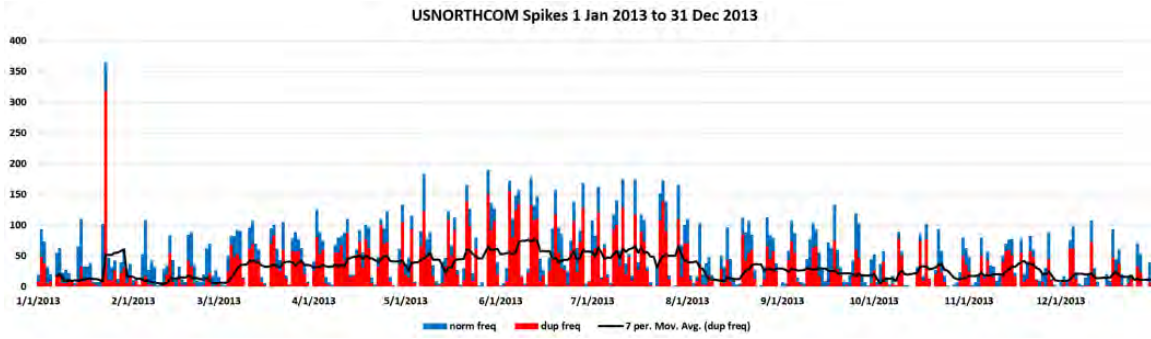


Figure 24. NORTHCOM frequency of orders by date in 2014

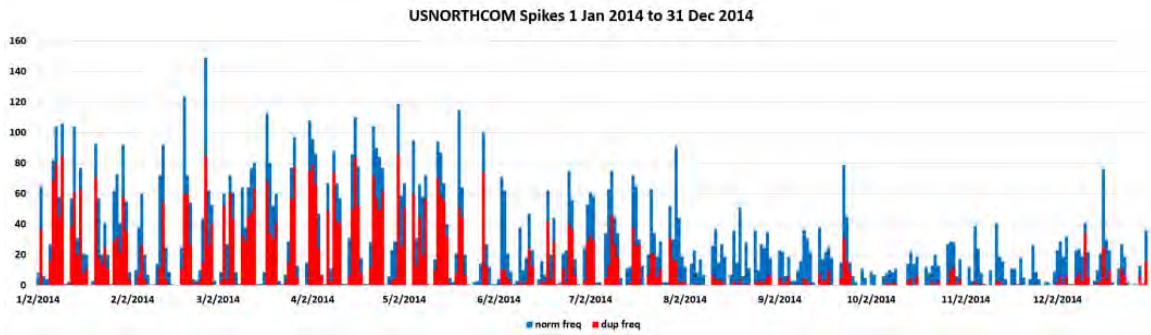
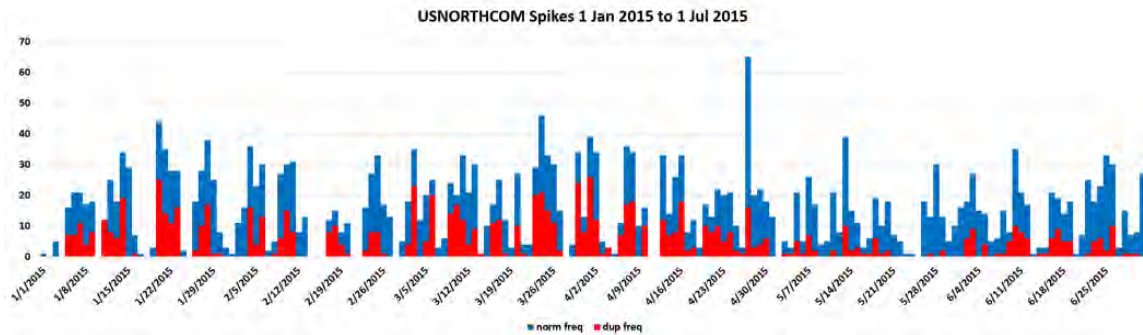


Figure 25. NORTHCOM frequency of orders by date in 2015



The exact cause and nature of these spikes may be requirements related and associated with significant unit activities. There also appears to be a trend of seasonality associated with the spikes in demand for Class IV lumber items. Some of the seasonal events could include unit training, deployment preparation, and container loading prior to unit movements. The first half of 2014 was a particular bad year for duplicate orders in NORTHCOM. During that initial six months, nearly half of all orders were duplicate. Conversely, however, during the last six months of 2014 the number of duplicate orders placed was greatly reduced. This is the only occurrence of this phenomenon throughout all of the COCOMs. The first six months of the final year, 2015, saw the lowest variance in orders. Further, the duplicate average was below is 23.3% duplicate ordering rate. 2015 was the best year in terms of minimizing duplicate orders, particularly the early summer months of May and June within NORTHCOM.

(4) Overall trends of NORTHCOM by DODAAC

Table 15 and Figures 26–28 represent the NORTHCOM frequency of normal and duplicate orders placed by DODAAC. Table 15 describes how 1,329 units placed orders for lumber during the period of study. Of the 1,329 units which ordered lumber, 299 of these units or 22.50% placed duplicate orders. With the exception of SOUTHCOM and its extremely low sample size, this duplicate order rate by DODAAC is the lowest of all the COCOMs. This means that 77.5% of units in NORTHCOM did not place a duplicate order, only 22.5% of the units ordered in duplicate.

Table 15. NORTHCOM DODAACs with duplicating problems

# DODAACs w/ duplicates	299
# DODAACs	1329
% of DODAAC reordering	22.50%

Figure 26 displays the frequency of normal and duplicate orders placed by a DODAAC within NORTHCOM. There is a large amount of variance present between ordering DODAACs. Every DODAAC produced at least one duplicate order. The more the red-bar overlies the blue-bar, the greater the severity of duplicate ordering. Particularly noticeable was that DODAAC W19DX3 which placed 5,542 orders, of which, 3,485 were duplicate orders. Also, W90HDC had a 94.3% duplicate order rate. Nearly every order was a duplicate. When looking at a DODAAC that places orders correctly, such as SB3300, one notices a much different trend. SB3300 ordered 360 times, of which, only 5 were duplicate orders. This Figure could allow the DOD to focus supply training efforts onto certain units who have historically placed duplicate orders.

Figure 26. NORTHCOM duplicate-ordering DODAACs

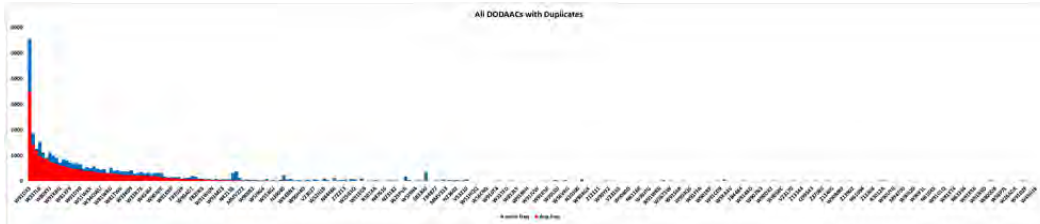
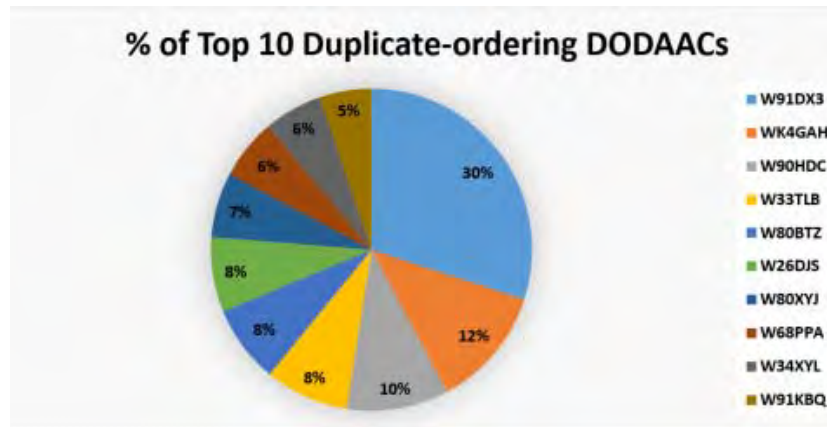


Figure 27 describes the top ten duplicate ordering NORTHCOM units by DODAAC. The leading DODAAC, W91DX3, was responsible for 30% of duplicate orders. Certain units are more responsible for placing duplicate orders over others.

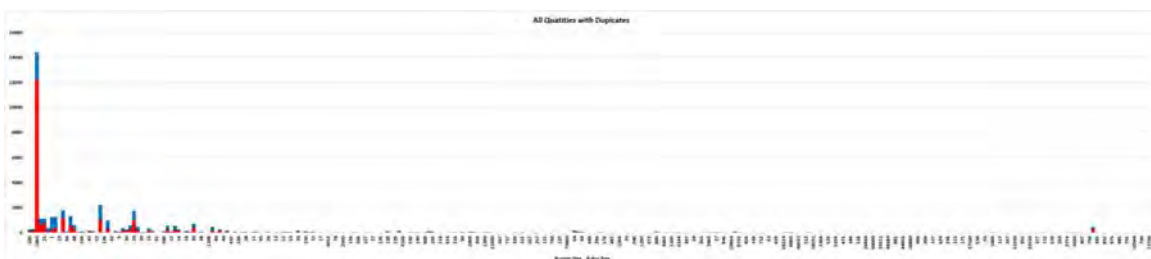
Figure 27. NORTHCOM percentage of top ten duplicate-ordering DODAACs



(5) Overall trends of NORTHCOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of NORTHCOM, there were 1,474 different quantities ordered. Of this amount, 301 were duplicate quantities, or just 20.24%. Figure 28 represents all of the duplicate orders placed in NORTHCOM during the period of study and shows their associated quantities on the x-axis. Some abnormal orders include one order which had a quantity of 1000 and was ordered 12,335 times while another order had a quantity of 99,999 which was ordered 11 times. Another order of 75,000 was ordered in duplicate 13 times out of 21. Further research could tie these large quantity numbers to requirements.

Figure 28. NORTHCOM duplicate orders to normal orders by quantity



(6) Summary of NORTHCOM

The identifiable trends in duplicates indicate a high demand for particular types of lumber in NORTHCOM. The identifiable 16 types of lumber NIINs can allow DLA to anticipate commonly needed high demand lumber items. The high demand lumber

duplicate order list could be used to anticipate demand and adjust stock pile quantities. The knowledge of the high demand items could be spread throughout DLA and the DOD providing awareness and potentially reduce the frequency of duplicates. These actions could result in a cost savings for DLA and DOD, along with improving the overall lumber supply chain.

Certain units above other have historically executed duplicate orders for lumber in a greater frequency over others. The identification of this type of trend data could allow for the DOD to focus supply improvement training efforts in order to reduce duplicate order placement.

Improving NORTHCOM stands to make the largest impact overall in the ordering process of lumber. Due to the fact that NORTHCOM takes up 64.18% of all duplicate orders, resources should be allocated to NORTHCOM's SCM system.

Primarily, the best areas to improve in the SCM process is creating policy or ordering procedures that ensures the top 16 NIINs are ordered properly. In the case of NORTHCOM, they have the overwhelming majority of all duplicate orders, whether by NIIN or sheer quantity. Improving the ordering of each piece of lumber can reduce their duplicate rate. Alternately, the next best area to improve upon in NORTHCOM is the 22.5% duplicate ordering rate by DODAAC. Improving in this area would ensure less duplicate orders, possibly with potential to eliminate all duplicates if done correctly. Tables 16–19 depict the average daily normal and duplicate order rates for NORTHCOM which allow for further understanding of NORTHCOM's duplicate order issue.

Table 16. NORTHCOM average order rate per day

USNORTHCOM	
Normal Orders	42.18
Duplicate Orders	23.30
% Duplicate	55.24%

Table 17. NORTHCOM average number of orders per DODAAC

USNORTHCOM	
# of DODAACs	1329
# DODAACs duplicate	299

% of duplicate DODAACs	22.50%
Normal Orders	32.24
Duplicate Orders	17.81
% Duplicate	55.24%

Table 18. NORTHCOM average lumber items per day

USNORTHCOM	
Normal Orders	47214.86
Duplicate Orders	17644.46
% Duplicate	37.37%

Table 19. NORTHCOM average quantity of orders per day

USNORTHCOM	
Normal Orders	1206.48
Duplicate Orders	817.95
% Duplicate	67.80%

C. REMAINING COCOM TRENDS

During the period of study all COCOMs displayed a similar pattern of duplicate order placement. Spikes in demand are also prevalent across all COCOMs as a result of DOD requirements, which may be associated with significant activities. Large order placement was also observed in many of the COCOMs and is a further indicator of irregular unit behavior. Particular focus of DLA and DOD efforts in training and SCM improvements should begin with NORTHCOM. The similarities in duplicate placement behaviors indicate a systematic problem DOD-wide. Further in depth analysis of each COCOM is available in Section A of the Appendix.

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V. SUMMARY AND RECOMMENDATIONS

A. CONCLUSION

From July 2012 to July 2015, units across all DOD COCOMs placed 74,021 orders for lumber. This quantity represents 21.52% of all of the Class IV items ordered during this period. Of all the lumber orders placed during the period of study, 49.83% of these were duplicate orders. Of the major COCOMs, NORTHCOM is responsible for the vast majority of all duplicate lumber orders. The data indicates that duplicate order placement is linked to the disposition of forces across the COCOMs, with the more units assigned arise more duplicate order placement. In total 2,211 units placed orders for lumber with 26%, or 586, of those units placing duplicate orders. The reasons for the lumber order placement have not been part of this study, however results from the attached Operation United Assistance (OUA) case study indicate that significant activities are driving demand for lumber. Significant activities include events such as unit deployments, redeployments, training events, major events during operations, and the end of the fiscal year spending, all of which can call for large quantities of lumber.

The increase in demand caused by significant activities resulted in spikes of demand across all COCOMs. High demand periods are also associated with large volumes of duplicate order placement. Day to day lumber ordering results over the period of study have shown that the average quantity of actual lumber items ordered per day is 81,456 pieces of lumber, of which 27,723 pieces or 34% are ordered in duplicate. Lastly, the average quantity of lumber orders placed per day is 1,205 orders, of which, 823 or 68.3% were ordered in duplicate.

Each COCOM has certain high demand NIIN lumber items as described in the previous chapter and whose knowledge can allow DLA to anticipate commonly needed items. The high demand order list by COCOM could be used to forecast demand and adjust stock quantities. The knowledge of the high demand items could be spread throughout DLA and DOD to provide awareness and potentially reduce the frequency of duplicate orders. A reduction of duplicates could lead to a reduction in shipping and

holding costs, increased savings for DLA and DOD, and improvements to the overall lumber supply chain.

From the DOD-wide averages, honing in on the smaller COCOM specific percentages can provide insight into the duplicate order trend by each COCOM. All COCOMs, including the unknown display similar trends in demand for lumber with an associated pattern of placing duplicate orders. Some COCOMs have an increased tendency to place duplicate orders; however, the disposition of forces affects the demand for lumber and associated duplicate order placing behavior. Each data set by each COCOM reveals specific patterns and is further explored throughout this research.

B. ASSESSMENT AND RECOMMENDATIONS

Due to the large rate of duplicates, many detrimental factors are apparent. There are only so many resources available to ship lumber worldwide. Lumber is unique due to its large size and large quantities needed for mission requirements. As such, shipping lumber can become problematic. If duplicate orders stay at their current rate, the opportunity cost lost to provide transportation for other mission requirements stands to be huge. Further, costs associated with shipping lumber will be higher than they should be. Duplicate orders, if left uncontrolled, can lead to a decrease in military readiness since these orders require transportation and manpower for shipping and receiving that could otherwise be used for other mission requirements. Changes in DLA policy should reflect efforts to optimize the transportation, delivery, holding of lumber, and training of supply corps professionals charged with ordering and safekeeping lumber. NORTHCOM should be the first location that DLA focuses its efforts. Primarily, NORTHCOM is domestic and can afford different measures of lumber optimization.

Lumber will always remain a unique commodity. The analysis, owing to the fact lumber is unique unto itself, shows the strange ordering habits at times of units. Lumber's status as a highly sought after commodity and hard to optimize and ship item, should lend to special care. Just as Class III material is segregated by types of petroleum, oils, and lubricants, Class IV should be segregated to include lumber items and non-lumber items. This can allow for ordering systems to explicitly look closer at Class IV orders to ensure duplicates are minimized. Further, DLA can produce policy governing restrictions for

ordering. This could be based on a given amount of time, perhaps seven day ordering windows, as in the case of our research.

The analysis of the data suggests a couple of certain things. One, a minority of units are responsible for the vast majority of duplicate orders. Two, unit ordering behavior is erratic at times. This suggests superfluous orders are tied and untied to mission requirements. The fact that these actions and behaviors occur at the focal point of ordering at the lowest echelons of the supply chain management system, suggest that change should occur at this level. DLA policy should include efforts within NORTHCOM at the ordering level to be more proactive in waiting to place an order for the same request. Restriction codes and cancelation codes should be programmed to highlight orders meeting the criteria of being a duplicate order as based on this research – same NIIN, same quantity, same units, and same date or within a set number of days.

Attention should be given to training supply corps professionals on the handling of lumber. Greater resources should be taken in initial as well as advance training of supply corps personnel. Currently, supply support activity personnel are trained in a school house setting with conceptual operating environments that focus little efforts on the lumber supply chain. Lumber is a unique commodity that must be valued as such. Supply custodians and ordering specialists should take care to account for and order lumber. Lumber holding procedures should be an area of focus when considering supply chain improvements. Units requesting lumber must understand that at certain time lumber can be a scarce resource. Instances where requests of 99,999 pieces of lumber being approved multiple times within a seven day ordering window period, must stop. Disciplined supply professionals who understand the scarcity of lumber can be advocates for quality control of ordering. Further, refining the ordering system itself with programs to recognize the strain that duplicates place on the lumber supply chain will serve to improve the supply chain.

Barcodes are an inexpensive means of accounting for lumber inventory. Currently, civilian industry utilizes barcodes to account for all uncut dimensional pieces of lumber. DLA and DOD should follow and adopt this process more in depth. Barcoding is an inexpensive means to hold and account for inventory. The middleware associated

with barcoding is relatively cheap and easy to implement. Further, if need be, this inventory technology can be sent forward with lumber into austere environments and work as part of a local network. This barcode system has a very small digital and physical footprint associated with it. A secondary action of implementing a barcode system will affect ordering behavior. The perceived control mechanism now associated with holding lumber, will show to ordering units that it is more of a scarce item. As such, ordering behavior can impact positively the lumber supply chain system.

Adhering to the status quo works, but is detrimental to other mission requirements throughout the DOD. The quicker DLA can control is duplicate orders, the quicker and can free assets to conduct other mission requirements throughout the DOD. At a minimum, DLA should strengthen control measures at each ordering point to account for inventory as well as focus efforts on training a corps of supply professional who understand the value of lumber.

1. NORTHCOM

During the period of study 1,329 DOD units assigned to NORTHCOM placed orders for lumber, with 299 of those units or 22.50% placing orders in duplicate. The concentration of duplicate-ordering units is greater in NORTHCOM than the other COCOM. Units assigned to NORTHCOM placed on average 23.3 duplicate orders per day being during the period of study, in total 52.24% of all NORTHCOM lumber order placed were duplicate orders. These duplicate orders from NORTHCOM account for 64.18% of all duplicate orders DOD wide. NORTHCOM should be the focus of DOD supply training and stands to gain the most from improvement.

16 individual NIIN lumber items, including plywood and dimensional lumber, were most frequently placed on order in duplicate within NORTHCOM. NIIN items ordered in NORTHCOM were ordered with a duplicate rate of 48.33%. This means that 449 total different types of lumber items were placed on order and 217 of those orders were placed in duplicate. This data could prove useful because it reinforces the idea that the top 16 duplicate ordered items are also high demand items. NORTHCOM, similarly to EUCOM, experienced large volumes of extremely high quantity duplicates. In certain

instances quantities of 99,999 NIIN lumber items were duplicated 11 times as well as orders of 75,000 lumber items were placed 21 times.

Certain units assigned within NORTHCOM placed lumber orders in duplicate more frequently than other units. The DOD could focus its training efforts onto these NORTHCOM specific units who have a historically high duplicate order placement record. Conversely in the first half of 2015 NORTHCOM, experienced a declining trend of duplicate order placement with only 23.3% compared to an overall 52% of NORTHCOM units placing duplicate orders throughout the period of study.

2. CENTCOM

136 DOD units assigned to CENTCOM placed orders for lumber, with 44 of those units, or 32.35%, placing orders in duplicate. Units assigned to CENTCOM placed on average 4.3 duplicate orders per day during the period of study. These duplicate orders from CENTCOM units account for 27% of all duplicate orders DOD wide. CENTCOM should be the second focus of DOD supply training and stands to gain the most from improvement after NORTHCOM. 15 individual NIIN lumber items, including plywood and dimensional lumber, were most frequently placed on order in duplicate within CENTCOM. This data could prove useful because it reinforces the idea that the items placed in duplicate are also in high demand.

CENTCOM, like a few of the other COCOMs, has also experienced extremely high demand spikes resulting in large volumes of regular and duplicate lumber orders. Certain days during the period of study were responsible for most of the duplicate orders. For example, on 1 May 2014, 181 out of 196 orders were placed in duplicate. CENTCOM also experienced some lumber orders of 99,999 lumber items ordered in duplicate six times. The exact reason for these extremely large spike in demand is not known; however, owing to observations from other COCOMs and the OUA case study, it can be safely assumed that significant requirement-driven events were the main factor.

Certain units assigned within CENTCOM placed lumber orders in duplicate more frequently than other units. One unit in particular was responsible for 50% of all the duplicate orders placed in CENTCOM during the period of study. The DOD could focus its training efforts onto these CENTCOM specific units who have historically had a high

duplicate order placement record. These efforts could result in cost savings for DLA/DOD and an overall improvement to the lumber supply chain.

3. PACOM

During the period of study 168 DOD units assigned to PACOM placed orders for lumber, with 42 of those units or 25% placing orders in duplicate. Units assigned to PACOM placed on average 3.38 duplicate orders per day during the period of study. In total 25% of all PACOM DODAACs placed duplicate orders. Nonetheless, nearly 43.2% of all lumber orders placed in PACOM were duplicate orders. These duplicate orders from PACOM account for only 7.56% of all duplicate orders DOD wide. PACOM's relatively small impact on the DOD wide duplicate order problem should command less focus and attention of DOD supply training when compared to other COCOMs, however improvement would still result in cost savings and supply chain improvement.

17 individual NIIN lumber items including plywood and dimensional lumber were most frequently placed on order in duplicate within PACOM. This data could prove useful because it reinforces the idea that items placed in duplicate are also in high demand.

Certain units assigned within PACOM placed lumber orders in duplicate more frequently than other units. Units within PACOM unlike other COCOMs placed duplicate orders in a more even distribution without small numbers of DODAACs being responsible for a majority of the duplicate orders. Nonetheless the phenomenon of extremely large duplicate order placement also occurred in PACOM. These phenomenon may be indicative of a larger demand than normal as in other COCOMs but remains unknown at this time. The DOD could focus its training efforts onto these PACOM specific units who have a historically high duplicate order placement record. These efforts could reduce costs and improve the overall supply chain.

4. EUCOM

During the period of study 108 DOD units assigned to EUCOM placed orders for lumber, 31 of those units or 28.70% placing orders in duplicate. On average, 2.27 duplicate orders per day were placed during the period of study. EUCOM only accounts

for 4.23% of all duplicate orders placed DOD wide during the period of study. 16 individual NIIN lumber items including plywood and dimensional lumber were most frequently placed on order in duplicate within EUCOM. This data could prove useful because it supports the idea that items placed in duplicate are also in high demand. Moreover, focusing efforts on the duplicate prone orders of these 16 NIINs could eliminate 80% of all duplicate order occurrence in EUCOM.

Certain units assigned to EUCOM placed lumber orders in duplicate more frequently than other units which indicates that order duplicate placement is not systemic across EUCOM. Within EUCOM large duplicate orders are a frequent occurrence, with order quantities of 1000 lumber items being placed in duplicate over 250 times. With order placements occurring in such large frequency the DOD could focus its training efforts onto those EUCOM units which have a historically high duplicate order placement record. These training efforts could help to eliminate duplicate placement and further improve the lumber supply chain in EUCOM. The EUCOM data also indicates that greater oversight and management of the supply process may be required in order to reduce duplicate order placement.

5. AFRICOM

During the period of study, 19 DOD units assigned to AFRICOM placed orders for lumber with six of those units, or 31.58%, placing orders in duplicate. Units assigned to AFRICOM placed on average just .84 duplicate orders per day during the period of study. These duplicate orders from AFRICOM account for less than 1% of all duplicate orders DOD wide. AFRICOMs relatively small impact on the DOD wide duplicate order problem should command less focus and attention of DOD supply training when compared to other COCOMs however improvement would still result in cost savings and supply chain improvement.

16 individual NIIN lumber items including plywood and dimensional lumber were most frequently placed on order in duplicate within AFRICOM. Unlike the other COCOMs, the top 10 NIINs placed in duplicate represent 90% of all of the duplicate ordered items in AFRICOM. This focused top ten list can allow for refinement of DLA stock procedures and supply operations. This data could prove useful because it

reinforces the items placed in duplicate are also in high demand. Order data from the year 2014 also reveals how a major operation in this case OUA affects lumber demand.

AFRICOM experienced a large spike in demand as seen in both regular and duplicate order placement. Certain units assigned within AFRICOM placed lumber orders in duplicate more frequently than other units. In the case of AFRICOM, a single DODAAC was responsible for 97% of all of the duplicate orders during the period of study. The DOD could focus its training efforts onto these AFRICOM specific units who have a historically high duplicate order placement record. Unlike other COCOMs, AFRICOM does not have an end of the fiscal year uptick in lumber order placement or duplicate order placement. This suggests that significant activities in AFRICOM were more operationally related to events like OUA. Unique to AFRICOM is also the age of the command, being the newest COCOM, AFRICOM is positioned to implement procedures early, thus potentially avoiding other supply chain issues associated with the other COCOMs.

6. SOUTHCOM

SOUTHCOM has smallest footprint in terms of operational DOD units assigned. This low density of units also corresponds to little data on lumber orders when compared to other COCOMs. Nonetheless during the period one of those units or 11.11% placing orders in duplicate. Units assigned to SOUTHCOM placed on average just .46 duplicate orders per day during the period of study. These duplicate orders from SOUTHCOM account for only .02% of all duplicate orders DOD wide. SOUTHCOM's relatively small impact on the DOD wide duplicate order problem should command less focus and attention of DOD supply training when compared to other COCOMs. However improvement would still result in cost savings and supply chain improvement. Only two individual NIIN Plywood items were ordered in duplicate within SOUTHCOM. Unlike other COCOMs, SOUTHCOM does not have a large unit presence or many significant activities. The observations do indicate that at certain times significant activities do demand lumber like other COCOMs.

7. UNKNOWN COCOM

442 DOD units have an unknown COCOM associated with them and placed orders for lumber, with 159 of those units, or 35.97%, placing orders in duplicate. Units assigned from this unknown COCOM placed on average 4.78 duplicate orders per day during the period of study. These duplicate orders from the unknown category account for 12.14% of all duplicate orders. Units with an unidentifiable COCOM account for the third largest category COCOM with a relatively larger impact on the DOD wide duplicate order problems and should garner attention of DOD supply training to achieve cost savings and supply chain improvement.

18 individual NIIN lumber items, including plywood, dimensional lumber, wedge wood, and plug wood, were most frequently placed on order in duplicate within the unknown category. This focused top 18 list can allow for refinement of DLA stock procedures and supply operations. This data could prove useful because it reinforces the idea that items placed in duplicate are also in high demand.

Units from this unknown COCOM also experienced large spikes in demand as seen in both regular and duplicate order placement. Certain units assigned within the unknown category placed lumber orders in duplicate more frequently than other units. The DOD could focus its training efforts onto these specific units who have a historically high duplicate order placement record.

8. ROOT CAUSE OF DUPLICATES

This study has revealed much about the issue of duplicate orders from the information learned in the background and literature review and the DLA provided data. To best estimate why duplicate orders are occurring, we have elected to use a root cause diagram to help explain the underlying causes of duplicate order placement. Figure 29 describes the root cause of duplicate orders with seven different categories of causes and 12 sub causes. Underneath each sub cause a label has identified the supporting information which may corroborate this sub cause as a viable factor in contributing to duplicate orders. For the reason that there are limitations to this study, only sub causes will have data or background information.

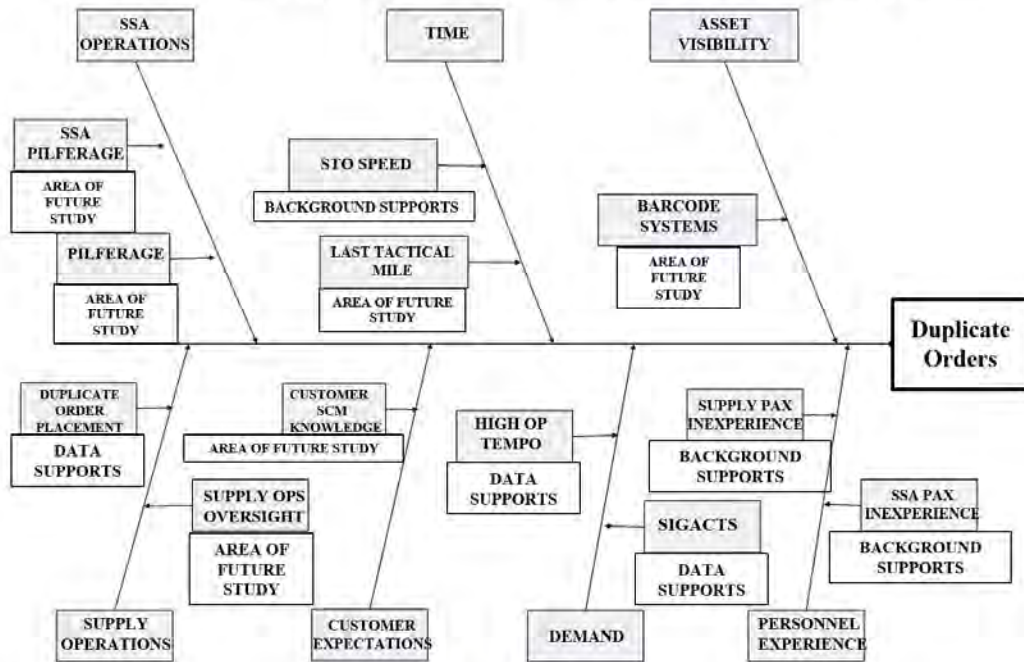
The first and most relevant cause of duplicate orders is the actual duplicate order placement by units in the various COCOMs. Units are placing duplicate orders during supply operations. Duplicate orders have been shown to accompany regular lumber orders as a result of high demand. This demand is driven by significant activities which are the result of a higher operational tempo. Units who need lumber urgently, frequently order lumber in duplicate. Our background and literature information acknowledges that SSA and supply personnel may be inexperienced. This inexperience as acknowledged in U.S. Army doctrine and may be a contributing factor to duplicate order placement.

The time associated with receiving lumber may also be a contributing factor. Certain timelines for stock transfer order lumber as listed in DLA documentation is not immediate or timely in many cases. The knowledge of the stock transfer timeline and of the lumber supply chain may be limited as the experience level of the supply personnel may also be limited. These factors have been identified as being some of the known causes of duplicate order placement within the DOD lumber supply chain. DLA can use the data provided in this project to improve the lumber supply chain and potentially make it more responsive to the customer demands. Some of the specific recommendations for improvement for DLA and DOD are listed following the root cause chart.

There are assured aspects to duplicate orders. Whether there is a discrepancy in a unit ordering, quality ordered, NIIN ordered, or the date of orders, all four things have one thing in common – the ordering system. Often, this system is at the lowest echelon of units needing lumber. This focal point of ordering, holding lumber, and filling requests, must be looked at in greater detail. Fixing the DODAAC ordering problem potentially would reverse approximately 25% of DODAACs in each COCOM from ordering duplicates, resulting in cutting almost 90% of all duplicate orders. Next, one could look to fix high anomaly orders, such as a quantity of 99,999 ordered half a dozen times.

Figure 29. Root cause analysis of duplicate orders

Fishbone Chart for Root Cause Analysis for Duplicate Orders



Duplicate orders will always be present. Reducing duplicate orders to a manageable percentage, far lower than the current level of 50%, will provide a more optimised and responsive lumber supply chain.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

Future research possibilities are numerous and could provide value added. There are many areas to focus on; however, the following areas will provide the best way forward in determining how to reduce duplicate lumber orders within the Defense Logistics Agency.

1. Conduct research focusing on areas of customer ordering behavior to answer the following question. Why is there such a prevalence of duplicate order placement?

2. Conduct a Cost-benefit analysis of implementing a barcode system for all lumber items at the lowest level of ordering within the NORTHCOM AOR. If possible, DLA should further research barcode system implementation in forward environments as

a means to reduce duplicate orders. An added benefit to barcode usage could include an increase in the warfighting capability of units as a result of increased readiness from reduced supply chain inefficiencies.

3. Determine the feasibility of setting an order ceiling for amounts of lumber. This policy would limit the maximum allowable amount of lumber by quantity which units could order through supply systems such as PBUSE.

4. Educate and train the supply personnel and Supply Support Activity (SSA) personnel about the impacts duplicate orders place on the lumber supply chain.

VI. OPERATION UNITED ASSISTANCE LUMBER CASE STUDY

A. INTRODUCTION

In March of 2014, West Africa experienced the largest ever Ebola virus outbreak. The International Community and the United States responded with an unprecedented level of support. United States Agency for International Development (USAID) and the Department of Defense (DOD) responded to the Ebola outbreak in the form of Operation United Assistance (OUA) in the Nation of Liberia. This multi-agency task force committed to build 17 Ebola Treatment Units (ETUs) in order to enable Liberia to more effectively treat and contain Ebola victims. The Defense Logistics Agency (DLA) provided all the Class IV (lumber) needed to construct these ETUs and for housing the 3,500 troops who supported this effort. This case study will explore Class IV (lumber) supply, demand, and consumption during OUA as a vehicle for exploring DLA's issues with the lumber supply chain.

B. OPERATION UNITED ASSISTANCE BACKGROUND

According to the Center for Disease Control (CDC), "Ebola virus disease (EVD) is a rare and deadly disease resulting in infection from one of the many strains of the Ebola virus and, if untreated, is often fatal" (CDC, 2014, para. 1). "The first discovery of Ebola was in 1976 near the Ebola River in what is now the Democratic Republic of the Congo" (CDC, 2014, para. 1). "In March 2014, West Africa experienced the largest and most complex Ebola outbreak since the virus was discovered" (WHO, 2015, para. 1). The World Health Organization (WHO, 2015, para. 1) reported that the 2014 Ebola Outbreak resulted in 28,041 infections and 11,302 deaths in 10 different countries.

According to the Department of Defense (DOD), in September 2014 President Obama declared the Ebola outbreak in West Africa a "top security priority for the United States" (DOD, 2014, para. 1). In 2014 the White House Press released the following statement, "In order to contain and combat it [Ebola], we [U.S.] are partnering with the United Nations and other international partners to help the Governments of Guinea,

Liberia, Sierra Leone, Nigeria, and Senegal respond just as we fortify our defenses at home” (White House, 2014, para. 1).

The DOD component of Operation United Assistance (OUA) began on September 16, 2014 with an initial reconnaissance of Liberia. The U.S. government projected that OUA would include 4,000 DOD service members and civilians (Garamone, 2014, para. 1). The DOD, as part of OUA, would have a two-fold mission, with four lines of effort under the lead of the United States Agency for International Development (USAID). “First, support USAID in overall U.S. government efforts and the second is respond to Department of State requests for security or evacuation assistance if required...[the] four lines of effort [include]: command and control, logistics support, engineering support, and training assistance” (Roulo, 2014, para. 1).

According to DOD sources, “the DOD was required to establish an intermediate staging base in Dakar, Senegal, provide a tactical airlift into Liberia, and establish a Command and Control Center near Monrovia, Liberia. Also, the DOD was directed to construct one 25-bed hospital in Monrovia (MMU), as well as construct 17 100-bed Ebola treatment units (ETUs) (i.e. clinics) across Liberia. Further, the DOD was directed to train local and third-country health care support personnel, enabling them to serve as first responders in the Ebola units. This DOD capability-building mission was directed to coordinate with the United States Agency for International Development (USAID) and other international efforts to combat the spread of Ebola” (DOD, 2014, para. 1).

According to USAID in November 2014, 17 100-bed ETUs were scheduled to be constructed across Liberia (see Liberia ETU status image). According to DOD, one ETU per each of Liberia’s 15 counties was to be constructed, with more in the heavily populated county of Montserrado, Liberia (Zoroya, 2014, para. 1). DOD was also given the direction to construct one 25-bed Monrovia Medical hospital along with several DOD laboratories. This case study focuses on the ETUs only. Captain Andrew K. Hill, a U.S. Army Engineer whom helped design the ETUs, has given this description of the ETUs used in OUA.

an ETU, in the context of this outbreak, is a 100-bed facility approximately the size of a soccer field, separated into two risk level

zones where confirmed and suspected victims can be isolated and treated. It includes ward areas, staff changing and resting areas, various level of chlorinated water distribution, electrical production and distribution, a morgue, and other ancillary facilities, such as a separate visitor area and a room for religious and social workers. (Hill, 2014, p. 2)

Figure 30. Aerial Photo of Gbediah ETU, Dec 22, 2014

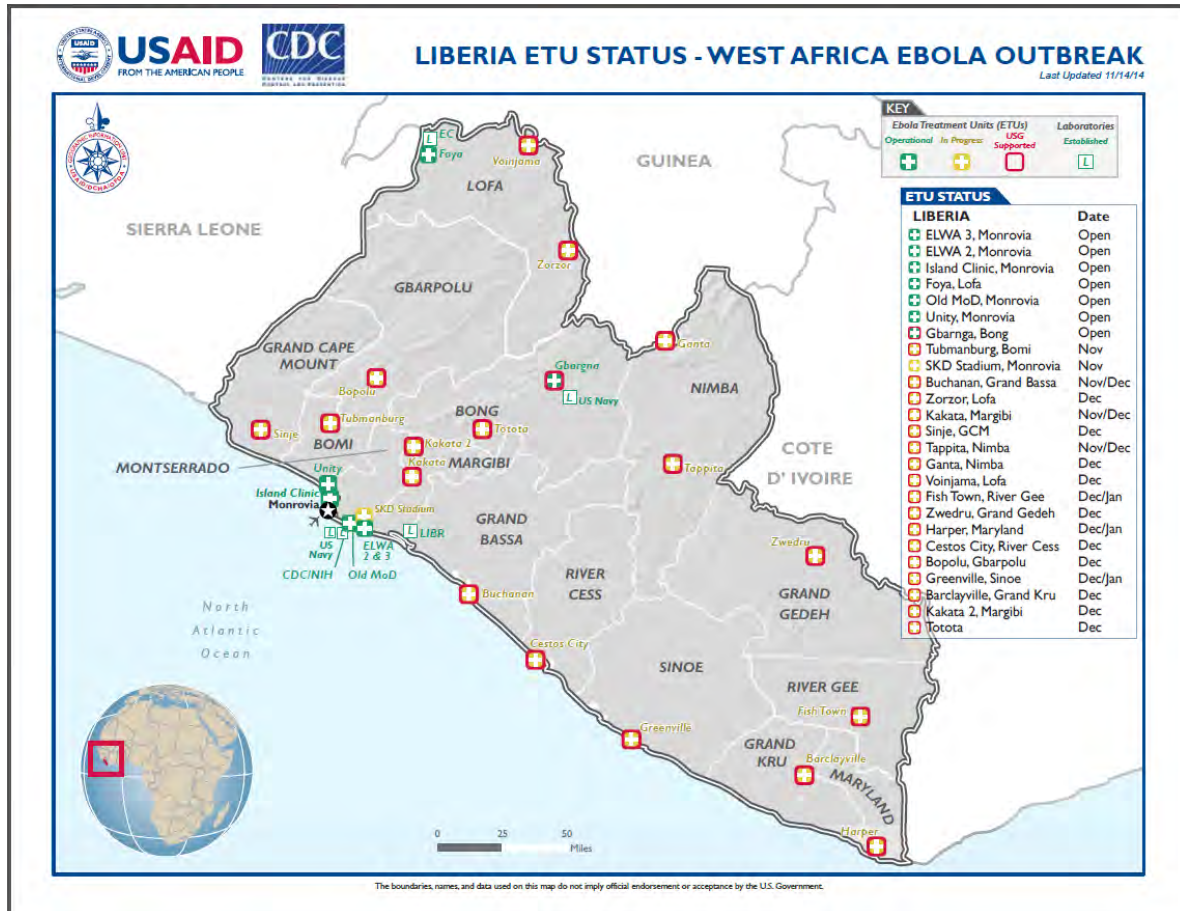


Source: Rhodes, Terrance (2014). Gbediah Ebola treatment unit nearly complete. Retrieved from <https://www.dvidshub.net/image/1707613/gbediah-ebola-treatment-unit-nearly-complete#.Vmequ7grLBR>

According to U.S. Army Engineer sources, the ETUs built and contracted by the DOD were based on a design from the World Health Organization with input from the CDC, DOD, Doctors without Borders, and the Liberian Army. Blueprints were developed for the DOD ETU model and a bill of materials (BOM) was compiled. Because the ETUs would not be built solely by U.S. Army Engineers, local construction practices were taken into account. The blueprints and BOM documents were used to write performance of work statements in preparation for DOD and DLA contracting actions for ETU completion. According to DOD and DLA sources, the ETU blueprints and BOM

documents were sent from Army Engineers of the U.S. Army Forces Africa (USARAF) to DLA to provide the construction materials (DLA, 2015h).

Figure 31. OUA Liberia ETU Status as of November 2014 (USAID)



From USAID. (2012). Case study: Exporting to the department of defense. Washington, DC USAID publications.

According to AFRICOM, by November 2014 the projected DOD-sponsored ETU requirement was reduced to 10 ETUs with a reduced capacity of 50 beds each due to a reduction in new Ebola cases. Of the 17 planned DOD-sponsored ETUs, seven were constructed by NGOs and other non-DOD organizations (reference the ETU table). Ten ETUs were completed by the DOD, and four ETUs were constructed by U.S. Military units in partnership with the Liberian Army. The remaining six ETUs were constructed using the U.S. Army logistics Civil Augmentation Program (LOGCAP). Through

LOGCAP, the FLUOR Corporation and Pacific Architects Engineers (PAE) companies completed the ETUs according to DOD sources.

Table 20. OUA ETU Locations, Construction Dates, and Capacity

ETU #	ETU NAME	COUNTY LOCATION	Lumber provided by	Constructed by	Date completed	Planned Capacity	Actual Capacity
1	Tubmanburg	Bomi	DLA J & A Contract	DoD, 36th EN BDE / LA	10-Nov-14	100 bed	50 bed
2	Sinje	Grand Cape Mount	DLA J & A Contract	DoD, 104th EN / LA	20-Nov-14	100 bed	50 bed
3	Buchanan	Grand Bassa	DLA J & A Contract	DoD, 902nd EN / LA	22-Nov-14	100 bed	50 bed
4	Gbediah (cestos city)	Rivercess	DLA J & A Contract	DoD, 104th EN / LA	23-Dec-14	100 bed	50 bed
5	Ganta	Nimba	DLA, GFM	DoD / FLUOR	27-Dec-14	100 bed	36 bed
6	Tappita	Nimba	UNKNOWN	DoD / FLUOR	27-Dec-14	100 bed	50 bed
7	Bopolu	Gbarpolu	UNKNOWN	DoD / FLUOR	31-Dec-14	100 bed	50 bed
8	Vionjama	Lofa	UNKNOWN	DoD / PAE	2-Jan-15	100 bed	50 bed
9	Zorzor	Lofa	UNKNOWN	DoD / PAE	15-Jan-15	100 bed	50 bed
10	Barclayville	Grand Cru	UNKNOWN	DoD / PAE	20-Jan-15	100 bed	50 bed
11	Zwedru	Grand Gedeh	Local purchase Bamboo	NGO-Welthungerhilfe	26-Jan-15	100 bed	50 bed
12	Fish Town	River Gee County	UNKNOWN	NGO-ARC	2-Feb-15	100 bed	50 bed
13	Harper	Maryland	UNKNOWN	Partners in health /PAE	2-Feb-15	100 bed	50 bed
14	Greenville	Sinoe	UNKNOWN	NGO-MSB/PAE	2-Feb-15	100 bed	50 bed
15	Totota or Suakoko	Bong	UNKNOWN	NGO-IMC	15-Oct-14	100 bed	71 bed
16	Kakata	Margibi	UNKNOWN	NGO-IMC	Prior to Mar 15	100 bed	70 bed
17	Kakata 2 or Firestone ETC	Margibi	UNKNOWN	Firestone Company	4-Sep-14	100 bed	31 bed

From USAID. (2012). Case study: Exporting to the department of defense. Washington, DC USAID publications.

According to the Office of the President of the United States, approximately 3,000 troops participated in OUA, including Soldiers, Sailors, Marines, and Airmen. As of August 2015, DOD constructed 10 ETUs. These ETUs treated Ebola patients throughout Liberia with the DOD component completing operations on or about May 2015. USAID in partnership with NGOs and other organizations have continued operations through August 2015. The Ebola outbreak that began in March 2014 has largely been contained and subdued. According to the WHO, as of August 2015 Liberia has experienced only one new case of Ebola over a 45-day period (Zoroya, 2014).

C. BACKGROUND OF DLA SUPPORT TO OUA

“The Defense Logistics Agency is the Department of Defense's largest logistics combat support agency, providing worldwide logistics support in both peacetime and wartime to the military services as well as several civilian agencies and foreign countries” (DLA, 2013, para. 1). According to DLA publications, DLA provided extensive support to OUA in the form of boots on the ground, contracting, and troops.

DLA's support to OUA included Class IV (lumber) support that provided ETU construction for U.S. government and partner use. DLA sources confirm that in September 2014 DLA received blueprints and a bill of materials (BOM) from USARAF. This bill of materials was then used by DLA to provide the required lumber and Class IV supplies for OUA. Alternatively, for the ETU Buchanon, the initial BOM required that the 17 ETUs be derived from the DLA-provided BOM list (DLA, 2015h).

Table 21. OUA Lumber Requisition for a ETU

The U.S. Government reserves the right to change any/all delivery dates listed in Exhibit A through 24 hour advance notification to the Contractor. ¹⁷⁰								
BUCHANON (ETU#3) BUILDING MATERIALS								
LINE ITEM #	DESCRIPTION	QUANTITY		NUMBER OF DAYS	PER UNIT/DAY PRICE \$USD	EXTENDED PRICE \$USD	REQUIRED DELIVERY DATE	REMARKS
		# UNITS	UNIT OF ISSUE					
BUCHANON (ETU#3)								
Equipment Procurement								
Lumber								
1	Dimensional Lumber, Stringer, 1"x12"x14'	30	EA		\$0.00	\$0.00	11-Oct-14	
2	Dimensional Lumber, 2"x2"x14'	420	EA		\$0.00	\$0.00	11-Oct-14	
3	Dimensional Lumber, 2"x4"x14'	210	EA		N/A	N/A	11-Oct-14	DLA WILL PROVIDE FROM WAREHOUSE
4	Dimensional Lumber, 2"x6"x14'	210	EA		N/A	N/A	11-Oct-14	DLA WILL PROVIDE FROM WAREHOUSE
5	Fascia board, 1"x 4"x16'	100	EA		\$0.00	\$0.00	11-Oct-14	
6	Door frame 4"x36"x 84"	12	EA		\$0.00	\$0.00	11-Oct-14	
7	Plywood door 35"x77"	12	EA		\$0.00	\$0.00	11-Oct-14	
8	Roof Cumming 15"x8'	80	EA		\$0.00	\$0.00	11-Oct-14	
9	Plywood Sheet, 1/4"	40	EA		\$0.00	\$0.00	11-Oct-14	Ceiling plywood
10	Plywood, 1/2"	300	Sheet		\$0.00	\$0.00	11-Oct-14	200 for tent flooring
11	Wooden pallette (4'x8'x8")	200	EA		\$0.00	\$0.00	11-Oct-14	200 for tent flooring
12	Dimensional Lumber, 4"x4"x12'	200	EA		N/A	N/A	11-Oct-14	DLA WILL PROVIDE FROM WAREHOUSE
13	Dimensional Lumber, 2"x6"x8'	124	EA					

From Defense Logistics Agency. (2015h). *Electronic mail correspondence* (Unpublished manuscript). Philadelphia, PA: Author.

According to DLA, lumber was provided in two ways. First was through local procurement and the second was thru a STO (stock transfer order) from DDDE which was moved on the [leased commercial ship] Vega (DLA, 2015b). According to DLA sources, the lumber for the ETUs was provided via stock transfer order aboard a DLA-contracted commercial ship, the MV Vega. After picking up 690 20-foot containers worth of supplies from the DLA DDDE depot in Germany, the MV Vega arrived in the Port of Monrovia on October 25, 2014. The DLA lumber supplies brought aboard the MV Vega are listed in Table 22.

Table 22. OUA MV Vega Class IV Manifest

		CITY	(All)
		QTY by NSN	
	NOM	Row Labels	Sum of AOD_QTY
5/8" C/C Plywood	PLYWOOD,CO	001285147	12022
1/4" A/C Plywood	PLYWOOD,CO	001297721	5621
3/8" A/C Plywood	PLYWOOD,CO	001297749	22122
1/2" A/C Plywood	PLYWOOD,CO	001297777	5369
3/4" A/C Plywood	PLYWOOD,CO	001297833	6276
Decking DO NOT RESTOCK!	LUMBER,SOF	001327108	387312
	BARBED WIR	002248663	61
	POST,FENCE	002629914	7447
	POST,FENCE	002701510	11224
	POST,FENCE	002701587	1122
	POST,FENCE	002701588	7420
	POST,FENCE	002701589	6914
1/2" CDX Plywood	PLYWOOD,CO	006186958	10402
	BARBED TAP	009215516	6230
	BARBED WIR	013094223	358
2X4X16 Lumber	LUMBER,SOF	014331244	104892
2X6X16 Lumber	LUMBER,SOF	014331371	104960
2X6X16 Lumber	LUMBER,SOF	014331510	290697
2X12X16 lumber	LUMBER,SOF	014333930	185130
4X4X16 Lumber	LUMBER,SOF	014334221	16578
4X6X16 Lumber	LUMBER,SOF	014334243	163771
2X10X14 Lumber	LUMBER,SOF	014334331	8357
	LUMBER,HAR	014548568	15401
	BARBED WIR	014956200	458
	BARBED WIR	014956277	896
	BARBED WIR	014956284	628
	BARBED WIR	014959566	1102
	BARBED WIR	014959581	534
1" CDX Plywood	PLYWOOD,CO	015855999	283
	WALL,PROTE	993910852	20
	WALL,PROTE	998357866	20
		Grand Total	1383627

From Defense Logistics Agency. (2015g). *Vega cargo manifest* (Unpublished manuscript). Philadelphia, PA: Author.

According to DLA sources, the urgent nature of the 2014 Ebola outbreak called for swift action in the construction of the ETUs. The construction of the ETUs required a tremendous amount of lumber and supplies listed in the bill of materials or BOM. The BOM for the ETUs could not be provided to the DOD units on the ground fast enough using the DLA traditional stock transfer order method, or even via the MV Vega that prepositioned supplies in Monrovia Liberia on October 25, 2014. Nor could the required BOM for the ETUs arrive at the Liberian construction sites fast enough to meet the urgent need of the ETU emplacement. In order to provide the required BOM, DLA contracting officers issued a Justification and Approval (J&A) form that allowed the use of other than full-and-open competition for U.S. Government contracts. This contracting mechanism provided immediate ETU BOM. Some of the construction material was contracted for “immediately” delivery or “1-day after” the signing of the J&A document. DLA contracted three separate government contracting companies, Atlantic Diving Supplies (ADS), Theodor Wille & Co. (TWI), and NOBLE, to provide immediate BOM. According to DLA sources, these contracting companies were selected because of previous awards of DOD contracts in the African region, all with proven performance records.

The combined quantities of lumber and other Class IV construction material provided by DLA through the STO and local procurement methods allowed U.S. and Liberian Army Engineers to begin construction on the ETUs immediately with local procured materials. Supplies coming from the MV Vega cargo ship and through the STO DLA supply chain method followed the contracted materials. By harnessing the power of the marketplace, DLA was able to deliver lumber and other construction materials faster than the DLA supply chain allowed.

Table 23. OUA Justification and Approval for Lumber

JUSTIFICATION FOR OTHER THAN FULL AND OPEN COMPETITION

1. The Defense Logistics Agency (DLA) Troop Support, Construction and Equipment Supply Chain, is the contracting activity.
2. The action being approved is the ability to solicit for DLA requirements on an Other Than Full and Open Competition basis.
3. Following are the supplies required to meet DLA's needs:

Date of Award	Vendor	Items	UI	Quantity	Price	Total Price	Delivery
9/23/2014	ADS	2,500 SH 3/4" CDX Plywood	SH	2,500	\$		7 days
9/23/2014	TWI	25,000 BF 2"x4"x14' Lumber	BF	25,000	\$		7 days
9/23/2014	TWI	25,000 BF 2"x6"x14' Lumber	BF	25,000	\$		7 days
9/28/2014	ADS	Lease Grader, Operator, Fuel	EA	1	\$		1 day
9/29/2014	TWI	Gravel (1/2" - 3/4")	CY	6,500	\$		1 day
9/29/2014	TWI	Gravel (3/4" - 2")	CY	30	\$		Immediately
9/28/2014	ADS	Vibratory Roller with Operator	EA	15 days	\$		2 days
9/28/2014	TWI	Backhoe Bucket with Operator	EA	15 days	\$		2 days
9/28/2014	TWI	Dozer	EA	15 days	\$		2 days
9/28/2014	TWI	Front end Loader	EA	15 days	\$		1 day
9/28/2014	TWI	Lumber Stringer, 1"x12"x14'	BF	85,000	\$		40 days
9/28/2014	TWI	Timber, 2"x2"x14'	BF	85,000	\$		40 days
9/28/2014	TWI	Timber, 4"x4"x12'	BF	85,000	\$		40 days
9/28/2014	TWI	Plywood, 1/2"	SH	17,000	\$		24 days
9/28/2014	TWI	Chain Link 7x7/5' long	RL	731	\$		10 days
9/29/2014	TWI	Cement blocks 6"x8"x16"	EA	20,400	\$		10 days
9/28/2014	TWI	48" x 100' Orange Warning Fence w/ Stakes	EA	102	\$		10 days
9/28/2014	TWI	Cement, Portland Type II	RL	3,400	\$		10 days
9/28/2014	TWI	Wire Nails 2"	94lb Bag	785	\$		10 days
9/28/2014	TWI	Zinc Nail 3.5	CT	391	\$		10 days
9/28/2014	TWI	Plastic Sheeting Rolls - 1.5 Mil, 60" x 80"	CT	1,020	\$		10 days
9/28/2014	TWI	Construction rope (lines)	CT	51,000	\$		10 days
9/28/2014	Noble	1/2" fiber (#4), 4' in length	PK	1,700	\$		28 days
9/28/2014	Noble	Wire Nails 3"	CT	935	\$		28 days
9/28/2014	Noble	Wire Nails 4" (80 pks)	PK	136	\$		28 days
9/28/2014	Noble	Wood screws 2" & 1.5"	RL	306	\$		28 days
9/28/2014	Noble	1/2" wood screw	EA	450	\$		28 days
9/28/2014	Noble	Plastic cover, tarpaulin, at least 20'x30'	RL	340	\$		28 days
9/28/2014	Noble	10 ft x 100 ft Clear 4 mil Plastic Sheeting	FT	1,180	\$		28 days
9/27/2014	Noble	20"-24" Coarse Cut Hand Saw	EA	10	\$		10 days
9/27/2014	Noble	16 pound Double Face Sledge Hammer	EA	5	\$		10 days
9/27/2014	Noble	Carpenter's Claw Hammer	EA	10	\$		10 days
9/27/2014	Noble	Hacksaw, adjustable	EA	8	\$		10 days
9/27/2014	Noble	Hacksaw blades (12 pcs/package)	PG	10	\$		10 days
9/27/2014	Noble	4" Paint Brush	EA	100	\$		10 days
9/27/2014	Noble	Paint Roller Frame, 9 in., Plastic Handle	EA	50	\$		10 days
9/27/2014	Noble	Paint Roller, 9 in. Replacement Brushes	EA	200	\$		10 days
9/27/2014	TWI	Galvanized chain linked fencing to include, three pedestrian gates and one vehicle gate	LF	1,000	\$		10 days

The total dollar value of the procurements made under this Justification and Approval was \$1,609,769.45.

4. The applicable statutory authority permitting other than full and open competition is 10 U.S.C. 2304(c)(2), FAR Part 6.302-2, Unusual and Compelling Urgency.

From Federal Business Opportunities. (October 23, 2014). J&A for MRO Activity in Operation United Assistance. Retrieved from https://www.fbo.gov/index?s=opportunity&mode=form&id=6291a00d5aa5bb0ef69e7695a85f9a1c&tab=core&_cview=0

DLA also provided lumber to military units ordering through supply ordering systems—such as the U.S. Army Property Book Unit Supply Enhanced (PBUSE) system—via the STO supply chain method (SCM) (DLA, 2015d). DLA has records of all

orders placed for all classes of supply requested during Operation United Assistance. During the course of Operation United Assistance from September 2014–June 2015, DOD units placed 268 orders for Class IV lumber items (see Section A of the Appendix for the PBUSE DLA OUA order data).

In order to provide for the immediate demand of ETU building materials and of the deployed units, DLA provided Class IV lumber for OUA. DLA’s flexibility and forward-leaning approach to OUA allowed DOD deployed units and USAID to partner with the Liberian Army and other NGOs to build 10 ETUs within 120 days of deployment. The U.S. intervention into Liberia staved off a global Ebola pandemic and could not have been possible without DLA.

D. PURPOSE

The purpose of this case study is to assist DLA in the identification of opportunities for improvement of the lumber supply chain using the OUA experience. This case study allows understanding how the lumber supply chain functions during a contingency operation, exploring the supply and demand side of the DLA lumber supply chain during OUA. It also explores trends associated with all of the DOD unit orders for lumber placed during OUA. This study reveals some issues in the supply chain and recommendations for improvement.

E. METHODOLOGY

Information and data relating to the DLA lumber supply chain during OUA was collected using a variety of methods, including direct correspondence with AFRICOM, FORSCOM, and DLA representatives; data provided by DORRA on all CLS IV orders; and various literature sources relevant to this operation. U.S. Army Engineers from USARAF provided information about the demand requirements for lumber for ETU construction. Subsequently, USARAF developed the ETU blueprints and BOM lists required for the initial 17 ETUs. USARAF requested the BOM from DLA after ETU planning and BOM requirements development. The demand requirements of the ETUs was then compared to the supply of lumber which DLA provided in the form of the MV Vega container ship cargo manifest and the J&A document. These two documents

represent the sum of the provided supply of lumber for the planned ETUs construction. To identify potential problems with DLA's lumber supply chain, it is essential to understand the supply and demand of a particular job. These researchers then conducted a comparison of the supply and demand of lumber as it relates to the 17 ETUs.

Then we performed a statistical analysis of all of the Class IV orders placed during OUA using data provided by DLA's DORRA. We assumed that once the supply of lumber from the Vega cargo vessel was exhausted, lumber was ordered through DLA SCM means to keep up with demand. This case study uses the actual CLS IV orders to determine trends in orders and duplicate orders for all DOD lumber placed during OUA. The statistical analysis is telling and the resulting trends reveal a lot about DLA customers' order patterns and the types of lumber most often sought. The criteria we used to define a duplicate orders is as follows: same type and quantity request within a seven-day period, same DODAAC (unit) requesting each time, same monetary value associated with each order, and Same date within seven day sliding window associated with each order.

DLA has a lumber and wood products catalog of 1,024 items, and the lumber requirements of OUA include dozens of types of lumber products. This case study focuses only on the top five most highly demanded lumber products by military units deployed in support of OUA. These items include:

Table 24. OUA Duplicate NIINs

OUA		
NIIN	Nomenclature	Wood Type
1297777	1/2" x 48" x 96"	Plywood
1297833	3/4" x 48" x 96"	Plywood
1327108	2" x 6" x 6'	Lumber
14331371	2" x 6" x 16'	Lumber
1285147	0.625" x 48" x 96"	Plywood
14331244	2" x 4" x 16'	Lumber
5975367	Antiseize compound	Non wood
14331510	2" x 10" x 16'	Lumber
878630	Antiseize compound	Non wood
9215516	C-wire	Non wood
10445034	Antiseize compound	Non wood
14166557	Epoxy primer	Non wood
14500381	Sealing compound	Non wood

F. DATA ANALYSIS

The 17 ETUs scheduled for construction in support of OUA provide an opportunity to study the Class IV lumber supply chain from both the supply and the demand sides of a DOD construction project during a contingency operation. The NIIN table with quantities displays the demand of lumber required for the 17 ETUs in the calculated column. This number was extracted by using the ETU Buchanon as a template and then multiplying the quantities by 17 for the sum. The supply side of the ETU project shows in the J&A column and the container ship Vega column. Table 25 describes an initial demand for ETU building materials, which were calculated for material as is, not including overages or additional building material requirements. The quantities described for the 17 ETUs are far below what DLA provided aboard the container ship Vega and through DLA contracting using the J&A. It appears that the amount of lumber supplied for the 17 ETU projects exceeded the needs. The quantity of lumber for the 17 ETUs using the multiplication method may not reflect the total quantity provided by USARAF to DLA. The quantities listed describe a supply and demand situation that is imbalanced.

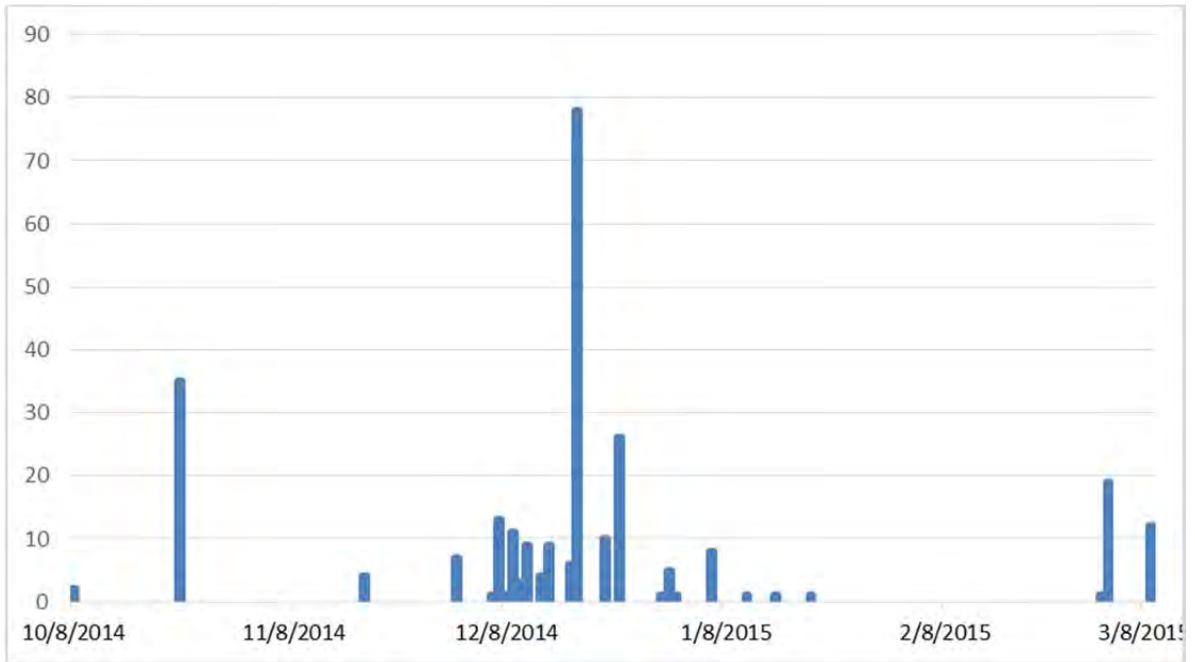
Table 25. OUA Duplicate Orders versus MV Original Demand

#	NIIN	Nomenclature	Wood Type	Qty 17 ETU's USARAF	Qty 1 ETU	Qty 17 ETU's	Qty from J&A	Qty from VEGA
1		1" x 12" x 14'	Dimensional lumber	TBD	30	510	85,000	0
2		2" x 2" x 14'	Dimensional lumber	TBD	420	7140	85,000	0
3		2" x 4" x 14'	Dimensional lumber	TBD	210	3570	25,000	Substitute? 2x4x16 - 104,862
4		2" x 6" x 14'	Dimensional lumber	TBD	210	3570	25,000	Substitute? 2x6x16 - 290,697
5		1" x 4" x 16'	Fascia board	TBD	100	1700	N/A	0
6		4" x 36" x 84"	Door frame	TBD	12	204	N/A	0
7		35" x 77"	Plywood door	TBD	12	204	N/A	0
8		15" x 8'	Roof Cumming	TBD	80	1360	N/A	0
9		1/4" x 48" x 96"	Plywood	TBD	40	680	N/A	5621
10	1297777	1/2" x 48" x 96"	Plywood	TBD	300	5100	17,000	5369
11		4' x 8' x 8"	Wood palette	TBD	200	3400	N/A	0
12		4" x 4" x 12'	Dimensional lumber	TBD	200	3400	85,000	Substitute? 4x4x16- 16,578
13		2" x 6" x 8'	Dimensional lumber	TBD	124	2108	Substitute for 2x6x14	Substitute? 2x6x16- 104,960

From Defense Logistics Agency. (2015h). *Electronic mail correspondence* (Unpublished manuscript). Philadelphia, PA: Author.

Once operations began in support of OUA, infrastructure and ordering systems were rapidly established. This allowed for new orders to be placed within DLA's SCM system to field user demand in Liberia. The first Class IV order occurred on October 8, 2014, and, from our data, the last order was on March 9, 2015. These orders spanned all classes of supply and totaled 7,329 orders valued at \$75,500,726.87. Specifically, Class IV made up 268 of these orders at a value of \$3,287,517.52. We focused our analysis on these 268 orders to determine if a duplicate ordering problem was prevalent during the sustaining operation phase of OUA. The *Lumbers Orders Chart* shows the frequency of Class IV orders over the span of OUA.

Figure 32. OUA Frequency of Lumber Order over span of mission



Of the 268 Class IV orders, 14.93% were duplicate orders, or 40 orders. The 14 duplicate NIIN represent 68% of the total value of duplicate Class IV within OUA. Specifically, all orders of Class IV totaled \$403,404.64 and the sum of the top five NIINs represents \$274,530.80.

Figure 33. OUA Percentage of Duplicate Orders

Overall Values	
total value all Classes	\$63,530,802.30
total value all Class IV	\$ 403,404.64
total value top 5 Class IV	\$ 274,530.80
Percent of top 5 Class IV	68.05%

Sorting all 268 orders revealed that only 76 national item identification numbers (NIIN) were ordered. Taking these, 40 duplicate orders from the original 268 orders, a trend emerges in regards to like items. Like items in this instance were characterized by a NIIN. Likewise, sorting these lumber orders by frequency revealed demand by NIIN. Next, taking the duplicate orders and finding their frequency per NIIN revealed that

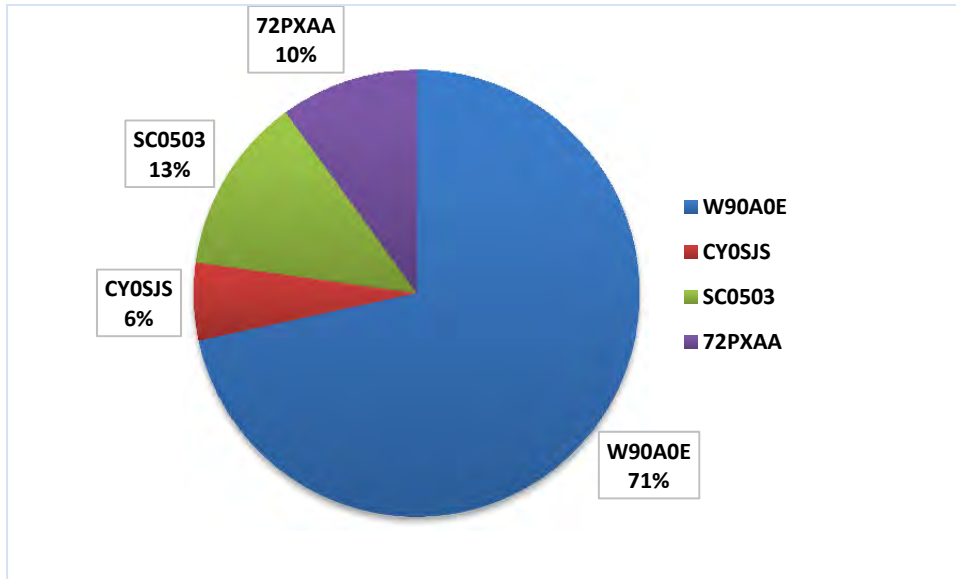
duplicate lumber orders are nearly the same as the high demand of regular orders. Ranking those NIINs by highest frequency ordered, we built a top 10 list of all duplicate orders.

Table 26. OUA Top Ten Duplicate NIINs and Duplicate Frequency

OUA		
NIIN	Nomenclature	Wood Type
1297777	1/2" x 48" x 96"	Plywood
1297833	3/4" x 48" x 96"	Plywood
1327108	2" x 6" x 6'	Lumber
14331371	2" x 6" x 16'	Lumber
1285147	0.625" x 48" x 96"	Plywood
14331244	2" x 4" x 16'	Lumber
5975367	Antiseize compound	Non wood
14331510	2" x 10" x 16'	Lumber
878630	Antiseize compound	Non wood
9215516	C-wire	Non wood
10445034	Antiseize compound	Non wood
14166557	Epoxy primer	Non wood
14500381	Sealing compound	Non wood

Focusing on the duplicate NIINs, a trend emerges for lumber within the top six orders by frequency. Specifically, the top five duplicate orders NIINs were all lumber. Focusing on just those highly demanded lumber items, we continued our research on additional trends and analyses.

Figure 34. OUA Percentage of DODAACs ordering Duplicates



Most significant is that the vast majority of duplicate orders came from one unit. Of the 11 DODAACs that places orders within the time frame and scope of OOUA only four DODAACs created duplicate orders. This represents a 36.36% trend, which is higher than the over DLA baseline from previous chapters. Further looking at these DODAACs, one can tell that only one DODAAC was susceptible to ordering duplicates at a rate of over 50%. In this case, the highest rate was 62.5%. Figure 94 shows the exact number of duplicate orders to normal orders per the four duplicate-ordering DODAACs.

Figure 35. OUA Frequency of Normal Order and Duplicate Orders per DODAAC

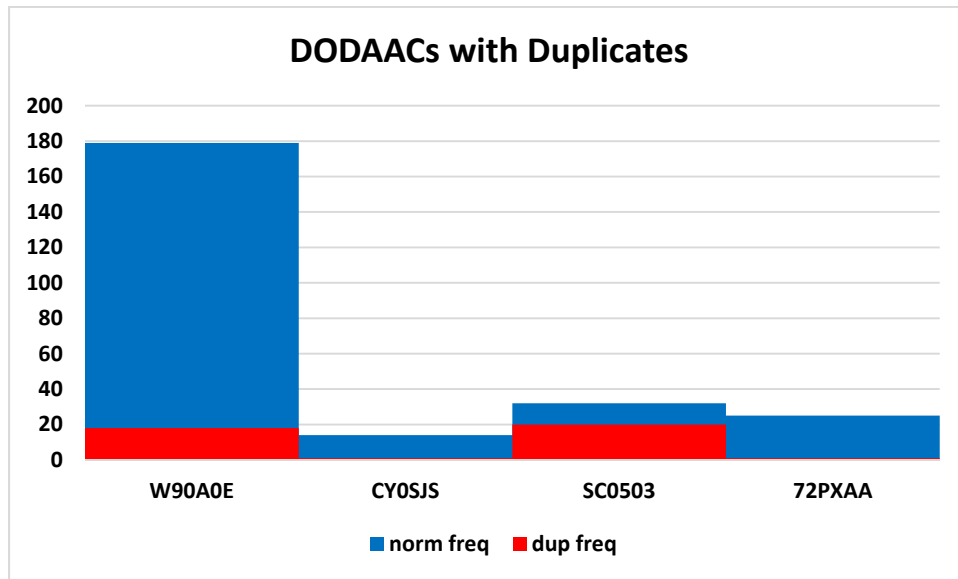
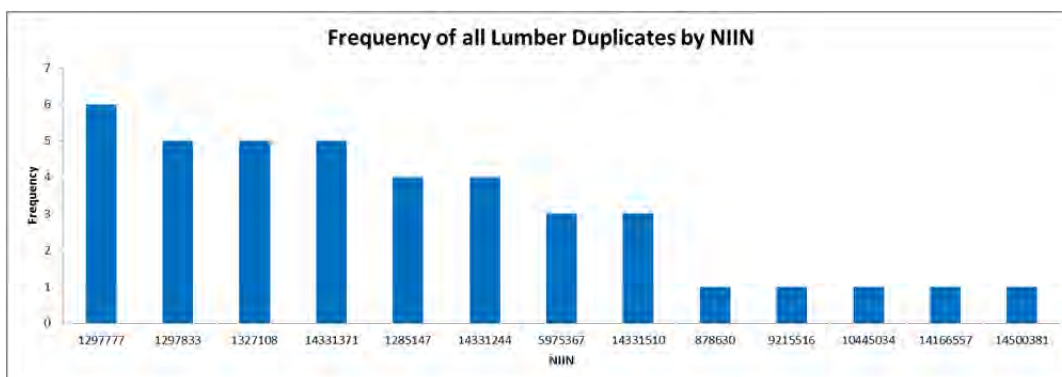


Figure 36. OUA Frequency of all Lumber Duplicates by NIIN



In summary, five lumber NIINs represented over 62.5% of the total duplicates. These five items directly linked with the original demand of these NIINs. If not managed correctly in the ordering system, the inference is that whichever lumber NIIN is highly sought will simultaneously be plagued by duplicate orders. In the case of OUA, if these ordering discrepancies were fixed, the savings could have been \$1,014,867.21.

When showing both the level of demand in terms of frequency of orders versus frequency of duplicate orders, a trend emerged for Class IV. A spike in demand for normal orders through the DLA's STO system occurred in late October, mid-December, and early March. Further, duplicate orders in December and March show those same

spikes. Specifically, on December 18, 15 duplicates were placed, and in early March, 24 duplicates were placed, each for four and seven NIINs of lumber, respectively. These two periods represent 88.37% of all duplicate NIINs ordered. Of note, the first duplicate orders did not take place until after two months of the beginning of DLA’s online ordering systems in Liberia.

Table 27. OUA Frequency of normal NIIN and Duplicate NIIN orders

order date	norm freq	reorder freq
10/8/2014	2	0
10/23/2014	35	0
11/18/2014	4	0
12/1/2014	7	0
12/6/2014	1	0
12/7/2014	13	0
12/8/2014	1	0
12/9/2014	11	2
12/10/2014	3	0
12/11/2014	9	0
12/13/2014	4	2
12/14/2014	9	0
12/17/2014	6	0
12/18/2014	78	15
12/22/2014	10	0
12/24/2014	26	0
12/30/2014	1	0
12/31/2014	5	0
1/1/2015	1	0
1/6/2015	8	0
1/11/2015	1	0
1/15/2015	1	0
1/20/2015	1	0
3/2/2015	1	1
3/3/2015	19	15
3/9/2015	12	8

Figure 37. OUA Frequency of normal NIIN and Duplicate NIIN orders

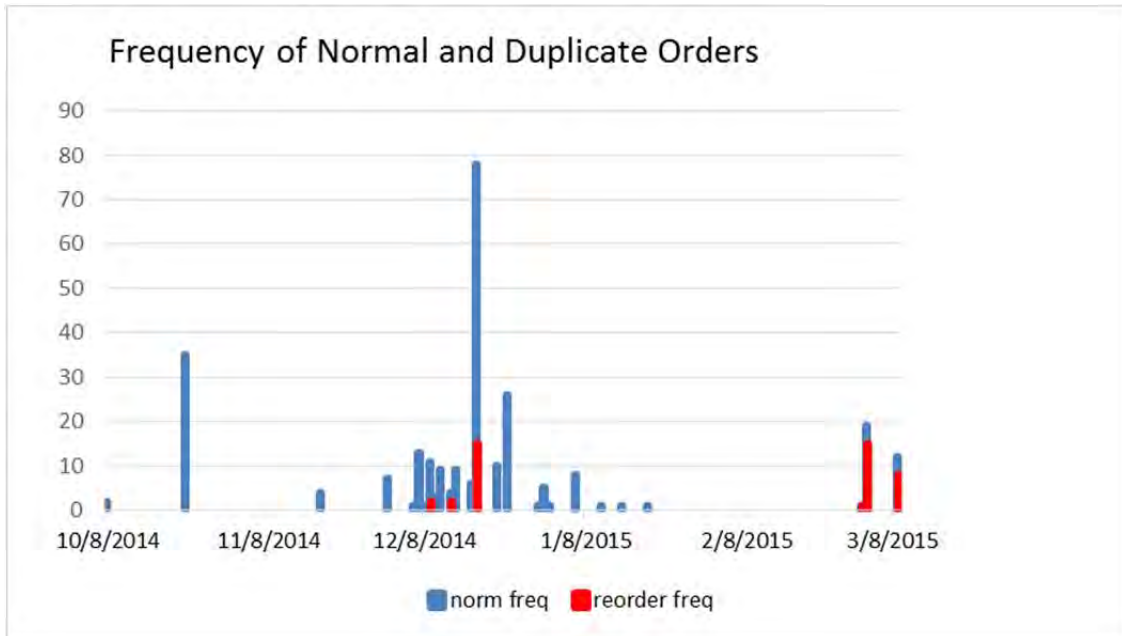


Table 28. OUA Dates of Significant Action

Lumber Demand Spikes 10 or more	Reorder Demand Spikes 8 or more	Significant Activities OUA
23-Oct-14		10-Oct-14, the 101st Abn div assumes command of OUA
7-Dec-14		Gbediah ETU construction
9-Dec-14		Gbediah ETU construction
18-Dec-14		Gbediah ETU construction
22-Dec-14	18-Dec-14	23-Dec-14, Gbediah ETU completed
24-Dec-14		23-Dec-14, Gbediah ETU completed
3-Mar-15	3-Mar-15	3-Mar-15, 48th Chemical Brigade executes RIPTOA activities
9-Mar-15	9-Mar-15	20-Mar-15, The 48th Chemical Brigade assumes command from 101st of OUA

From Roulo, C. (November 12, 2014). DOD brings unique capabilities to ebola response mission, official says. Retrieved from <http://www.defense.gov/News-Article-View/Article/603631>

G. CONCLUSION

At the outset of OUA in September 2014, the requirement for DLA to provide lumber to DOD was partially understood. DLA was proactive by providing construction material including lumber via the cargo ship VEGA early with an initial understanding of requirements for 17 ETUs. DLA was also proactive and solicited contracts for locally procured lumber to enable uninterrupted DOD construction of ETUs. Like many DOD

operations, requirements changed due to mission, enemy, terrain and weather, troops and support available, time available, and civil considerations (METT-TC). During this same time period, DOD units began to order lumber through organic supply ordering systems and DLA provided lumber through DLA's STO system. By November, 2014 the exact quantity of required ETUs for OUA was revised down to 10 after significant quantities of lumber for 17 ETUs had already been ordered and received. Significant spikes in orders and duplicates for lumber occurred during significant events during OUA. These spikes in demand occurred during major change of commands for OUA, during associated relief in place and transfer of authority (RIPTOA) activities, and during ETU construction completion. Despite mission and requirements changes, DLA successfully provided the DOD with the resources they needed to accomplish the mission.

The supply and demand data that relates to the initial ETU requirements for OUA describes a completely imbalanced relationship. DLA provided lumber in excess of the initial requirement to construct 17 ETUs in Liberia. DLA in some cases provided ten times the amount of lumber required to support the ETU build. The cause of this large difference in lumber quantities required vs provided by DLA to meet the ETU build remains unknown as of September 2015. In the absence of clear requirements guidance, DLA appears to have been proactive in support of OUA by provided excessive amounts of lumber in order to ensure mission success.

Duplicate orders will always be present in any operation. Effectively managing their rate to a rate below 14.93% can ensure cost savings for the government in the future. In the case of OUA, however, a duplicate rate of 14.93% might be effective in such conditions of rapid deployment to a highly austere environment. Efforts should be placed up front to forecast demand as accurately as possible. In the case of OUA, the Vega cargo vessel had enough lumber to meet the initial demand after arriving. Nevertheless, demand grew after the initial supply of lumber was depleted and replacement orders needed to be placed. In this case, just 14.93% of orders represents over half a million dollars for just seven highly sought after lumber types in a six month period. If not managed effectively, in the long run ordering costs can spiral upwards. Leaders and logisticians alike must

manage requirements of the mission given uncertain variables with procedures in place to ensure economy of force and supply.

Trends in demand and duplicate orders suggest one of two scenarios. First, orders could be keeping pace with the lumber stock on hand. In this case, they represent an order point to replenish their stock levels, often referred to as the economic order quantity (EOQ). Second (conversely to the first), these orders represent a reaction to a change or growth in mission requirements. Hasty planning to keep pace with a new demand saw a growth in orders and, subsequently, a growth in duplicates as well. Regardless of which scenario, in all certainty, there was a spike in both demand and duplicate orders associated with that demand.

H. RECOMMENDATIONS

DLA can anticipate spikes in orders based off of historical trends in similar operations in the future. By anticipating surges in needs, DLA could provide timely increases in capacity of shipment or increases in prepositioned stocks. DLA could also preposition certain types of lumber based off of the type of operation being conducted such as a medical quarantine situation, which requires the construction of ETUs. A preposition of the top ten most highly sought after lumber types for a certain situation will provide even better customer service.

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APPENDIX. REMAINING COCOMS TRENDS

A. EUCOM

(1) Overall trends of EUCOM by top lumber items

Between 1 July 2012 and 1 July 2015, units placed orders for lumber items during this period of study. Table 29 represents the top 10 duplicate NIINs ordered during the period for EUCOM. The top 10 duplicate orders vary from day to day and end up representing 16 individual NIINs, depending on the day within the period of study. In short, a one day sliding window versus a seven day sliding window will have different results of top ten duplicate NIINs. Table 29 further describes the lumber type and dimensions which were ordered in duplicate.

Table 29. Types of duplicate lumber for EUCOM

EUCOM		
NIIN	Nomenclature	Wood Type
6186958	1/2" x 48" x 96"	Veneer Plywod
14334200	2" x 4" x 8'	Lumber
14451016	4" x 4" x 8'	Lumber
1297833	3/4" x 48" x 96"	Plywood
14331216	2" x 4" x 8'	Lumber
2206198	2" x 8" x 6'	Lumber
1297777	1/2" x 48" x 96"	Plywood
510497	1/4" x 48" x 96"	Plywood
1297721	1/4" x 48" x 96"	Plywood
14548568	2" x 4" x 8'	Lumber
1297889	1" x 48" x 96"	Plywood
14334221	4" x 4" x 16'	Lumber
14334215	4" x 4" x 12'	Lumber
14331173	1" x 6" x 16'	Lumber
1297749	3/8" x 48" x 96"	Plywood
6188073	3/4" x 48" x 96"	Plywood

The listed lumber items range from plywood to lumber boards and vary in dimension and type. Many of the types of lumber are sheets of plywood with varying thickness from 1/4" to 1" all with the same width and length. The dimensional lumber boards range from 2" to 4" in thickness with widths that vary from 4" to 8". The lengths of the boards vary from 6' to 16'. These types of lumber are suitable for construction purposes including both interior and exterior surface. The listed lumber is also useful for

building wall frames, flooring, structural support posts, and bracing cargo inside of military shipping containers.

(2) Overall trends of EUCOM by NIIN

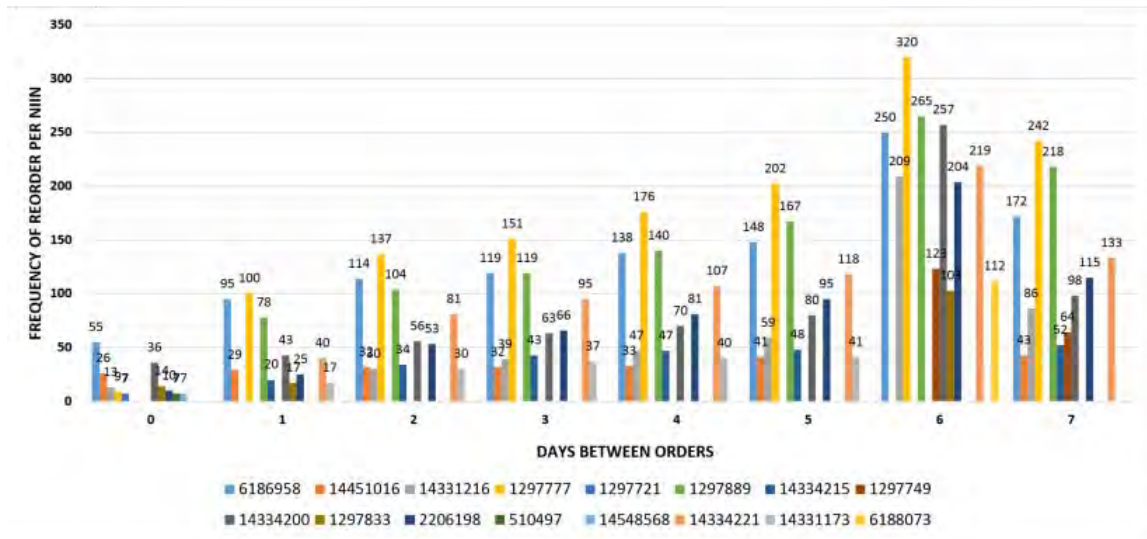
Table 30 shows the exact number of NIINs within EUCOM. 111 different NIINs were ordered, of which, 57 were duplicated. This represents a 51.35% duplicate rate by NIIN, which is slightly above the overall average of 48.46%.

Table 30. EUCOM NIIN order total, duplicates, and percentage rate

USEUCOM	
Total NIINs	111
NIINs duplicated	57
% Duplicate	51.35%

Figure 38 describes the top ten NIIN duplicate lumber items by each day within a duplicate order period of one week. The top ten orders were not identical each day as one might think. As the days between original order placement and potential duplicate order placement increased, the type and amount of each duplicate order changed. As such, 16 total NIINs emerged as the high frequency duplicate NIINs.

Figure 38. EUCOM top NIIN Duplicates using a one to seven day sliding window



The top 10 duplicate orders vary from day to day and represent 16 individual NIINs depending on the day within the period of study. The number one item placed in duplicate for EUCCOM during the three year period of study is the ½" x 48" x 96" sheet of plywood. The ½" sheet of plywood was placed on order 1,337 times during the three year period of study by various units within EUCCOM. Table 31 displays the data as it relates to Figure 39.

Table 31. EUCCOM quantity of duplicate NIINs per day of duplicate

	Number of days in ordering period							
	0	1	2	3	4	5	6	7
6186958	55	95	114	119	138	148	250	172
14334200	36	43	56	63	70	80	257	98
14451016	26	29	32	32	33	41		43
1297833	14	17					103	
14331216	13		30	39	47	59	209	86
2206198	10	25	53	66	81	95	204	115
1297777	9	100	137	151	176	202	320	242
510497	7							
1297721	7							
14548568	7							
1297889		78	104	119	140	167	265	218
14334221		40	81	95	107	118	219	133
14334215		20	34	43	47	48		52
14331173		17	30	37	40	41		
1297749							123	64
6188073							112	
	Number of times duplicate NIIN occurred in each day							

Figures 39 and 40 illustrate the types of lumber items placed on order in duplicate using a one to seven day sliding window. Each NIIN represents an individual type of lumber placed on order over the three year period of study. In short, when using a seven day ordering window to look for duplicates, USEUCCOM has over 80% of its duplicates rooted in just 10 NIINs. This grows to 16 NIINs if you change the ordering period to a different number of days between 1 and 7 days.

Figure 39. EUCOM all duplicate NIINs by frequency and cumulative percentage

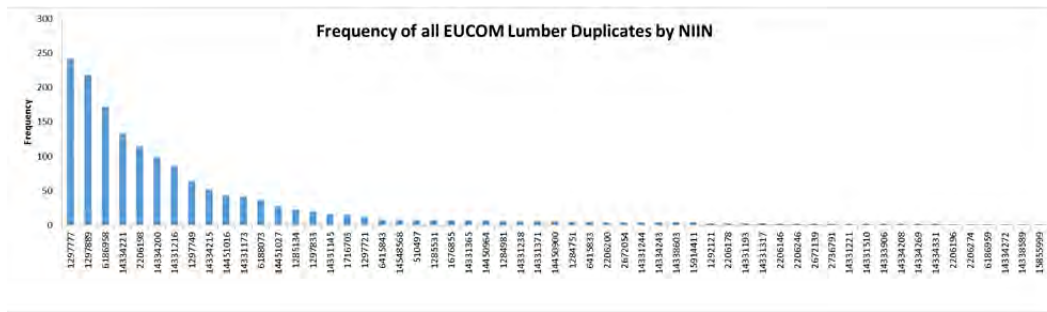
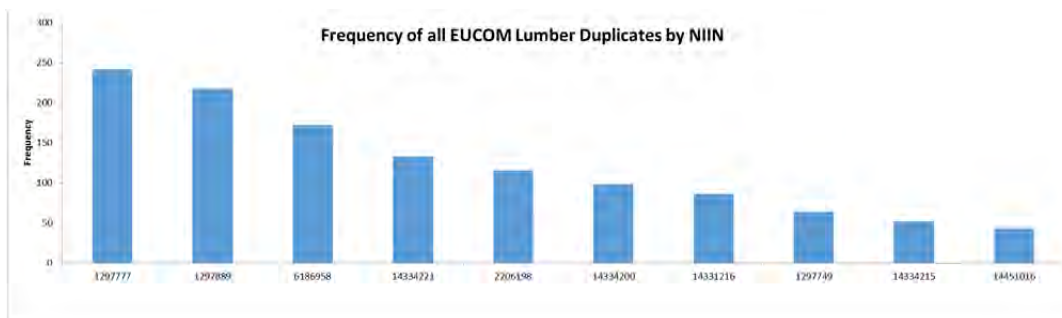


Figure 40. EUCOM top ten duplicate NIINs by frequency and cumulative percentage



The NIIN changes in type and frequency throughout the duration of the seven day order period. At day seven, the frequency of the type of lumber ordered in duplicate has changed along with the rank order of frequency. NIIN 129777 which is a ½” sheet of plywood, on day one was observed as being 7th in the rank order of the most frequently ordered item in duplicate. By day seven of the duplicate order period, this same ½” sheet of plywood has moved to the 1st rank order of the duplicate order period. The type of lumber item being duplicated changes during the duplicate period. Certain lumber items have a varying degree of demand throughout the duplicate order period. Units appear to experience a sliding demand scale for different types of lumber items depending on the day during the order period. This data could prove useful because it reinforces the top 16 high demand items and supports the idea the items placed in duplicate are also in high demand. Moreover, fixing the duplicate prone orders of these 16 NIINs could eliminate 80% of all duplicate orders in EUCOM.

(3) Overall trends of EUCOM by Date

Figures 41 through 44 represent the frequency of Class IV lumber items placed in either normal or in duplicates during the seven day sliding window. Each chart shows its respective year, starting in July of 2012. Each spike represents normal and duplicate lumber orders placed by all units throughout EUCOM. The more the red-bar is stacked on the blue-bar, then the more prevalent the duplicate order is. Significant to this is the Y-axis. The variability in total orders, whether normal or duplicate, is roughly the same every year, thus representing small variability in orders. Less variance can contribute to smoother ordering and shipment of lumber. When viewing duplicate orders by day, there is on average 2.27 duplicate orders per day.

Figure 41. EUCOM 2012 normal and duplicate order frequency by date

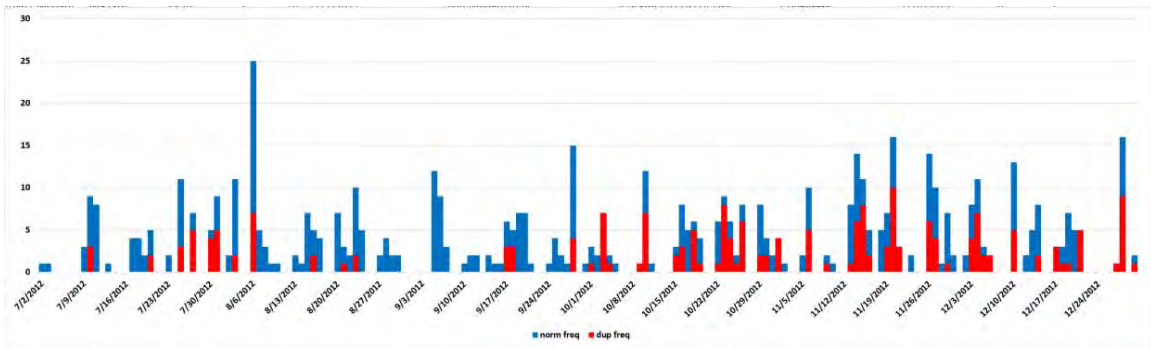


Figure 42. EUCOM 2013 normal and duplicate order frequency by date

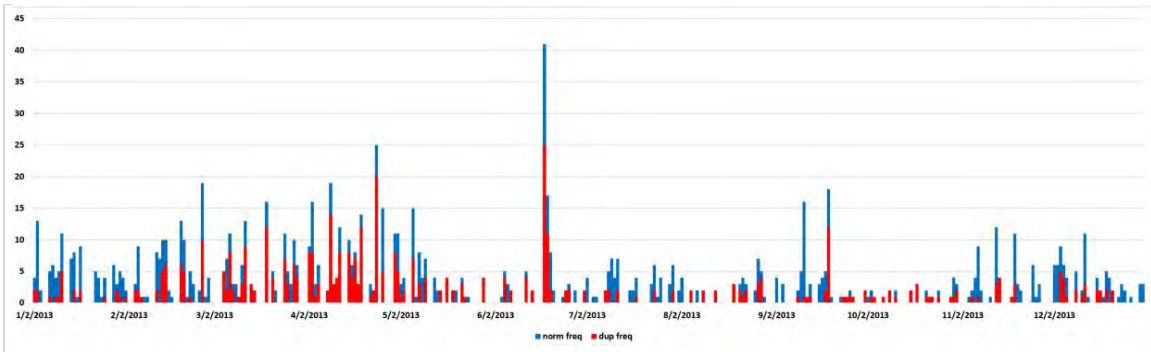


Figure 43. EUCOM 2014 normal and duplicate order frequency by date

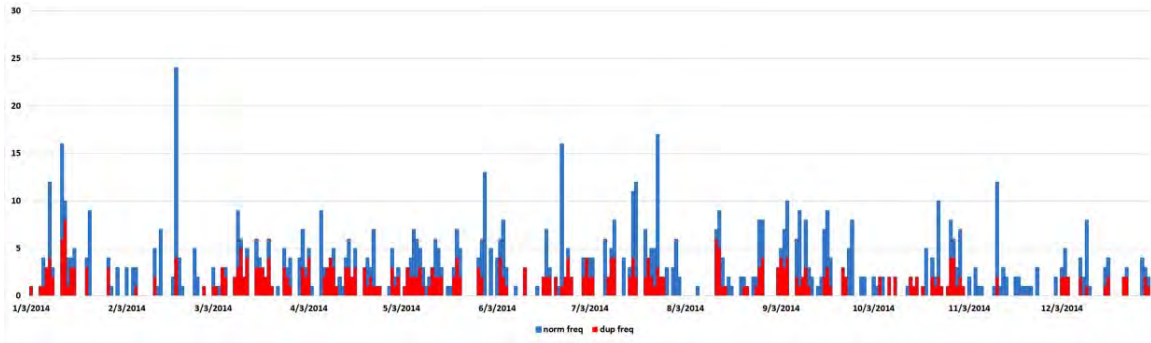
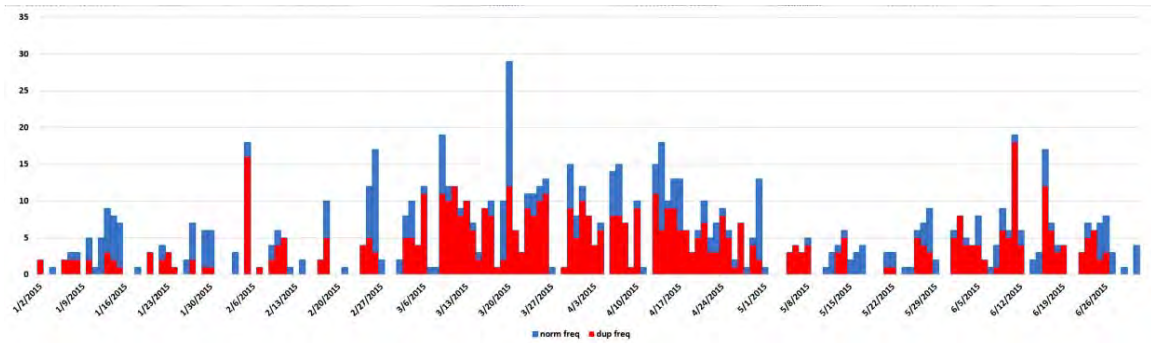


Figure 44. EUCOM 2015 normal and duplicate order frequency by date



The exact cause and nature of these spikes may be event driven and would require further research. However, there appears to be a trend of seasonality associated with the spikes in demand for lumber items. Spikes in demand are associated with significant activities. Perhaps significant unit activities could attribute to spikes in demand for lumber and contribute to duplicate orders. Significant events in the context of this study could include training events prior to deployments or packing containers prior to humanitarian assistance missions.

(4) Overall trends of EUCOM by DODAAC

Table 32 and Figures 45–47 represent the EUCOM frequency of lumber orders and duplicate orders placed by individual units as identified by their respective DODAACs. Table 32 further describes how 108 units placed orders for lumber during the period of study. Of the 108 units which ordered lumber, 31 of these units or 28.70% placed duplicate orders. This tends to show that duplicate ordering problems are not systemic throughout all units.

Table 32. EUCOM DODAACs with duplicating problem

# DODAACs w/ duplicates	31
# DODAACs	108
% of DODAAC duplicate	28.70%

Figure 45 displays the frequency of normal and duplicate orders placed by DODAACs within EUCOM. A trend of a high demand for lumber can also indicate a high frequency of duplicate orders being placed. This chart could allow supply training efforts onto certain units who have historically placed duplicate lumber orders.

Figure 45. EUCOM total of duplicate orders to normal orders per DODAAC

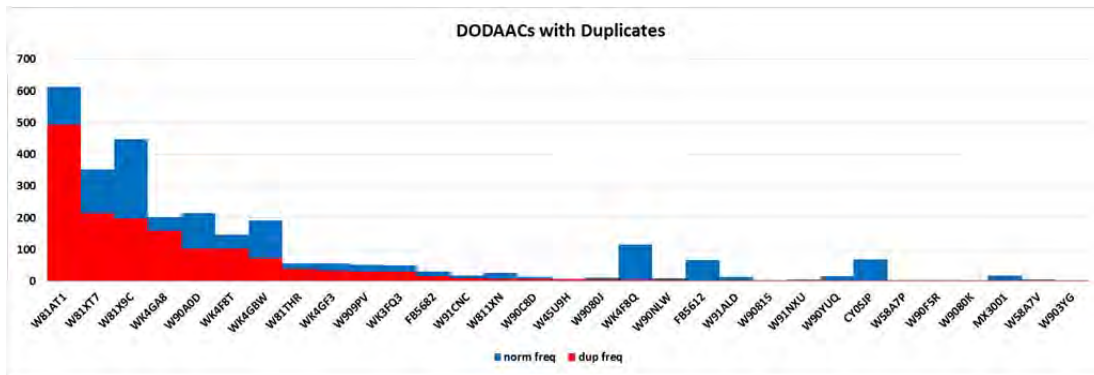
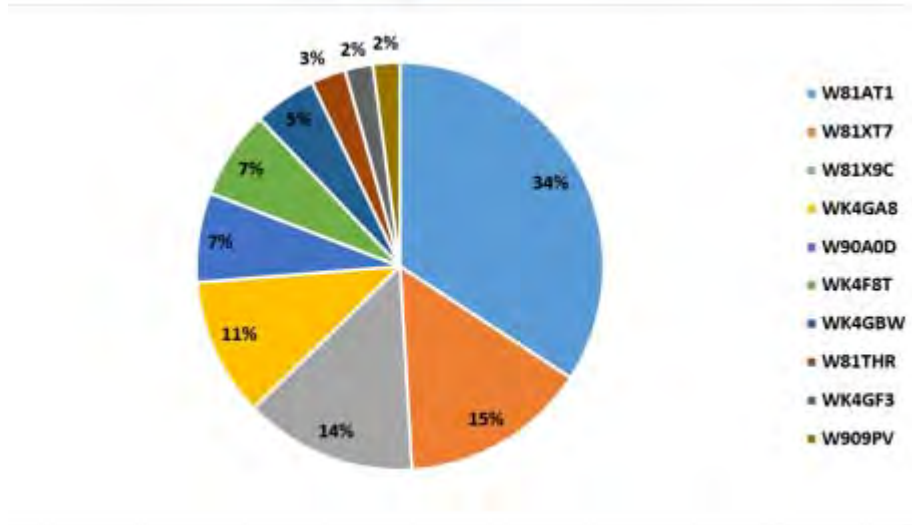


Figure 46 describes the top ten duplicate-ordering units as represented by DODAACs. These 10 DODAACs are further broken down to show the percentage of the duplicate orders each DODAAC is responsible for placing during the three year period of study. Certain units tend to be more of a culprit in possessing duplicate ordering tendencies. This means that greater control measures must be taken at the user interface level when ordering lumber.

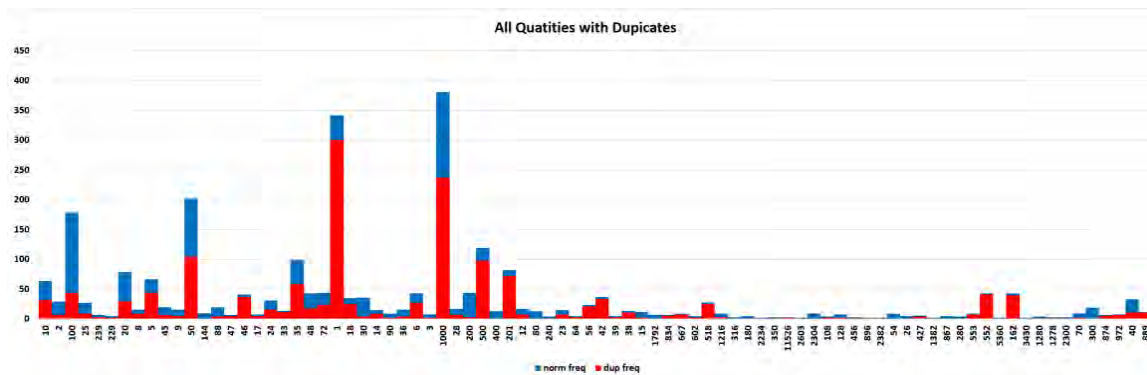
Figure 46. EUCOM percentage of top ten duplicate-ordering DODAACs



(5) Overall trends of EUCOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of EUCOM, there were 442 different quantities ordered. Of this amount, 84 were duplicate quantities, or just 19%. Figure 47 represents all of the duplicate orders and shows their associated quantities on the x-axis. Some abnormal orders associated with this COCOM include an order of one, but whose quantity was ordered 300 times while another order with a quantity of 1,000 was ordered just under 250 times. Yet another order of 5,360 was duplicated only once, but represented 50% of the quantity’s duplicate rate of order.

Figure 47. EUCOM total of duplicate to normal orders by quantity



(6) Summary of EUCCOM

The identifiable trends in duplicate items indicate a high demand for particular types of lumber in EUCCOM. The identifiable 16 types of NIINs can allow DLA to anticipate commonly needed high demand lumber items. The high demand lumber duplicate order list could be used to anticipate demand and adjust stock pile quantities. Furthermore duplicate order points could potentially be adjusted using the knowledge provided by the NIIN table. The knowledge of the high demand items could be spread throughout DLA and the DOD providing awareness and potentially reduce the frequency of duplicates. These actions could result in a cost savings for DLA and DOD along with improving the overall lumber supply chain. The EUCCOM data also reveals a certain seasonality to duplicate and regular lumber orders, which may be tied to significant events associated with units.

Certain units have historically executed duplicate orders in a greater frequency over others. The identification of this type of trend could allow for the DOD to focus supply improvement training efforts in order to reduce duplicate order placement.

Improving EUCCOM stands to make a marginal impact overall in the ordering process of lumber. Due to the fact that EUCCOM only takes up 4.23% of all duplicates, resources could best be used elsewhere, such as NORTHCOM. Conversely, however, EUCCOM can become a focal point of operations and if operations increase, more efforts should be given to its SCM process to ensure great optimization of first time orders.

Tables 33–36 shows, based on the three years of data, what the average normal and duplicate order rates look like for EUCCOM. Primarily, the best areas to improve in is creating policy or ordering procedures that ensures the top 16 NIINs are ordered properly. Improving this area would cut duplicate orders in EUCCOM by 80%. Alternately, the next best area to improve upon in EUCCOM is the 28.7% duplicate ordering rate of all ODAACs. Improving in this area would ensure less duplicate orders, possibly with potential to eliminate all duplicates if done correctly.

Table 33. EUCOM average order rate per day

USEUCOM	
Normal Orders	4.90
Duplicate Orders	2.27
% Duplicate	46.35%
% of total duplicates	5.77%

Table 34. EUCOM average order rate per DODAAC

USEUCOM	
# of DODAACs	108
# DODAACs duplicate	31
% of duplicate DODAACs	28.70%
% of tot duplicate DODAACs	5.29%
Normal Orders	31.20
Duplicate Orders	14.46
% Duplicate	46.35%
% of total duplicates	13.73%

Table 35. EUCOM average lumber items per day

USEUCOM	
Normal Orders	3672.47
Duplicate Orders	426.57
% Duplicate	11.62%
% of total duplicates	1.54%

Table 36. EUCOM average quantity of orders per day

USEUCOM	
Normal Orders	1193.63
Duplicate Orders	299.04
% Duplicate	25.05%
% of total duplicates	6.34%

B. PACOM

(1) Overall trends of PACOM by top lumber items

Between 1 July 2012 and 1 July 2015, units within PACOM placed duplicate orders for lumber items. Table 37 represents the top 10 NIINs ordered during the period of study. The top 10 duplicate orders vary from day to day and represent 17 individual NIIN items depending on the day within the period of study. PACOM had 6,459 orders,

of which, 2,790 were duplicate order using a one week ordering window. This represents a 43.2% duplicate order rate within PCOM, but only represents 7.56% of all total duplicate orders within all of DLA's duplicate orders. Table 37 also describes the lumber type and dimensions which were the top 17 NIINs ordered in duplicate.

Table 37. PACOM types of duplicate lumber

NIIN	PACOM	
	Nomenclature	Wood Type
1297833	3/4" x 48" x 96"	Plywood
14773335	4" x 6" x 9'	Lumber
14331238	2" x 4" x 12'	Lumber
14331365	2" x 6" x 12'	Lumber
6634687	2" x 4" x 12'	Lumber
1285031	3/4" x 48" x 8'	Plywood
500611	1" x 6" x 8'	Lumber
5559065	8" x 4" x 4'	Lumber
2206178	4" x 4" x 8'	Lumber
1285255	1/2" x 48" x 8'	Plywood
2206194	2" x 4" x 6'	Lumber
14334200	2" x 4" x 8'	Lumber
14334239	4" x 6" x 12'	Lumber
14338589	1" x 4" x 12'	Lumber
14334221	4" x 4" x 16'	Lumber
14338603	1" x 6" x 12'	Lumber

The listed lumber items range from plywood to lumber boards and vary in dimension and type. There are subtle differences in the NIINs ordered within PACOM as compared to the two previous COCOMs, however, a trends in like items starts to emerge. Plywood, support beams, and various 12 foot bards emerge in PACOM, as well as the two other previous COCOMs, as highly sought after lumber.

(2) Overall trends of PACOM by NIIN

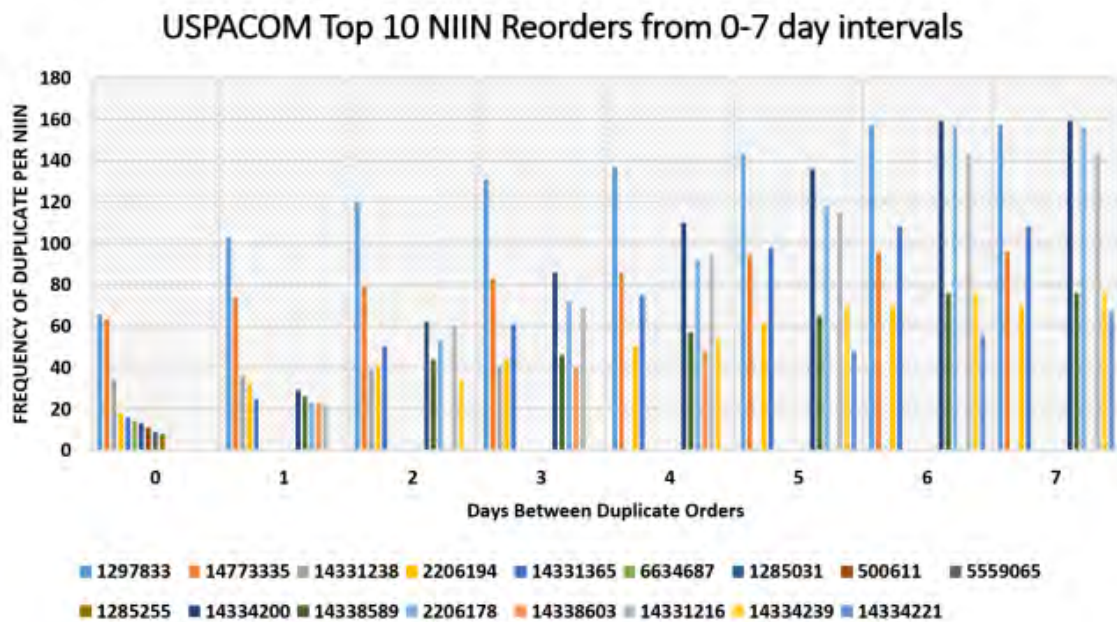
Table 38 shows the exact number of NIINs within PACOM. 272 different NIINs were ordered, of which, 97 were duplicated. This represents a 35.66% duplicate rate by NIIN, which is below the overall average of 48.46%. Barring SOUTHCOCOM extremely small sample size, this is the best COCOM in regards to fewest NIINs being duplicated.

Table 38. PACOM NIIN order total, duplicates, and percentage rate

USPACOM	
Total NIINs	272
NIINs duplicated	97
% Duplicate	35.66%

Figure 48 describes the top ten NIIN duplicated items by day within the duplicate period. In the case of PACOM, these top ten items changed each day. Using a one week order window, each day saw a change in the top ten. In total, 17 NIINs emerged as the most order NIIN win PACOM.

Figure 48. PACOM top ten NIIN duplicates using a one to seven day sliding window



The top 10 duplicate orders vary from day to day and represent 17 individual NIIN items depending on the day within the period of study. The number one item placed in duplicate for PACOM during the three year period of study is NIIN 1297833 the 3/4” x 48” x 96” sheet of plywood. This plywood item was placed in duplicate 1,014 times during the three year period of study by various units within PACOM. Table 39 shows

the number of NIINs ordered throughout the seven day sliding window within PACOM and how that number increases or decreases by using zero days between duplicates or 7 days between duplicates.

Table 39. PACOM quantity of duplicate NIINs per day of duplicate

	Number of days in ordering period							
	0	1	2	3	4	5	6	7
1297833	66	103	120	131	137	143	157	157
14773335	63	74	79	83	86	94	96	96
14331238	34	36	39	41				
2206194	18	32	41	44	50	61	70	70
14331365	16	25	50	61	75	98	108	108
6634687	14							
1285031	13							
500611	11							
5559065	9							
1285255	8							
14334200		29	62	86	110	136	159	159
14338589		26	44	46	57	65	76	76
2206178		23	53	72	92	118	156	156
14338603		23		40	48			
14331216		22	60	69	94	115	143	143
14334239			34		54	70	76	76
14334221						48	56	67
	Number of times duplicate NIIN occurred in each day							

Figures 49 and 50 illustrate the types of lumber placed in duplicate within a one to seven day ordering window. Each NIIN represents an individual type of lumber placed on order over the three year period of study. The vast majority of NIINs are ordered correctly; however, the majority of duplicate NIINs represents 43.2% of all duplicate NIINs in NORTHCOM's case. If we use a Day 0 baseline, which represent an original order that won't be duplicated later one in the week, PACCOM's duplicate order rate is only 5.98%, or just under 6% total of all of DLA's duplicate order across all COCOMs. This means that units place about 5.98% duplicate orders in any one day within PACOM. Within seven days, it grows tremendously. In PACOM's case, it grew to a 43.2% duplicate rate when the ordering sliding window is changed to seven days. The top ten NIINs are listed. These ten NIINs represent nearly 50% of the duplicate ordered NIINs.

Figure 49. PACOM total duplicate NIINs by frequency and cumulative percentage

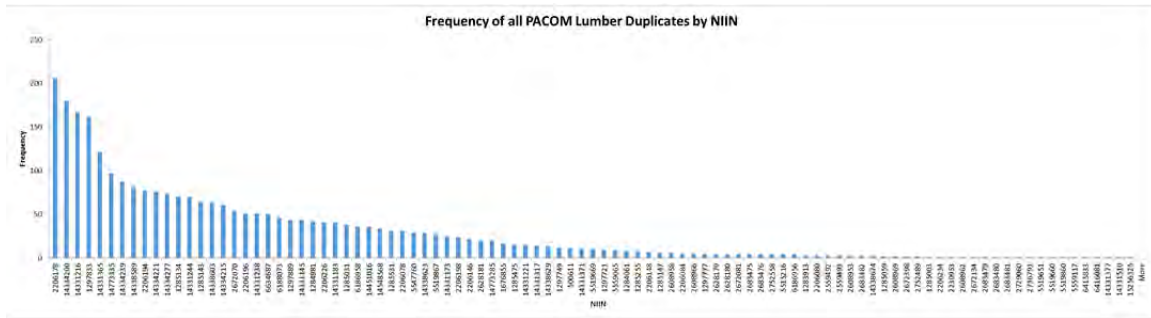
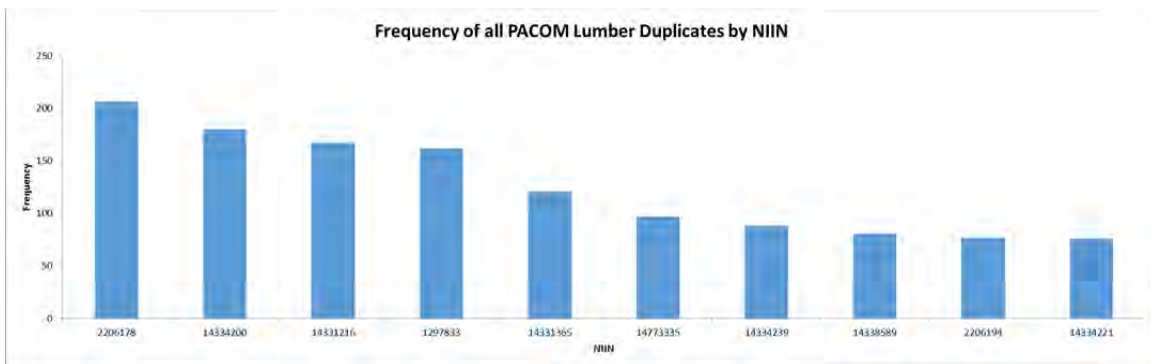


Figure 50. PACOM top ten duplicate NIINs by frequency and cumulative percentage



The NIIN type of lumber order changes in type and frequency throughout the duplicate period. At day seven the frequency of the type of lumber ordered in duplicate has changed along with the rank order of frequency. For example NIIN 2206178 which is a 4” x 4” x 8’ lumber board on day one was observed as being 8th in the rank order of the most frequently ordered in duplicate. By day ten of the duplicate order period this same item has moved to the 1st rank order of the duplicate order period. The type of lumber item being duplicated changes during the duplicate period. Certain lumber items have a varying degree of demand throughout the duplicate order period.

Units in PACOM appear to experience a sliding demand scale for different types of lumber items depending on the day during the 7 day order period. This data could prove useful because it reinforces the idea that items placed in duplicate are also in high demand.

(3) Overall trends of PACOM by date

Figures 51–54 represent the frequency of Class IV lumber items placed in either normal or duplicate order. Each spike represents lumber orders placed by all units in PACOM. The more the red-bar is stacked on the blue-bar, then the more prevalent the duplicate order is. Significant to this is Y-axis, which shows the quantity of orders, or the variance in orders per day. The variability in total orders, whether normal or duplicate, changes each year, sometimes drastically. When viewing duplicate orders by day, there is on average 3.38 duplicate orders in NORTHCOM. When compared with other COCOMs, EUCOM actually did really well in this category; however, a low daily average still means a high yearly average.

Figure 51. PACOM 2012 normal and duplicate order frequency by date

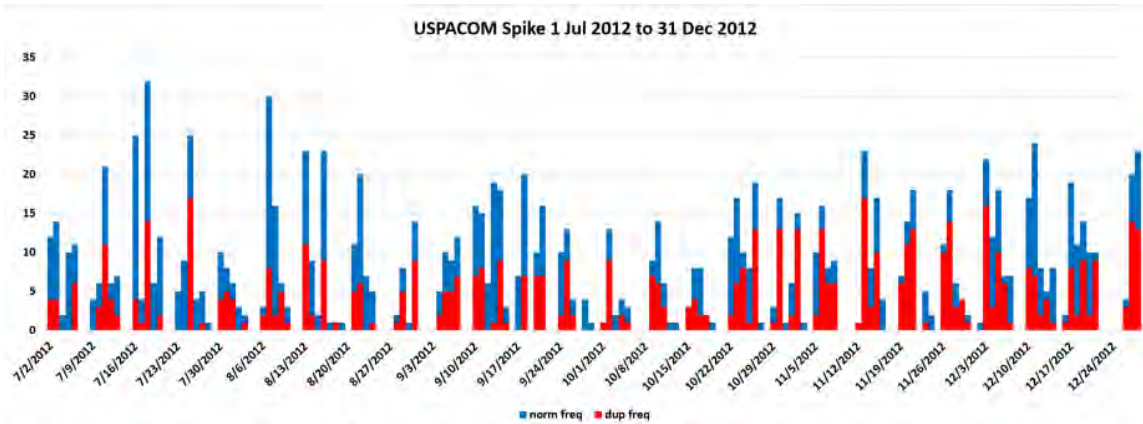


Figure 52. PACOM 2013 normal and duplicate order frequency by date

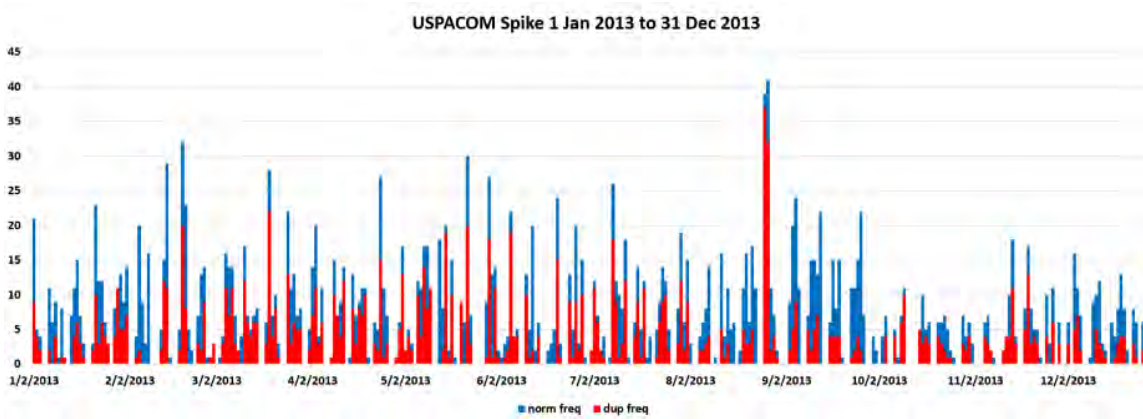


Figure 53. PACOM 2014 normal and duplicate order frequency by date

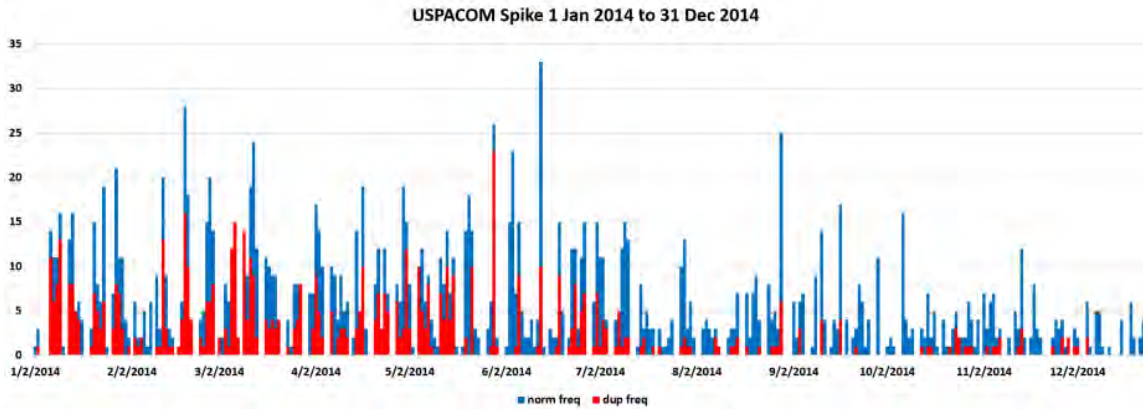
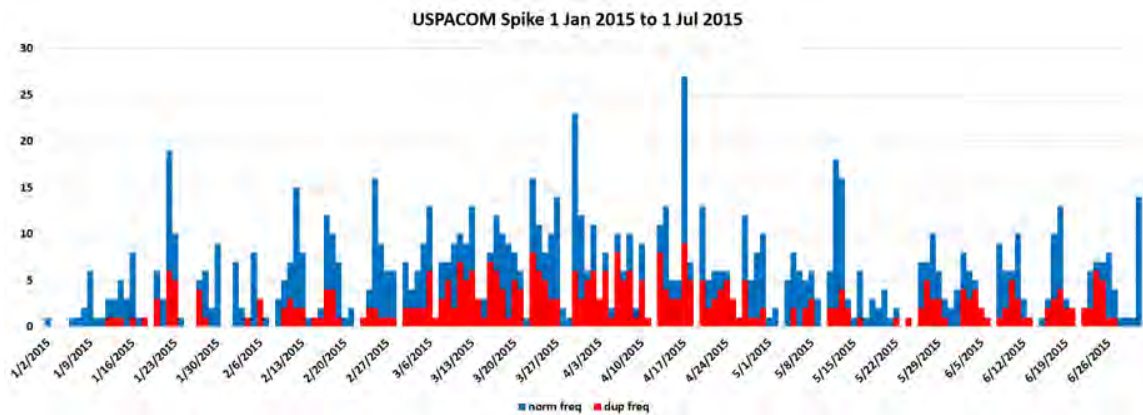


Figure 54. PACOM 2015 normal and duplicate order frequency by date



The exact cause and nature of these spikes may be tied to unit activities. Furthermore there does appear to be a trend of seasonality associated with the spikes in demand for Class IV lumber items. Further, certain years distinguished themselves differently from each other. For example, the first half of 2014 was particularly unstable in predictability of orders placed per day, which in turn lead to a large duplicate order rate. The remaining half of 2015, though, saw the exact opposite. Normal orders were more stable and, as such, less duplicates occurred. 2015 was by far the best year for PACOM in terms of expected order, minimized duplicate orders, and small variance in both. On August 26th and 27th of 2013, there was a total of 39 and 41 orders placed respectively. Of these, 37 were duplicate orders on 26 August and 32 were duplicate orders on 27 August. These two dates were the highest ordering days in terms of both

normal orders and duplicate orders. This spike around this time also occurs, not as drastically, in each year. This could be indicative to end of fiscal year spending.

(4) Overall trends of PACOM by DODAAC

Table 40 and Figures 55–57 represent the PACOM frequency of lumber orders and duplicate orders placed by units as identified by their respective DODAACs. Table 40 describes how 168 units placed orders for lumber during the period of study. Of the 168 units which ordered lumber, 42 of these units or 25% placed duplicate orders. PACOM was slightly above average with only 25% ordering duplicates. The baseline of DOAACs consulting duplicate orders throughout all COCOMs is 26.5%. Though PACOM has 25% of its DOAAC conducting duplicate orders, this still only totaled to be 7.56% of all total duplicate orders.

Table 40. PACOM DODAACs with duplicating problems

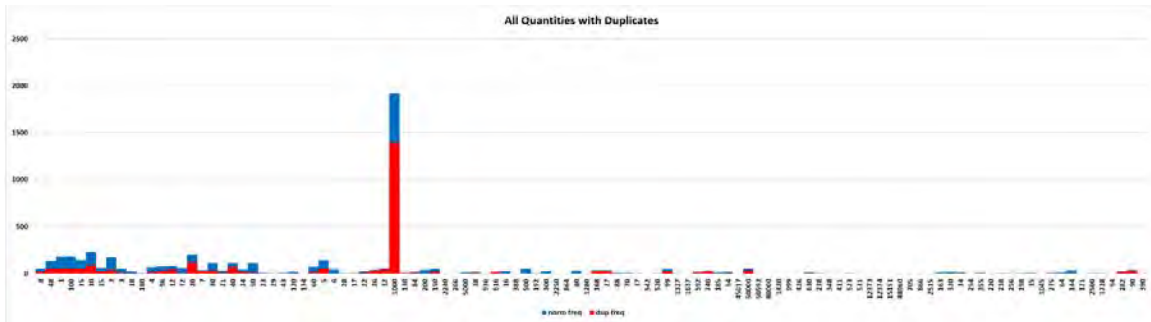
# DODAACs w/ duplicates	42
# DODAACs	168
% of DODAAC duplicate	25.00%

Figure 55 displays the frequency of lumber orders and duplicate orders placed by DODAAC within the period of study for the PACOM AOR. A trend of a high demand for lumber can also indicate a high frequency of duplicate orders being placed. There is no one unit that is the sole culprit in duplicates. Often, the high duplicate ordering DOAACs, conducted erroneous orders 50% of the time or more. An example of this is DODAAC WT4KDK, which placed 612 order, of which, 431 were duplicates. Further, DODAAC W90DGX placed 576 orders, of which, 331 were duplicates.

(5) Overall trends of PACOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of PACOM, there were 645 different quantities ordered. Of this amount, 110 were duplicate quantities, or just 17.05%. Figure 57 represents all of the duplicate orders and shows their associated quantities on the x-axis. An order with a quantity of 1000 was duplicated 1,394 times while and order with a quantity of 80,000 was duplicated 2 times. An order of 50,000 was duplicated 34 times out of 52 times. A smaller order of 592 was duplicated 14 out of 16 times.

Figure 57. PACOM total duplicate orders to normal orders by quantity



(6) Summary of PACOM

The identifiable trends in duplicated items indicates a high demand for particular types of lumber within PACOM. The identifiable 17 types of lumber NIINs can allow DLA to anticipate commonly needed high demand lumber items. The high demand lumber duplicate order list, could be used to anticipate demand and adjust stock pile quantities. The knowledge of the high demand items could be spread throughout DLA and the DOD providing awareness and potentially reduce the frequency of duplicates. These actions could result in a cost savings for DLA and DOD along with improving the overall lumber supply chain.

Certain units above others have historically executed duplicate orders for lumber in a greater frequency over others. The identification of this type of trend data could allow the DOD to focus supply improvement training efforts in order to reduce duplicate order placement.

Improving PACOM stands to make a marginal impact overall in the ordering process of lumber. Due to the fact that PACOM only takes up 7.56% of all duplicates, resources could best be used elsewhere, such as NORTHCOM. Conversely, however, PACOM can become focal point of operations and if operations increase, more effort should be given to its SCM process to ensure great optimization of first time orders.

Tables 41–44 show, based on the three years of data, what the average normal and duplicate orders rates look like for PACOM. Primarily, the best area to improve upon in PACOM is the 25% duplicate ordering rate of all DODAACs. Improving in this area would ensure less duplicate orders, possibly with potential to eliminate all duplicates if done correctly. Alternately, the next best areas to improve in is creating policy or ordering procedures that ensures the top 17 NIINs are ordered properly. In the case of PACOM, they have a small percentage of all duplicate orders, whether by NIIN or sheer quantity. Improving the ordering of each piece of lumber can reduce their duplicate rate.

Table 41. PACOM average order rate per day

USPACOM	
Normal Orders	7.82
Duplicate Orders	3.38
% Duplicate	43.20%
% of total duplicates	8.58%

Table 42. PACOM average order rate per DODAAC

USPACOM	
# of DODAACs	168
# DODAACs duplicate	42
% of duplicate DODAACs	25.00%
% of tot duplicate DODAACs	7.17%
Normal Orders	38.45
Duplicate Orders	16.61
% Duplicate	43.20%
% of total duplicates	15.76%

Table 43. PACOM average lumber items per day

USPACOM	
Normal Orders	9638.03
Duplicate Orders	3461.07
% Duplicate	35.91%
% of total duplicates	12.50%

Table 44. PACOM average quantity of orders per day

USPACOM	
Normal Orders	1633.94
Duplicate Orders	1358.38
% Duplicate	83.13%

C. AFRICOM

(1) Overall trends of AFRICOM by top lumber items

Between 1 July 2012 and 1 July 2015, units in AFRICOM placed duplicate orders for lumber items during this period of study. The top 10 duplicate orders vary from day to day and represent 16 individual NIIN items depending on the day within the period of study. AFRICOM was one of the smallest ordering COCOMs in terms of lumber orders. There were only 19 DODAACs that ordered a total of just 819 orders, of which, 306 were duplicates, or 37.59%. There is further analysis done specifically highlighting an operation within Africa in Chapter VI. Table 45 represents the top 10 NIINs lumber items ordered during the period of study. Table 45 also describes the lumber type and dimensions which were ordered in duplicate.

Table 45. AFRICOM types of duplicate lumber

AFRICOM		
NIIN	Nomenclature	Wood Type
6186958	1/2" x 48" x 96"	Veneer Plywood
14334200	2" x 4" x 8'	Lumber
14450964	2" x 6" x 16'	Lumber
14331173	1" x 6" x 16'	Lumber
14333906	2" x 12" x 12'	Lumber
00000399	2" x 4" x 14'	Lumber
1297777	1/2" x 48" x 96"	Plywood
14331244	2" x 4" x 16'	Lumber
1285147	.625" x 48" x 8'	Plywood
6188073	3/4" x 48" x 96"	Plywood
14331365	2" x 6" x 12'	Lumber
14334221	4" x 4" x 16'	Lumber
1297833	3/4" x 48" x 96"	Plywood
2206226	3" x 4" x 8'	Lumber
1285059	1/2" x 48" x 8'	Plywood
14331238	2" x 4" x 12'	Lumber

The listed lumber items range from plywood to lumber boards and vary in dimension and type. These lumber products are in keeping with the trends of like dimensions as associated with other orders from other COCOMs. The only unique piece of lumber in AFRICOM is the plywood sheet that measures .625" x 48" x 8'. This is the only time this piece of plywood emerges in any COCOM as a highly order item and duplicate item.

(2) Overall trends of AFRICOM by NIIN

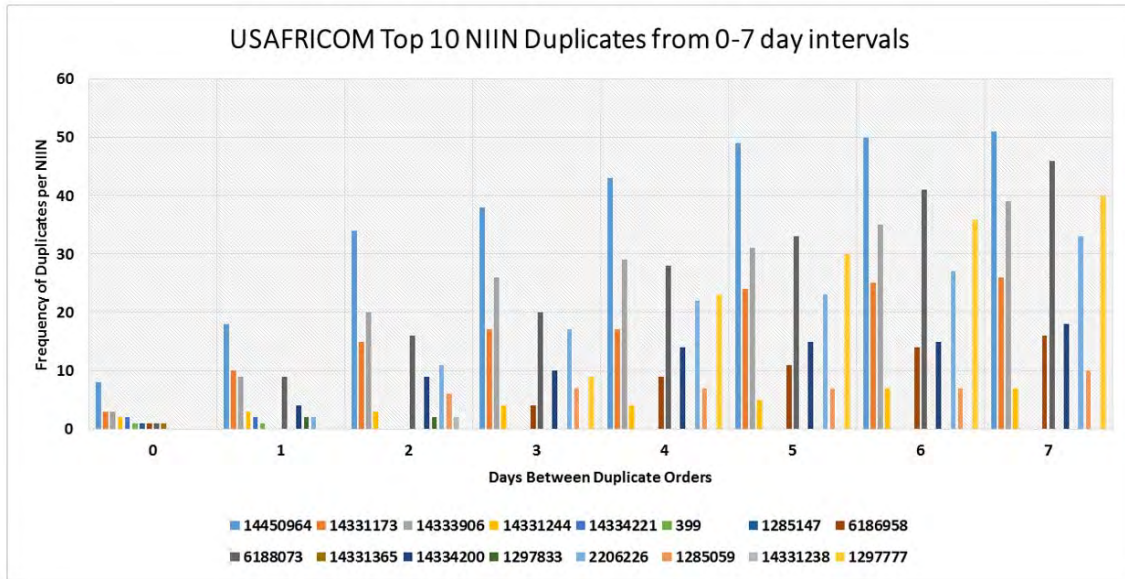
Table 46 shows the exact number of NIINs within AFRICOM. 51 different NIINs were ordered, of which, 21 were duplicated. This represents a 41.18% duplicate rate by NIIN, which is below the overall average of 48.46%.

Table 46. AFRICOM NIIN order total, duplicates, and percentage rate

USAFRICOM	
Total NIINs	51
NIINs duplicated	21
% Duplicate	41.18%

Figure 58 describes the top ten NIIN duplicate lumber items by each day within a duplicate order period of one week. As the days between original order placement and potential duplicate order placement increased, the type and amount of each duplicate order changed. As such, 16 total NIINs emerged as the high frequency duplicate NIINs.

Figure 58. AFRICOM top ten NIIN duplicates using a one to seven day sliding window



The top 10 duplicate orders vary from day to day and represent 16 individual NIINs depending on the day within the period of study. The number one item placed in duplicate for AFRICOM during the three year period of study was NIIN 14450964 the 2" x 6" x 16' lumber board. The board was placed in duplicate 291 times during the three year period of study by various units within AFRICOM. Table 47 data applies to Figure 58.

Table 47. AFRICOM quantity of duplicate NIINs per day of duplicate

	Number of days in ordering period							
	0	1	2	3	4	5	6	7
14450964	8	18	34	38	43	49	50	51
14331173	3	10	15	17	17	24	25	26
14333906	3	9	20	26	29	31	35	39
14331244	2	3	3	4	4	5	7	7
14334221	2	2						
399	1	1						
1285147	1							
6186958	1			4	9	11	14	16
6188073	1	9	16	20	28	33	41	46
14331365	1							
14334200		4	9	10	14	15	15	18
1297833		2	2					
2206226		2	11	17	22	23	27	33
1285059			6	7	7	7	7	10
14331238			2					
1297777				9	23	30	36	40
	Number of times duplicate NIIN occurred in each day							

Figures 59 and 60 illustrate the types of lumber items placed on order in duplicate using a one to seven day sliding window. Each NIIN represents an individual type of lumber placed on order over the three year period of study. In short, when using a seven day ordering window to look for duplicates, AFRICOM has over 90% of its duplicates rooted in just 10 NIINs. This grows to 16 NIINs if you change the ordering period to a different number of days between one and seven days.

Figure 59. AFRICOM duplicate NIINs by frequency and cumulative percentage

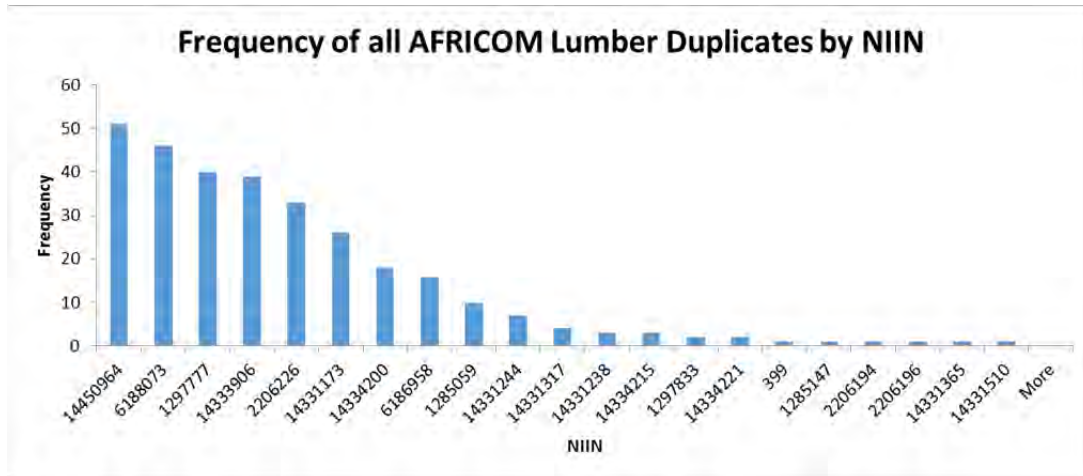
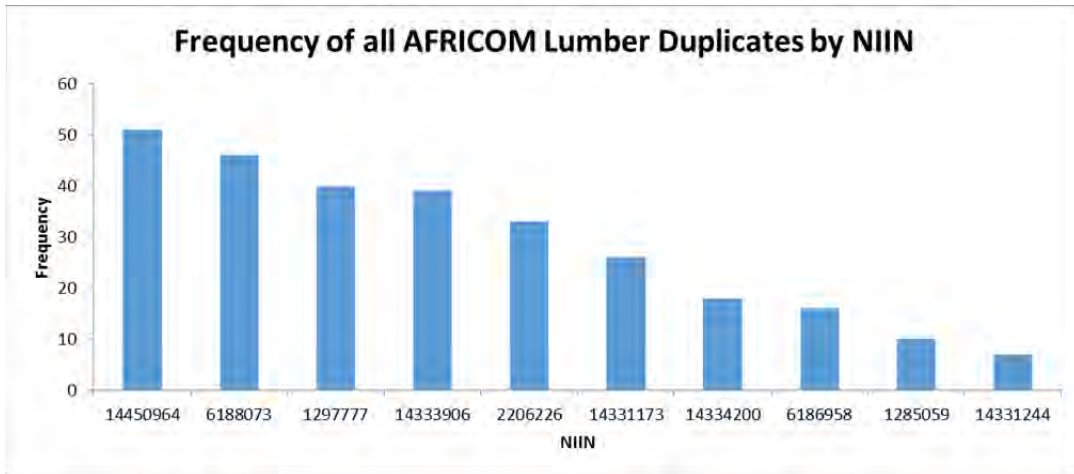


Figure 60. AFRICOM top ten duplicate NIINs by frequency and cumulative percentage



The NIIN type of lumber order changes in type and frequency throughout the duration of the order period. At day seven the frequency of the type of lumber ordered in duplicate has changed along with the rank order of frequency. For example NIIN 6188073 which is a 3/4" x 48" x 96" sheet of plywood on day one was observed as being 9th in the rank order of the most frequently ordered in duplicate. By day seven of the duplicate order period this same item has moved to the 2nd rank order of the duplicate order period. The type of lumber item being duplicated changes during the duplicate period.

Significant just to AFRICOM is that the top ten duplicate-ordered NIINs represent 90% of all duplicates. So by fixing just these top ten, great saving and optimization can be realized. AFRICOM is in a unique position currently. Unlike the other COCOMs, AFRICOM is fairly new and is still standing up infrastructure around Africa. As such, understanding these duplicate trends and ordering behavior of units upfront, could in turn prove more useful in the lumber ordering process.

(3) Overall trends of AFRICOM by date

Figures 61 - 64 represent the frequency of Class IV items placed in either normal or duplicate order. Each spike represents lumber orders placed by units throughout AFRICOM. The dates associated with AFRICOM suggest a reactionary ordering of lumber. Since AFRICOM only requests lumber usually for operational reasons, their

orders over time as very frequent or nonexistent. Further, the request for lumber in AFRICOM are very small, which suggests that initial shipments, separate from the ordering system, bring in lumber for operations, such as in the chapter VI case study of Operation United Assistance (OUA). On average, AFRICOM had 2.22 orders per day, of which, .84 were duplicates. This is the lowest of all COCOMs, but still represents a duplicate order rate of 37.59%.

Figure 61. AFRICOM 2012 normal and duplicate order frequency by date

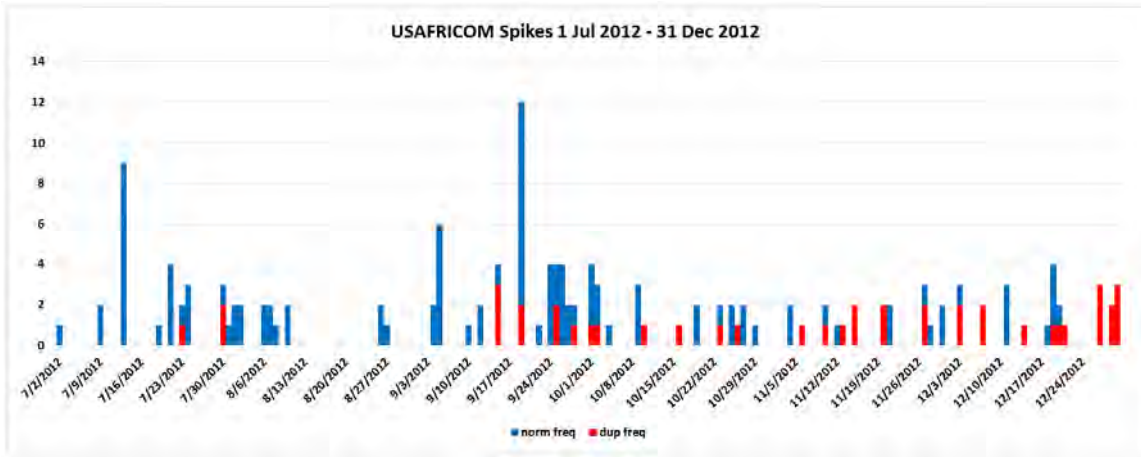


Figure 62. AFRICOM 2013 normal and duplicate order frequency by date

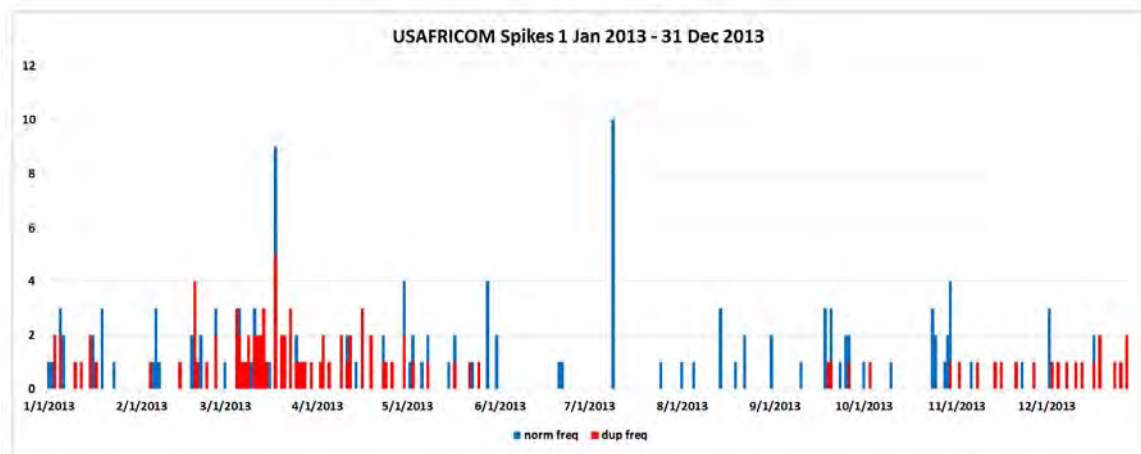


Figure 63. AFRICOM 2014 normal and duplicate order frequency by date

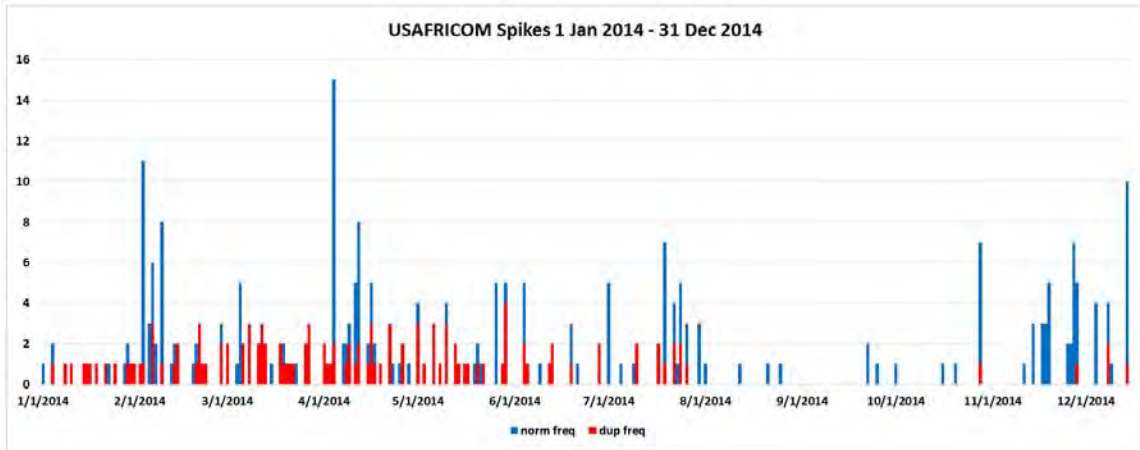
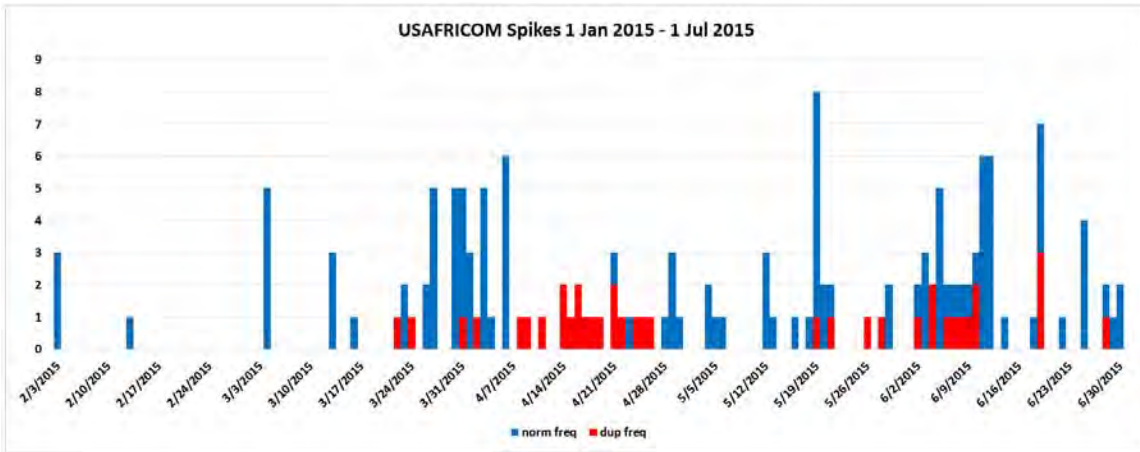


Figure 64. AFRICOM 2015 normal and duplicate order frequency by date



The year 2014 saw an uptick in lumber requests during the first six months. This demand for lumber, however, faded during the final half of the year. AFRICOM also does not show an uptick in ordering towards the end of the fiscal year like other COCOMs. 2015 saw a large uptick in duplicating due to OUA. This shows for the first time how an operation impacts ordering. Specifically, in early March of 2015, there was a transfer of authority between two units in AFRICOM during OUA. Following this transfer there was a spike in orders and duplicate orders.

(4) Overall trends of AFRICOM by DODAAC

Table 48 and Figures 65–67 represent the AFRICOM frequency of normal and duplicate orders placed by individual units. Table 48 further describes how 19 units

placed orders for lumber during the period of study. Of the 19 units which ordered lumber, 6 of these units or 31.58% of these units placed duplicate orders. Nearly one third of all DODAACs placed duplicate orders. This is somewhat high compared to the overall average of 26.5% of DODAACs conducting duplicate orders.

Table 48. AFRICOM DODAACs with duplicate ordering problems

# DODAACs w/ duplicates	6
# DODAACs	19
% of DODAAC duplicate	31.58%

Figure 65 displays the frequency of normal and duplicate orders placed by DODAACs in AFRICOM. Of note, the largest culprit of duplicate orders was DODAAC W91K61, who ordered 580 times, of which, 296 were duplicates. The remaining units only had two duplicate orders each. Figure 65 will not show the red-bar for the other DODAACs due to the large duplicate order by W91K61.

Figure 65. AFRICOM total duplicate orders to normal orders per DODAAC

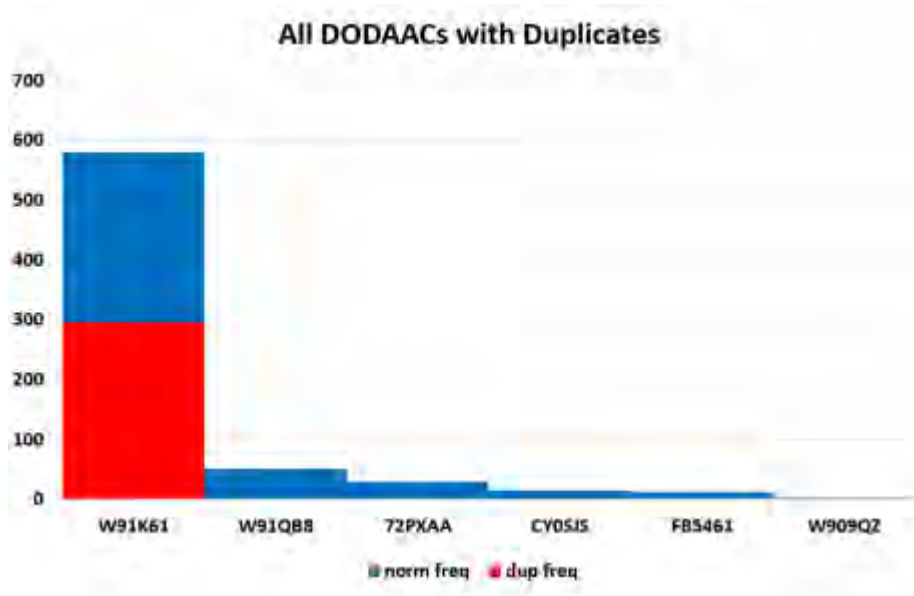
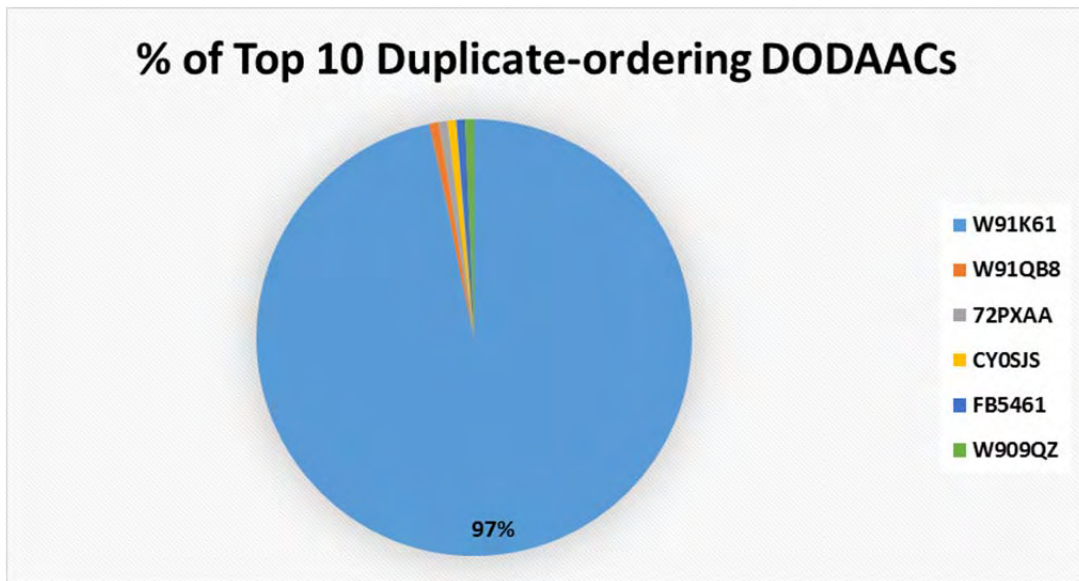


Figure 66 describes the top six duplicate ordering units as represented by DODAACs. These six DODAACs are further broken down to show the percentage of

the lumber duplicate orders each DODAAC is responsible for placing during the period of study. In the case of AFRICOM, due to the smallness of the operating environment needing lumber, only six units were found to have conducted duplicate orders. As Figure 65 suggests, only one real DODAAC was nefarious in conducting duplicate orders. Figure 66 sums up this point by showing how one unit led to 97% of all duplicate orders.

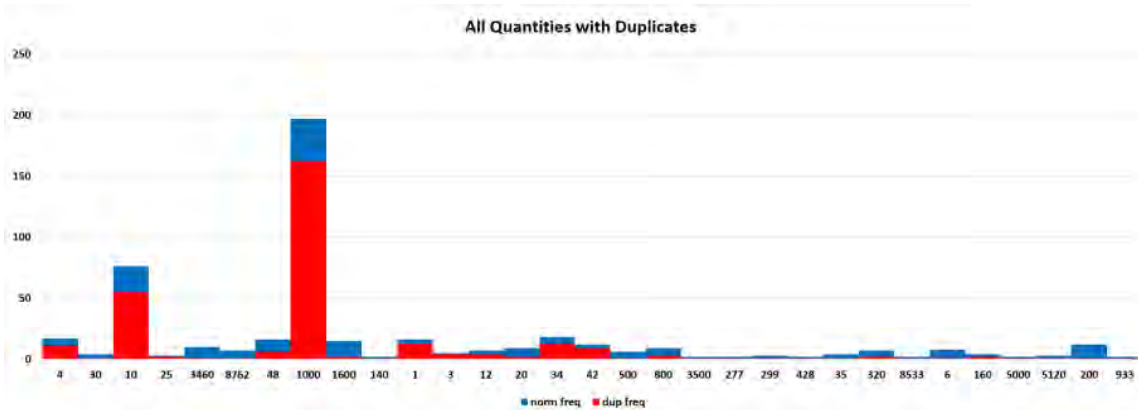
Figure 66. AFRICOM percentage of top ten duplicate-ordering DODAACs



(5) Overall trends of AFRICOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of AFRICOM, there were 242 different quantities ordered. Of this amount, 31 were duplicate quantities, or just 12.81%. Figure 67 represents all of the duplicate orders and shows their associated quantities on the x-axis. Some abnormal order include an order with a quantity of 1000 which was ordered in duplicate 162 times while another order with a quantity of 8,533 was ordered in duplicate 1 time, which represented 50% of that quantity's duplicate. An order of 10 lumber items was ordered in duplicate 55 times out of 76 times.

Figure 67. AFRICOM total duplicate orders to normal orders by quantity



(6) Summary of AFRICOM

AFRICOM operates differently than other COCOMs. Their requests from lumber derive from mission requirements. As such, their data set is truly unique and unpredictable. Due to this operating model, AFRICOM, if it wishes to order properly and minimized duplicate orders, must focus on ordering correctly at the user level. One DODAAC order 97% of all duplicates. This cannot stand in contingency operations since supply chains are not set and often are more cost expensive. Honing this ordering point to produce as few erroneous orders as possible will prove overall beneficial to the mission as well as the supply chain management system.

Improving AFRICOM will not impact the ordering process of lumber. Due to the fact that AFRICOM only takes up 0.83% of all duplicates, resources could best be used elsewhere. Conversely, however, AFRICOM can become focal point of operations and if operations increase, more effort should be given to its SCM process to ensure great optimization of first time orders.

Tables 49–52 show, based on the three years of data, what the average normal and duplicate orders rates look like for AFRICOM. Primarily, the best area to improve upon in AFRICOM is the 97% duplicate ordering rate of DODAACs. Improving in this area would ensure less duplicate orders, possibly with potential to eliminate all duplicates if done correctly. Alternately, the next best area to improve in is creating policy or ordering procedures that ensures the top 16 NIINs are ordered properly. In the case of AFRICOM,

they have the overwhelming majority of all duplicate orders, whether by NIIN or sheer quantity. Improving the ordering of each piece of lumber can reduce their duplicate rate.

Table 49. AFRICOM average order rate per day

USAFRICOM	
Normal Orders	2.22
Duplicate Orders	0.84
% Duplicate	37.59%
% of total duplicates	2.12%

Table 50. AFRICOM average order rate per DODAAC

USAFRICOM	
# of DODAACs	19
# DODAACs duplicate	6
% of duplicate DODAACs	31.58%
% of tot duplicate DODAACs	1.02%
Normal Orders	42.84
Duplicate Orders	16.05
% Duplicate	37.47%
% of total duplicates	15.24%

Table 51. AFRICOM average lumber items per day

USAFRICOM	
Normal Orders	1460.95
Duplicate Orders	189.63
% Duplicate	12.98%
% of total duplicates	0.68%

Table 52. AFRICOM average quantity of orders per day

USAFRICOM	
Normal Orders	1965.28
Duplicate Orders	678.59
% Duplicate	34.53%
% of total duplicates	14.38%

D. SOUTHCOM

(1) Overall trends of SOUTHCOM by top lumber items

SOUTHCOM represents the smallest ordering COCOM. There is very little data present that can create thoughtful analysis due to its low order rate. However, analysis can still be accomplished, albeit, not to the same scale as the previous COCOMs. Table 53 and Figure 68 represent the top two NIINs lumber items ordered during the period of study. Between 1 July 2012 and 1 July 2015, units within SOUTHCOM placed duplicate orders for lumber. Exactly, they placed a total of 46 orders, of which, only six were duplicates, or 13.04%, which is the lowest duplicate rate of all COCOMs. Further, Table 53, describes the lumber type and dimensions which were ordered in duplicate.

Table 53. SOUTHCOM types of duplicate lumber

SOUTHCOM		
NIIN	Nomenclature	Wood Type
1285255	1/2" x 48" x 8'	Plywood
1297721	1/4" x 48" x 96'	Plywood

The listed lumber items include only plywood. These two pieces of plywood are keeping with previous duplicate orders from other COCOMs.

(2) Overall trends of SOUTHCOM by NIIN

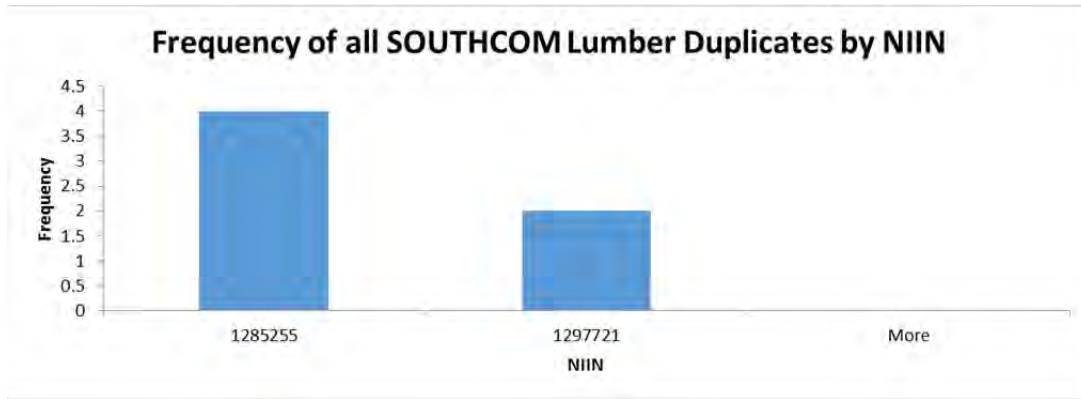
Table 54 shows the exact number of NIINs within SOUTHCOM. 13 different NIINs were ordered, of which, 2 were duplicated. This represents a 15.38% duplicate rate by NIIN, which is much lower than overall average of 48.46%. This drastic deviation from the average is due to SOUTHCOM's small size of order.

Table 54. SOUTHCOM NIIN order total, duplicates, and percentage rate

USSOUTHCOM	
Total NIINs	13
NIINs duplicated	2
% Duplicate	15.38%

Due to the small amount of orders and duplicate orders in SOUTHCOM, a top ten NIIN Figure, quantity of duplicate NIIN table, and total NIIN duplicate histogram Figure was not created. Figure 69, however, describes all NIIN duplicates ordered within the order period, in which there are none for this period.

Figure 68. SOUTHCOM top ten duplicate NIINs by frequency and cumulative percentage



The duplicate orders for SOUTHCOM include only two NIIN items during the period of study. Force disposition within the SOUTHCOM is much less than that when compared to other COCOMS. Two NIIN items were placed in duplicate six times during the three year period of study by various units within SOUTHCOM.

(3) Overall trends of SOUTHCOM by date

Figure 69–72 represent the frequency of lumber items placed in either normal or duplicate orders. Each spike represents lumber orders placed by all units throughout SOUTHCOM. Figure 71 represents the only period with duplicate orders.

Figure 69. SOUTHCOM 2012 normal and duplicate order frequency by date

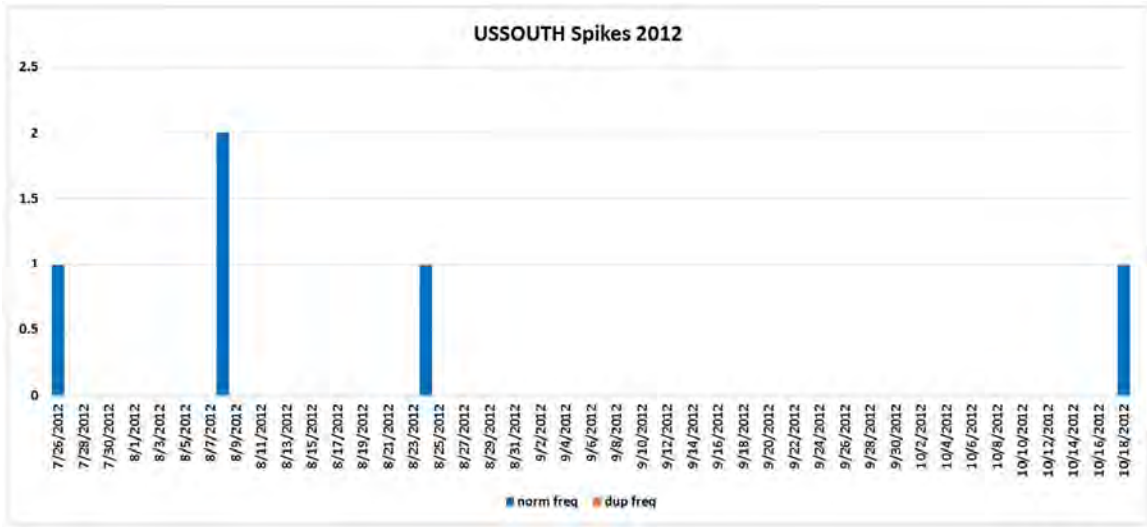


Figure 70. SOUTHCOM 2013 normal and duplicate order frequency by date

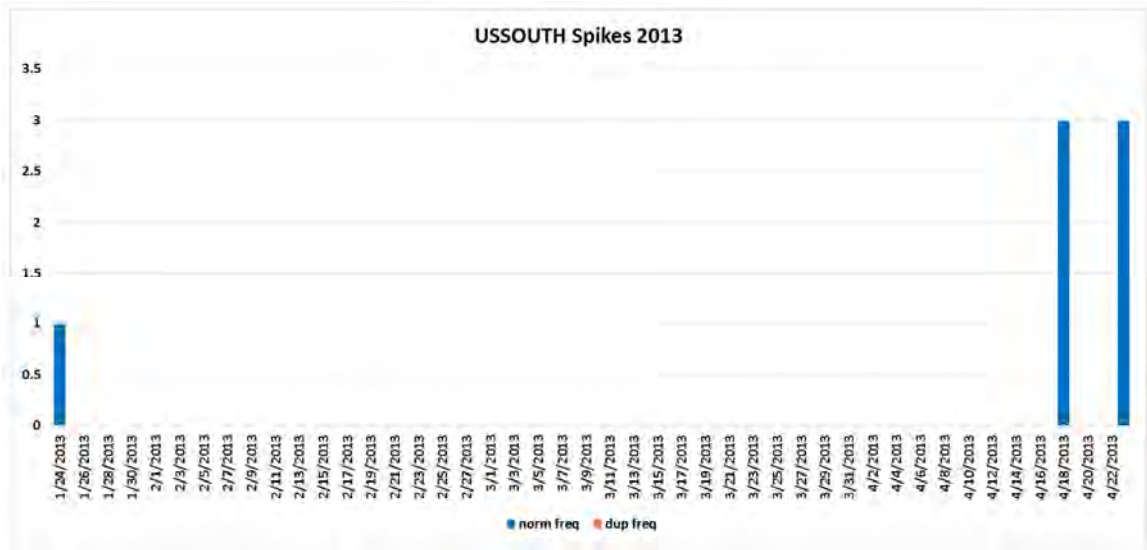


Figure 71. SOUTHCOM 2014 normal and duplicate order frequency by date

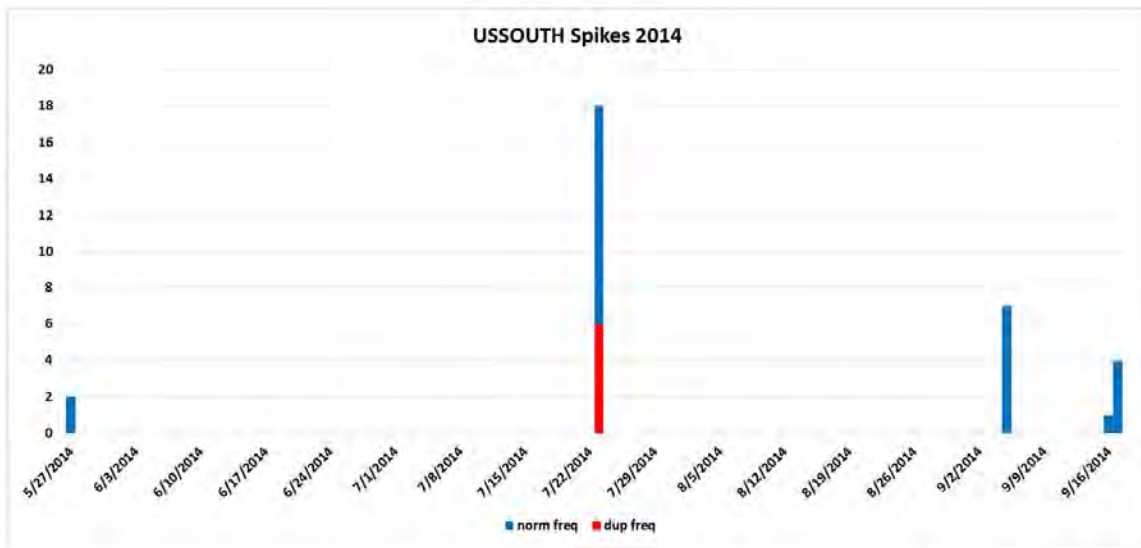
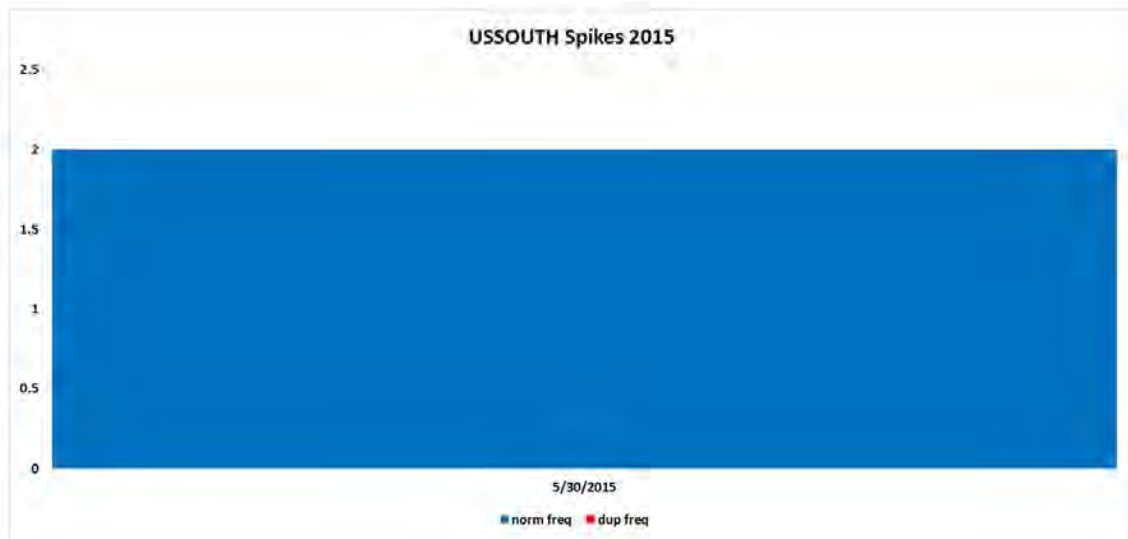


Figure 72. SOUTHCOM 2015 normal and duplicate order frequency by date



There was only one occurrence by date of a duplicate order. On 23 July 2014, 18 orders for lumber were placed, of which, 6 were duplicates. The two NIINs that were both ordered in duplicate were ordered on the exact same day. There was only one order in 2015, three orders in 2013, and four orders in 2012. Additionally, these three years saw zero duplicate orders. Ordering for lumber is genuinely sparse in SOUTHCOM.

(4) Overall trends of SOUTHCOM by DODAAC

Table 55 and Figure 73–75 represent the SOUTHCOM frequency of normal and duplicate orders placed by units as identified by DODAAC. Table 55 also describes how nine units placed orders for lumber during the period of study. Of the nine units which ordered lumber, one of these units or 11.11% of these units placed duplicate orders.

Table 55. SOUTHCOM DODAACs with duplicating problems

# DODAACs w/ duplicates	1
# DODAACs	9
% of DODAAC duplicate	11.11%

Figure 73 displays the frequency of lumber orders and duplicate orders placed by DODAACs within the period of study for SOUTHCOM. Just one DODAAC was guilty of ordering in duplicate. DODAAC W90YQT placed 29 orders, of which, 6 were duplicates.

Figure 73. SOUTHCOM total of duplicate orders to normal orders per DODAAC

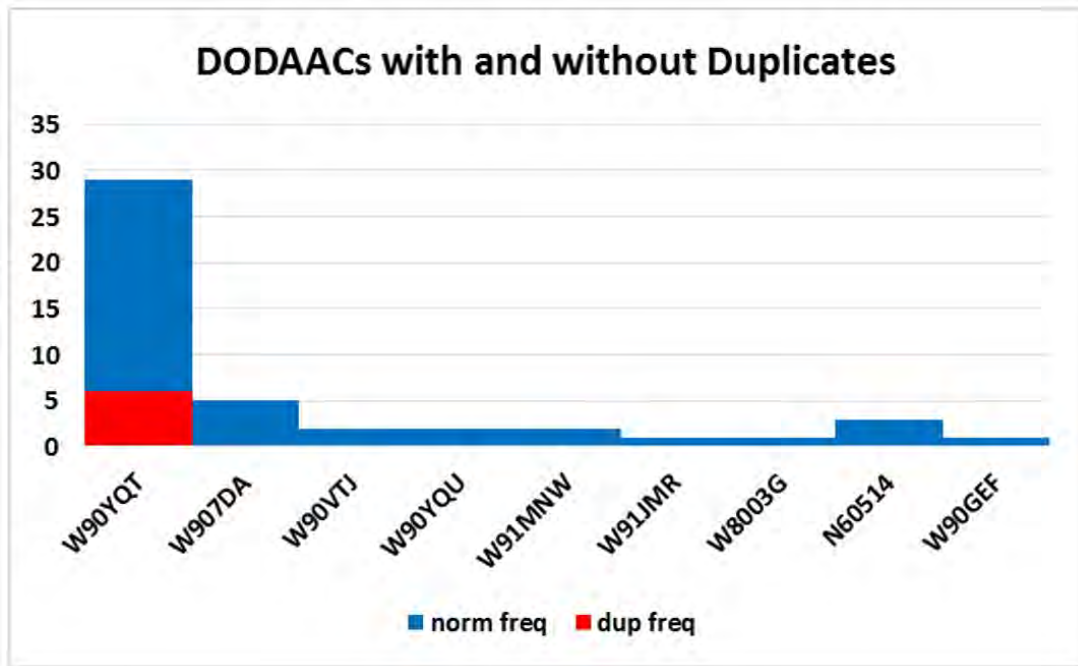
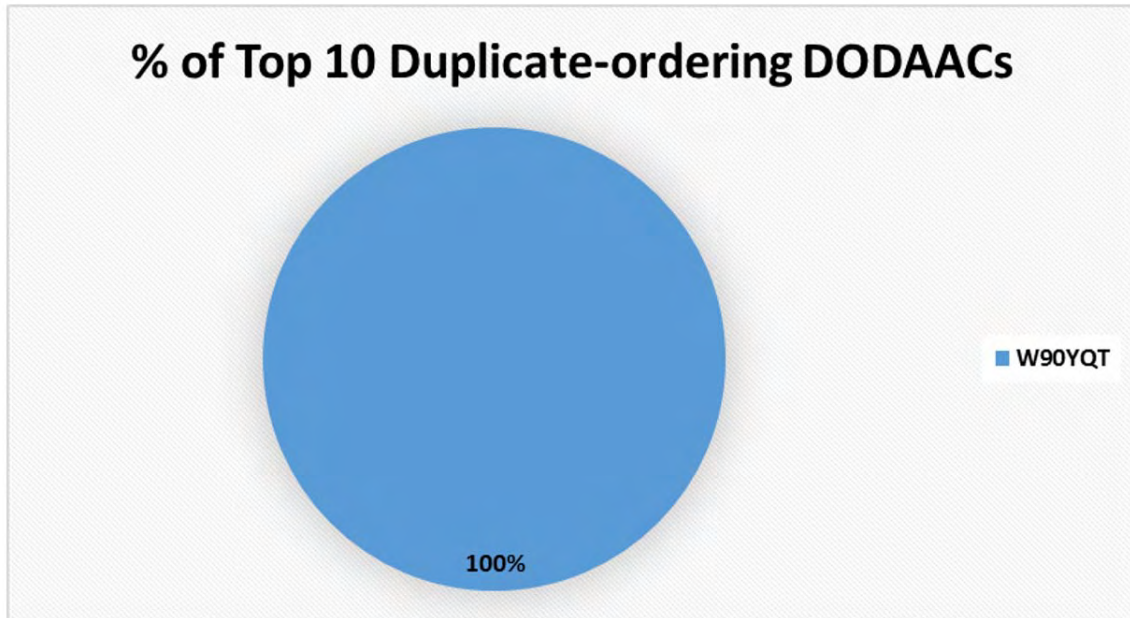


Figure 74 describes the top ten percent duplicate ordering military units as represented by DODAACs's. SOUTHCOM only has one DODAAC which placed duplicate orders.

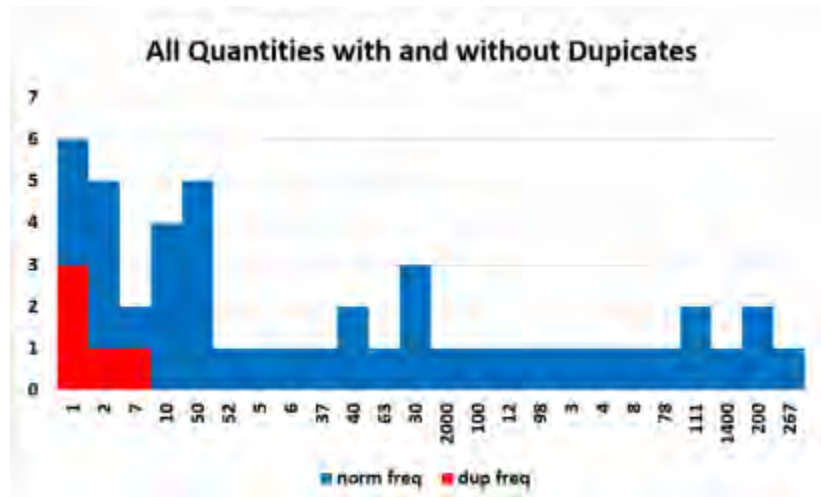
Figure 74. SOUTHCOM percentage of top ten duplicate-ordering DODAACs



(5) Overall trends of SOUTHCOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of SOUTHCOM, there were 24 different quantities ordered. Of this amount, 3 were duplicate quantities, or just 12.5%. Figure 75 represents all of the duplicate orders and shows their associated quantities on the x-axis. An order with a quantity of one was duplicated three times out of six, while an order with a quantity of two was duplicated one time, but still represented 20% of that quantity's duplicate. Further, an order of seven was duplicated one time out of two times. In all, SOUTHCOM's duplicate order, based on quantity, are small and insignificant. SOUTHCOM is not plagued by large quantity duplicates such as other COCOMs with large quantities of 1000 or more pieces of duplicate lumber.

Figure 75. SOUTHCOM total duplicate orders to normal orders by quantity



(6) Summary of SOUTHCOM

SOUTHCOM stands to gain a lot about ordering behavior based on other COCOMs’ performance. Since SOUTHCOM does not keep forward units permanently stationed there, but rather reacts in the form of contingency operations, emphasis must be placed on DODAACs ordering. The focal point for duplicate orders to occur in the case of SOUTHCOM will be at the unit level. Only after a unit orders will a top ten NIIN list of duplicate order be able to be constructed.

Improving SOUTHCOM stands to make no impact overall in the ordering process of lumber. Due to the fact that SOUTHCOM only takes up .02% of all duplicates, resources are best used elsewhere, such as NORTHCOM. Conversely, however, SOUTHCOM can become focal point of operations and if operations increase, more effort should be given to its SCM process to ensure great optimization of first time orders.

Tables 56–59 shows, based on the three years of data, what the average normal and duplicate orders rates look like for SOUTHCOM. Primarily, the best area to improve upon in SOUTHCOM is the 11.11% duplicate ordering rate of all DODAACs. Improving in this area would ensure less duplicate orders, possibly with potential to eliminate all duplicates if done correctly. Alternately, if it emerges in the future, the next best area to improve in is creating policy or ordering procedures that ensure the top NIINs are ordered

properly. In the case of SOUTHCOM, they are in a unique position to get ahead of potential duplicate ordering problems before they occur.

Table 56. SOUTHCOM average order rate per day

USSOUTHCOM	
Normal Orders	3.54
Duplicate Orders	0.46
% Duplicate	13.04%
% of total duplicates	1.17%

Table 57. SOUTHCOM average order rate per DODAAC

USSOUTHCOM	
# of DODAACs	9
# DODAACs duplicate	1
% of duplicate DODAACs	11.11%
% of tot duplicate DODAACs	0.17%
Normal Orders	5.11
Duplicate Orders	0.67
% Duplicate	13.04%
% of total duplicates	0.63%

Table 58. SOUTHCOM average lumber items per day

USSOUTHCOM	
Normal Orders	4.79
Duplicate Orders	0.01
% Duplicate	0.23%
% of total duplicates	0.00%

Table 59. SOUTHCOM average quantity of orders per day

USSOUTHCOM	
Normal Orders	114.02
Duplicate Orders	3.67
% Duplicate	3.22%
% of total duplicates	0.08%

E. CENTCOM

(1) Overall trends of CENTCOM by top lumber items

Between 1 July 2012 and 1 July 2015, units placed duplicate orders for lumber items. CENTCOM placed 8,129 orders, of which, 4,007 were duplicates, or 49.27%. This represents the second largest COCOM in terms of quantity of orders and percentage of duplicate orders. Of note, though this duplicate rate is high when viewed solely as a standalone COCOM, its overall impact on all orders throughout all COCOMs is only 10.86% due to NORTHCOM’s sheer size of duplicates. The top 10 duplicate orders vary from day to day and represent 15 individual NIIN items depending on the day within the period of study. Tables 60 and 61 represent the top 10 NIIN lumber items and describes their dimensions which were ordered in duplicate.

Table 60. CENTCOM types of duplicate lumber

CENTCOM		
NIIN	Nomenclature	Wood Type
6186958	1/2" x 48" x 96"	Veneer Plywood
1676855	2" x 4"x 8'	Lumber
6188073	3/4" x 48" x 96"	Plywood
2206226	4" x 4"x 6'	Lumber
1292063	1" x 48" x 8'	Plywood
2206198	2" x 8"x 6'	Lumber
14331511	2" x 12"x 8'	Lumber
1285531	3/4" x 48" x 8'	Plywood
1327108	2" x 6"x 6'	Lumber
2736791	6" x 6"x 10'	Lumber
2206194	2" x 4"x 8'	Lumber
1297749	3/4" x 48" x 8'	Plywood
2206200	2" x 10"x 6'	Lumber
2206178	4" x 4"x 8'	Lumber
14331216	2" x 4"x 8'	Lumber

The listed lumber items range from plywood to lumber boards and vary in dimension and type. CENTCOM has an interesting trend with duplicate orders of plywood. The dimension ¾” x 48” x 96” appears on three different NIINs, even though it is the same dimension for all three items.

(2) Overall trends of CENTCOM by NIIN

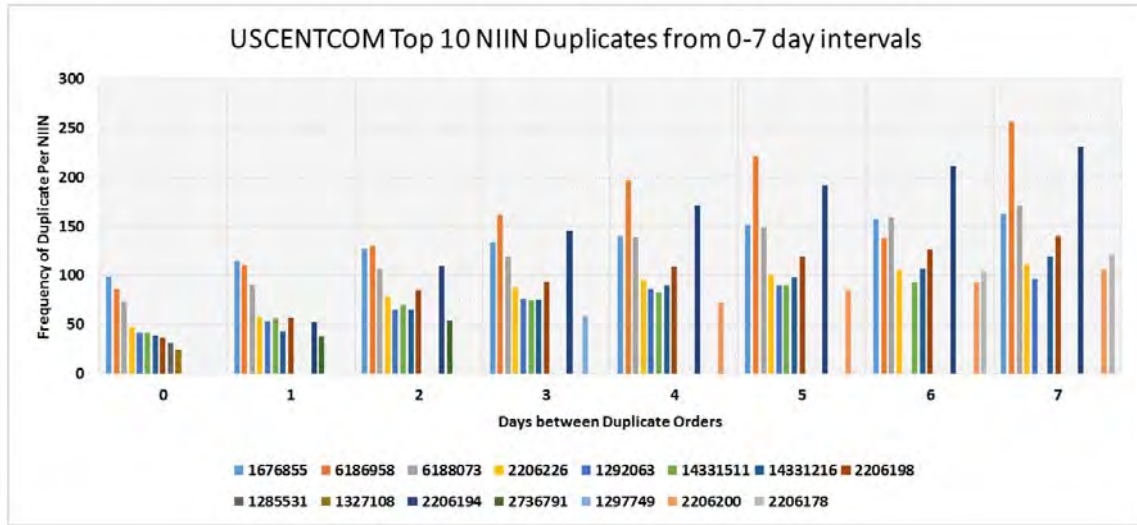
Table 61 shows the exact number of NIINs within CENTCOM. 212 different NIINs were ordered, of which, 114 were duplicated. This represents a 53.77% duplicate rate by NIIN, which is slightly above the overall average of 48.46%.

Table 61. CENTCOM NIIN order total, duplicates, and percentage rate

USCENTCOM	
Total NIINs	212
NIINs duplicated	114
% Duplicate	53.77%

Figure 76 describes the top ten NIIN duplicates within a duplicate period of one week. The top 10 duplicate orders vary from day to day and represent 15 individual NIINs, depending on the day within the period of study.

Figure 76. CENTCOM top NIIN duplicates using a one to seven day sliding window



The number one item placed in duplicate for CENTCOM during the three year period of study is NIIN 6186958, a 1/2" x 48" x 96" sheet of plywood. This plywood sheet was placed in duplicate 1,301 times during the three year period of study by various

units within CENTCOM. Table 62 shows the data to the above graph and shows the quantity of all NIINs per day or duplicate order.

Table 62. CENTCOM quantity of duplicate NIINs per day or duplicate

		Number of days in ordering period							
		0	1	2	3	4	5	6	7
NIINs	1676855	99	114	127	133	140	152	157	163
	6186958	86	111	130	162	196	221	138	257
	6188073	73	91	107	119	139	149	159	171
	2206226	48	58	78	88	95	101	105	112
	1292063	41	53	65	76	86	90		96
	14331511	41	56	70	74	82	90	92	
	14331216	39	43	65	75	90	98	107	119
	2206198	37	57	85	93	109	119	126	140
	1285531	31							
	1327108	24							
	2206194		52	110	145	171	192	211	231
	2736791		38	54					
	1297749				59				
	2206200					72	85	92	106
	2206178							103	122
			Number of times duplicate NIIN occurred in each day						

Figures 77 and 78 illustrate the types of lumber items placed in duplicate within the seven day sliding window ordering period. Each NIIN represents an individual type of lumber placed on order over the three year period of study. Overall, of the 212 total NIINs ordered in CENTCOM, 114 were ordered as a duplicate at least once, or a total of 53.77% overall. The top ten duplicate NIINs make up almost 40% of all duplicate orders. The top 51 NIINs account for 90% of all duplicate orders. In previous COCOMs, a few duplicate NIINs account for a large percentage of overall duplicates. This is not the case in CENTCOM. Their duplicate orders are more evenly distributed by frequency.

Figure 77. CENTCOM duplicate NIINs by frequency and cumulative percentage

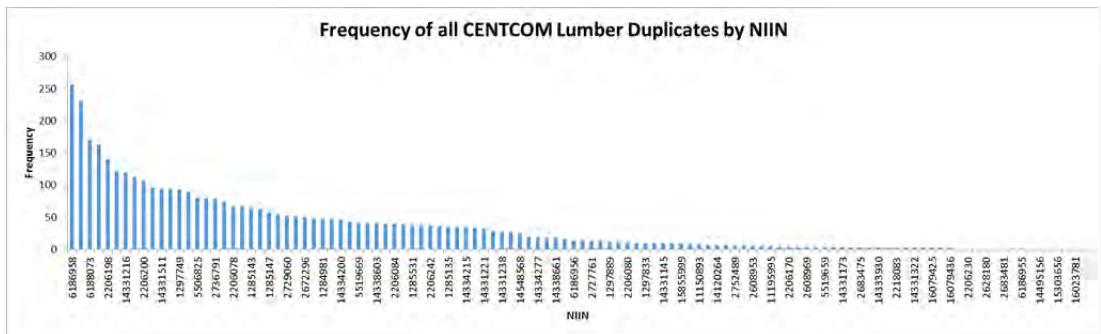
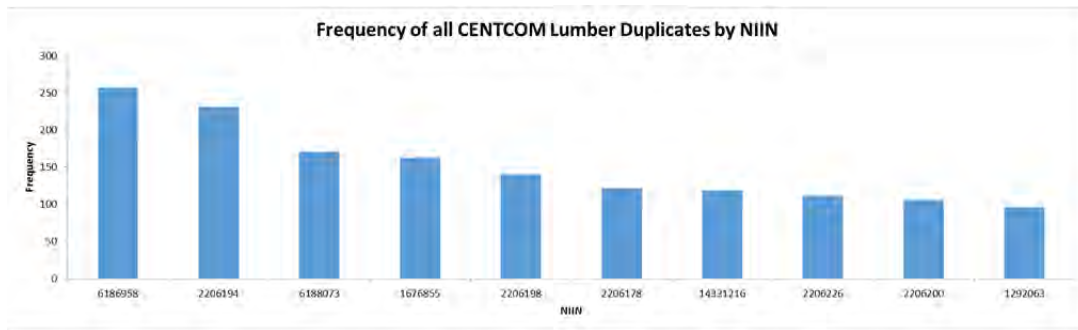


Figure 78. CENTCOM top ten duplicates NIINs by frequency and cumulative percentage



The NIIN type of lumber order changes in type and frequency throughout the duration of the duplicate period. At day seven, the frequency and the type of lumber ordered in duplicate has changed along with the rank order of frequency. For example NIIN 6186958 which is a 1/2" x 48" x 96" sheet of plywood and on day one was observed as being 2nd in the rank order of the most frequently ordered in duplicate. By day seven of the duplicate order period, this same item has moved to the 1st rank position. The type of lumber item being ordered in duplicate changes during the duplicate period. Certain lumber items have a varying degree of demand throughout the order period. Further, NIIN 2206194 was in the 9th rank position on day one but grew to the 2nd rank position by day seven. Finding the Pareto point of 90% on the curve represents 51 NIINs, or almost one quarter of all NIINs ordered in CENTCOM. To focus efforts on these NIINs would reduce duplicates by 90%.

(3) Overall trends of CENTCOM by date

Figures 79–82 represent the frequency of lumber items placed in either normal or duplicate order. Each spike represents lumber orders placed by all units throughout the CENTCOM. The more the red-bar is stacked on the blue-bar, then the more prevalent the duplicate order is. Significant to this is the Y-axis. The variability in total orders, whether normal or duplicate, changes each year, sometimes drastically. CENTCOM has one of the largest spikes in ordering and duplicate ordering of any COCOM. This large spike occurred twice over the span of study. IN short, it has a large berth of variability. Which is detrimental to a supply chain management system.

Figure 79. CENTCOM 2012 normal and duplicate order frequency by date

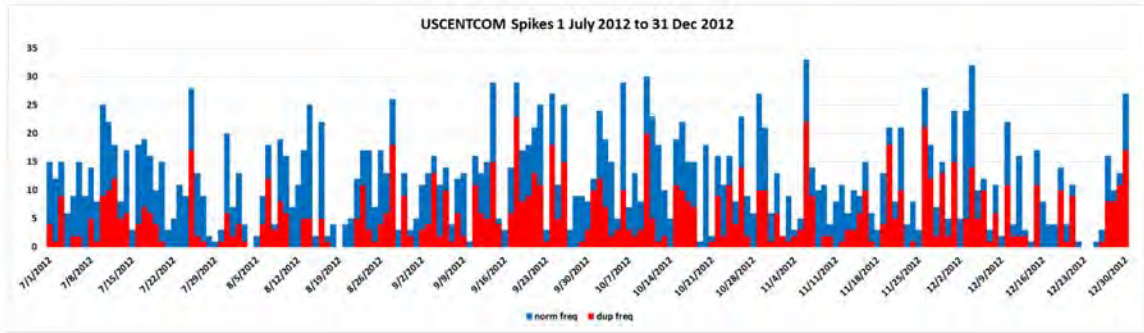


Figure 80. CENTCOM 2013 normal and duplicate order frequency by date

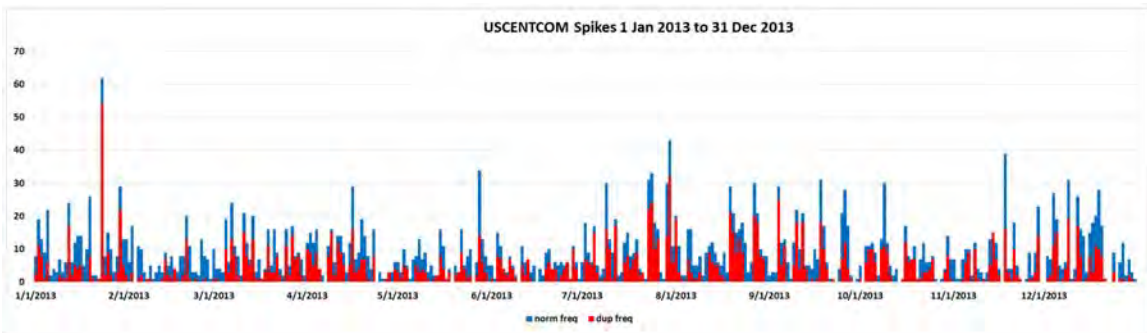


Figure 81. CENTCOM 2014 normal and duplicate order frequency by date

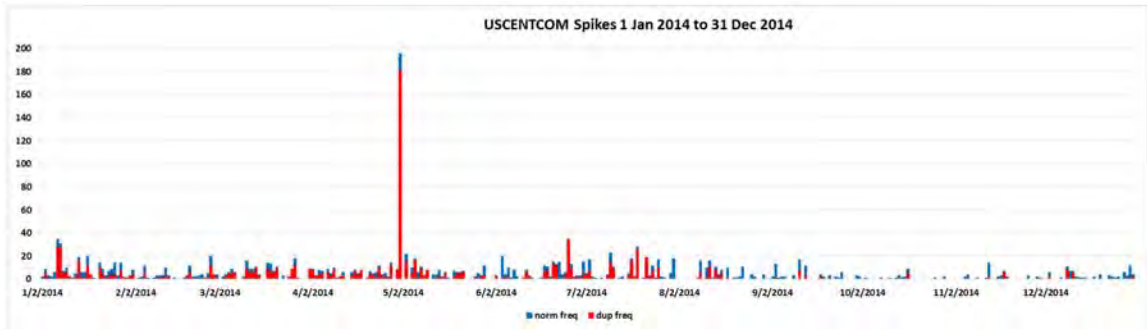
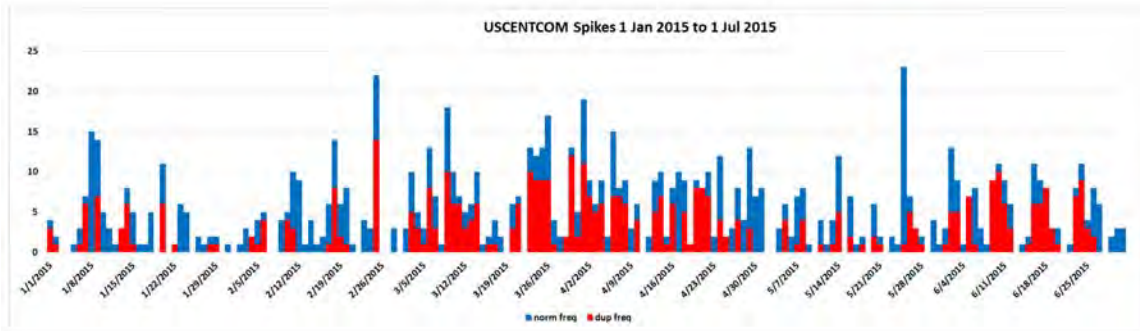


Figure 82. CENTCOM 2015 normal and duplicate order frequency by date



The first spike in orders occurred on 23 January 2013. This was the smaller of the two spikes. On this date, 62 orders were placed, of which, 54 were duplicates, or 85.71%. The largest spike occurred on 1 May 2014. On this date, 196 orders were placed, of which 181 were duplicates, or 92.34% of all orders on that date. This is significant since the average order rate per day is 8.8 normal orders and 4.3 duplicate orders per day on average. This shows a large variance in ordering. Fascinatingly, these spikes only occurred once each year. Though orders rise and fluctuate, no other such large spikes occurred on such a large scale.

(4) Overall trends of CENTCOM by DODAAC

Table 63 represents the CENTCOM frequency of lumber orders and duplicate orders placed by units as indicated by DODAACs. It also describes how 136 units placed orders for lumber during the period of study. Of the 136 units which ordered lumber, 44 of these units or 32.35% of these units placed duplicate orders. This percentage in DODAACs conducting duplicate orders is the lowest of all COCOMs. Further, of the 44 DOAACs that conducted duplicate orders in CENTCOM, this accounted for only 7.51% of all DOAACs conducting duplicate orders across all COCOMs. This is a success in itself when viewed just on DODAACs conducting duplicate orders.

Table 63. CENTCOM DODAACs with duplicating problems

# DODAACs w/ duplicates	44
# DODAACs	136
% of DODAAC duplicate	32.35%

Figure 83 displays the frequency of normal and duplicate orders placed by a DODAAC within CENTCOM. There is a large amount of variance present between ordering DODAACs. Every DODAAC produced at least one duplicate order. The more the red-bar overlies the blue-bar, the greater the severity of duplicate ordering. Particularly noticeable was that DODAAC W91EB8 placed 3,876 orders, of which, 1,923 were duplicate orders. Also, W90V9R had a 70.56% duplicate order rate, the highest within CENTCOM. When looking at a DODAAC that orders correctly, such as SB3300, one notices a much different trend. The best ordering DODAAC was W917DG, which ordered just 23 times with no duplicates.

Figure 83. CENTCOM total Duplicate orders to normal orders per DODAAC

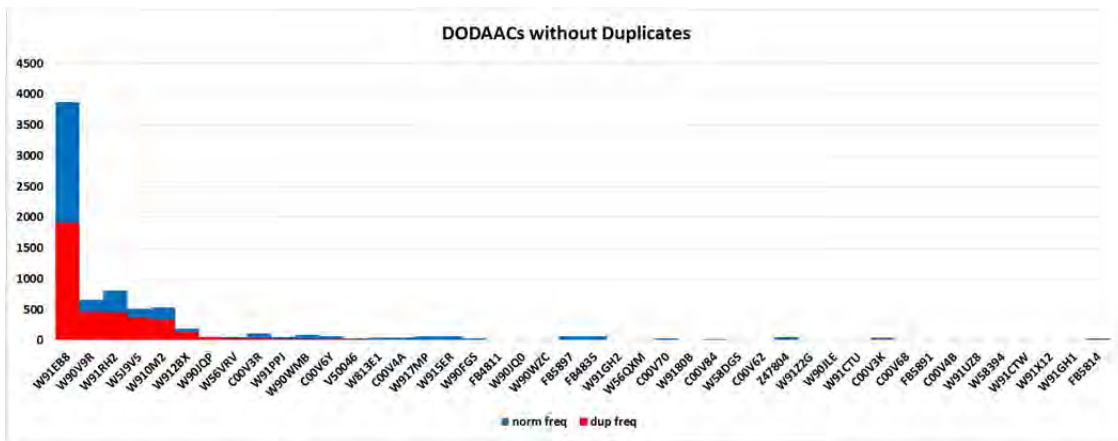
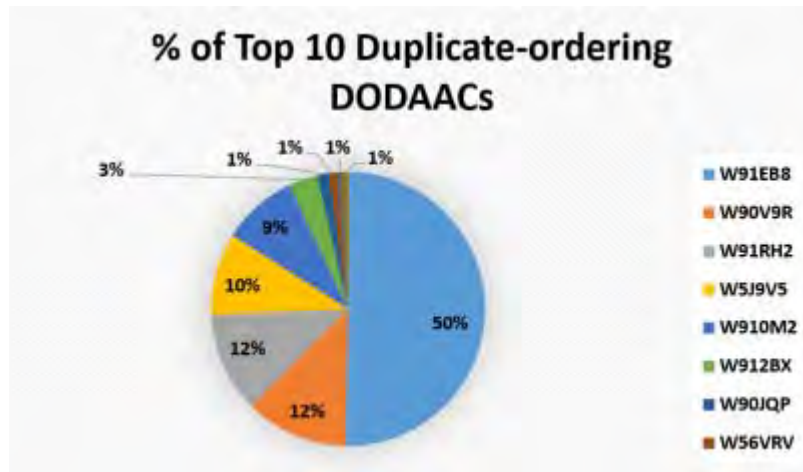


Figure 84 describes the top ten duplicate ordering military units as represented by DODAACs. These 10 DODAACs are further broken down to show the percentage of the lumber duplicate orders each DODAAC is responsible for placing during the period of study. CENTCOM finds its DOAAC ordering problem to be rooted largely in a few DODAACs. Specifically, DODAAC W91EB8 is responsible for 50% of all duplicate orders within the top ten ordering duplicate-ordering DODAACs.

Figure 84. CENTCOM percentage of top ten duplicate-ordering DODAACs

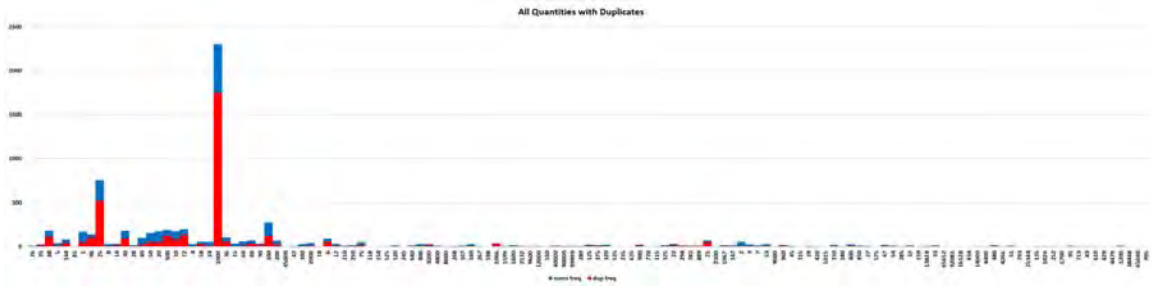


(5) Overall trends of CENTCOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of CENTCOM, there were 842 different quantities ordered. Of this amount, 133 were duplicate quantities, or just 15.8%. Figure 85 represents all of the duplicate orders and shows their associated quantities on the x-axis. An order with a quantity of 1,000 was duplicated 1,747 times, while another order with a quantity of 25 was duplicated 521 times, and represented 69% of that quantity’s duplicate. Further, an order of 99,999 was duplicated 6 times out of 9 times.

This continues in the trends of seeing orders of 1,000 quantity being placed in duplicate. Requirements must be well defined for placing lumber orders. If units error on the side of guessing or ordering what is convenient, then there is nothing to lose by ordering 1,000 pieces of lumber 1,747 times. Even worse, a unit might order 99,999 pieces of lumber six times, as happened in CENTCOM.

Figure 85. CENTCOM total duplicate orders to normal orders by quantity



(6) Summary of CENTCOM

The identifiable trends in duplicate items indicates a high demand for particular types of lumber in CENTCOM. The identifiable 15 types of lumber NIINs can allow DLA to anticipate commonly needed high demand lumber items. The high demand lumber duplicate order list could be used to anticipate demand and adjust stock pile quantities. The knowledge of the high demand items could be spread throughout DLA by providing awareness and potentially reduce the frequency of duplicates. These actions could result in a cost savings for DLA along with improving the overall lumber supply chain.

Certain units above other have historically executed duplicate orders for lumber in a greater frequency over others. The identification of this type of trend data could focus supply improvement training efforts in order to reduce duplicate order placement.

Improving CENTCOM stands to make a marginal impact overall in the ordering process of lumber. Due to the fact that CENTCOM only takes up 10.86% of all duplicates, resources could best be used elsewhere, such as NORTHCOM. Conversely, however, CENTCOM is a focal point of operations and as operations increase, more effort should be given to its SCM process.

Tables 64–67 show, based on the three years of data, what the average normal and duplicate orders rates look like for CENTCOM. Primarily, the best area to improve upon in CENTCOM is the 32.35% duplicate ordering rate of all DODAACs. Improving in this area would ensure less duplicate orders, possibly with potential to eliminate all duplicates if done correctly. Alternately, the best areas to improve in is creating policy or ordering procedures that ensures the top 15 NIINs are ordered properly. In the case of

NORTHCOM, they have the overwhelming majority of all duplicate orders, whether by NIIN or sheer quantity. Improving the ordering of each piece of lumber can reduce their duplicate rate.

Table 64. CENTCOM average order rate per day

USCENTCOM	
Normal Orders	8.80
Duplicate Orders	4.34
% Duplicate	49.29%
% of total duplicates	11.02%

Table 65. CENTCOM average order rate per DODAAC

USCENTCOM	
# of DODAACs	136
# DODAACs duplicate	44
% of duplicate DODAACs	32.35%
% of tot duplicate DODAACs	7.51%
Normal Orders	59.77
Duplicate Orders	29.46
% Duplicate	49.29%
% of total duplicates	27.97%

Table 66. CENTCOM average lumber items per day

USCENTCOM	
Normal Orders	12070.04
Duplicate Orders	3833.20
% Duplicate	31.76%
% of total duplicates	13.85%

Table 67. CENTCOM average quantity of orders per day

USCENTCOM	
Normal Orders	1625.87
Duplicate Orders	1047.50
% Duplicate	64.43%
% of total duplicates	22.20%

F. UNKNOWN COCOM

(1) Overall trends of unknown COCOM by top lumber items

Between 1 July 2012 and 1 July 2015, U.S. Military units placed duplicate orders for lumber items during the period of study. These orders were placed, however, the respective COCOM was not provided. The NIIN, DODAAC, quantity, and date were present. As such, they are still a legitimate order that can be analyzed for trends. This unknown COCOM placed 12,350 orders, of which, 4544 were duplicates, of 36.79%. This represented overall 12.32% of all DLA duplicate orders throughout all COCOMs. The top 10 duplicate vary from day to day like the other COCOMs and represent 18 individual NIINs. Table 68 represents the top 18 NIIN lumber items ordered during the period of study and describes the lumber type and dimensions which were ordered in duplicate. All data is present for these orders except the COCOM it was ordered in. Quantity, DODAAC, NIIN, and date are all present in each order.

Table 68. Unknown COCOM types of duplicate lumber

UNKNOWN		
NIIN	Nomenclature	Wood Type
16079431	2" x 12" x 16'	Lumber
2608953	1"x 3" Conical	Plug Wood
2608958	2" x 4" Conical	Plug Wood
2608962	3" x 8" Conical	Plug Wood
2683479	2" x 2" x 8"	Wedge Wood
2683482	3" x 6" x 12"	Wedge Wood
2683480	2" x 4" x 8"	Wedge Wood
1676855	2" x 4" x 8'	Lumber
2683481	3" x 3" x 12"	Wedge Plug
2608966	1" x 10" Conical	Wedge Wood
2206198	2" x 8" x 6'	Lumber
14331244	2" x 4" x 16'	Lumber
6186958	½" x 48" x 8'	Plywood
2736791	6" x 6" x 10'	Lumber
2206178	4" x 4" x 8'	Lumber
14334200	4" x 4" x 8'	Lumber
2206196	2" x 6" x 6'	Lumber
14331216	2" x 4" x 8'	Lumber

The listed lumber items range from lumber boards to plug wood suitable and wedges for naval applications and vary in dimension and type. This is the first time that

plug wood has emerged as a high ordered NIIN. These types of lumber are suitable for construction and naval purposes including both interior and exterior surfaces. The remaining listed lumber is also useful for building wall frames, structural support posts, bracing cargo inside of military shipping containers, naval and rail applications.

(2) Overall trends of unknown COCOM by NIIN

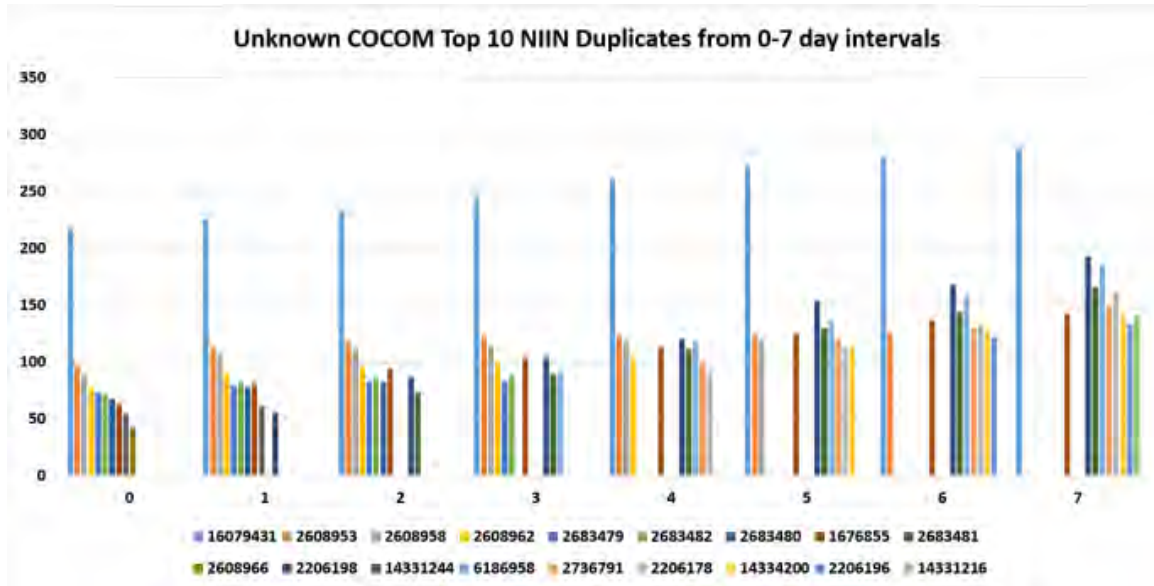
Table 69 shows the exact number of NIINs within EUCOM. 208 different NIINs were ordered, of which, 108 were duplicated. This represents a 51.92% duplicate rate by NIIN, which is slightly above the overall average of 48.46%.

Table 69. Unknown COCOM NIIN order total, duplicates, and percentage rate

Unknown	
Total NIINs	208
NIINs duplicated	108
% Duplicate	51.92%

Table 69 describes the top ten NIIN duplicates within a duplicate period of one week. The top 10 duplicate orders vary from day to day and represent 18 individual NIINs, depending on the day within the period of study. Figure 86 illustrates the types of lumber items placed on order in duplicate at day one and through day seven.

Figure 86. Unknown COCOM top NIIN duplicates using a one to seven day sliding window



The number one item placed in duplicate for the unknown COCOM during the three year period of study is NIIN 16079431, a 2' x 12' x 16" piece of lumber. This lumber was placed in duplicate 288 times during the three year period of study by various units. Table 70's data applies to Figure 86 and shows the quantity of all NIINs per day or duplicate order.

Table 70. Unknown COCOM quantity of duplicate NIINs per day of duplicate

		Number of days in ordering period							
		0	1	2	3	4	5	6	7
NIINs	16079431	218	225	233	246	261	272	280	288
	2608953	96	113	117	123	123	124	126	
	2608958	90	107	112	115	118	119		
	2608962	78	91	96	100	104			
	2683479	74	80	82	83				
	2683482	72	82	87	88				
	2683480	68	78	82					
	1676855	63	81	94	104	113	125	137	142
	2683481	55	61						
	2608966	43							
	2206198		56	87	105	120	154	168	193
	14331244			73	89	111	130	144	166
	6186958				92	118	137	158	186
	2736791					100	120	130	150
	2206178					93	113	133	162
	14334200						114	128	141
	2206196							122	133
	14331216								141
			Number of times duplicate NIIN occurred in each day						

Figures 87 and 88 illustrate the types of lumber items placed in duplicate within a seven day ordering period. Each NIIN represents an individual type of lumber placed on order over the three year period of study. Overall, of the 208 total NIINs ordered in the unknown COCOM, 108 were ordered as a duplicate at least once, or a total of 51.92% overall. The top ten duplicate NIINs make up almost 40% of all duplicate orders. The top 51 NIINs account for 90% of all duplicate orders. In previous COCOMs, a few duplicate NIINs account for a large percentage of overall duplicates. This is not the case in in the unknown COCOM. Their duplicate orders are more evenly distributed by frequency.

ordering of any Unknown COCOM. This large spike occurred twice over the span of study. This Unknown COCOM did not possess a wide amount of variance in order compared to other COCOMs. Each year, this group performed with less and less peaks and crest of orders as well as duplicate orders. Each year, the total amounts in orders and duplicate orders shrank by about 20 orders.

Figure 89. Unknown COCOM 2012 normal and duplicate order frequency by date

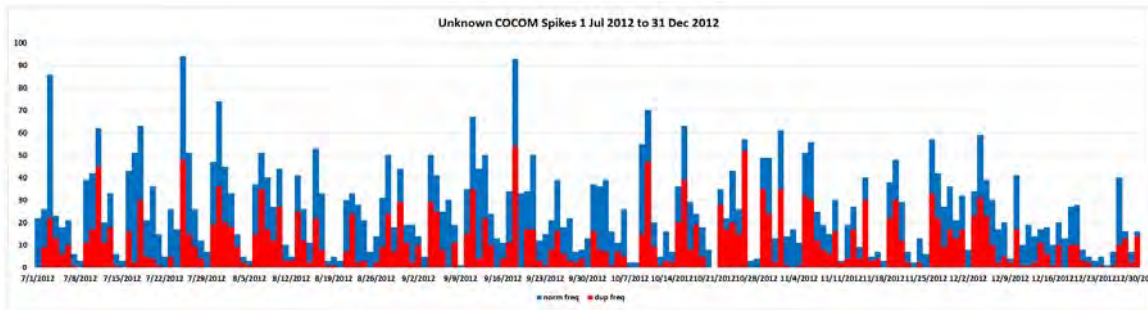


Figure 90. Unknown COCOM 2013 normal and duplicate order frequency by date

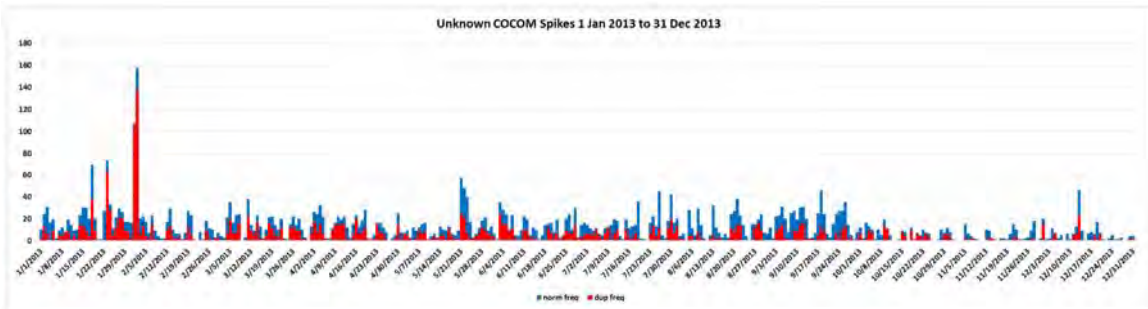


Figure 91. Unknown COCOM 2014 normal and duplicate order frequency by date

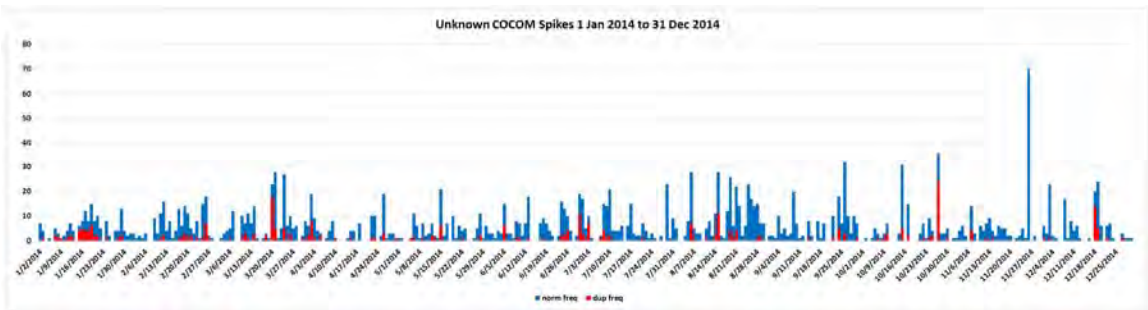
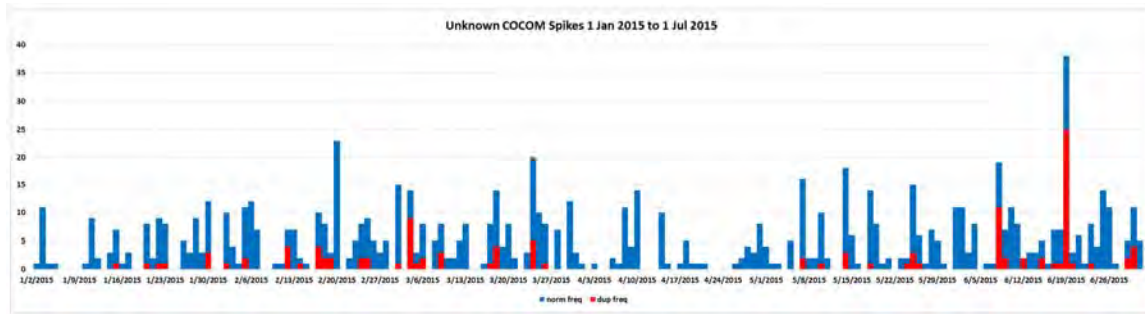


Figure 92. Unknown COCOM 2015 normal and duplicate order frequency by date



Spikes of demand are present during the period of study for the Unknown, however, each year, this Unknown COCOM performed very well compared to the other COCOMs. What is unique about this data is the final two years. There are very little duplicate orders present. In 2015, for two months there were zero duplicate orders, which is the longest length of time in DLA’s ordering system without a duplicate order. There were still some spikes of high normal orders and duplicate orders though. The worst spikes came on 2 and 3 February 2013, where, over two days 264 orders were placed, of which, 243 were duplicates.

(4) Overall trends of unknown COCOM by DODAAC

Table 71 represents the Unknown COCOM frequency of lumber orders and duplicate orders placed by units as indicated by DODAAACs. Table 71 additionally describes how 442 units placed orders for lumber during the period of study. Of the 159 units which ordered lumber, 44 of these units or 35.97% of these units placed duplicate orders. This percentage in DODAAACs conducting duplicate orders is above average when compared with all of the other COCOMs. Of the 159 DOAACs that conducted duplicate orders in Unknown COCOM, this accounted for only 9.76% of all DOAACs conducting duplicate orders across all COCOMs. This is a success in itself when viewed just on DODAAACs conducting duplicate orders. With the exception of SOUTHCOM small sample size, this was the lowest overall percentage of all COCOMs.

Table 71. Unknown COCOM DADAACs with duplicating problems

# DODAACS w/ duplicates	159
# DODAACS w/o duplicates	442
% of DODAAC duplicate	35.97%

Figure 93 displays the frequency of normal and duplicate orders placed by a DODAAC within this Unknown COCOM. There is a large amount of variance present between ordering DODAACs. Every DODAAC produced at least one duplicate order. The more the red-bar overlies the blue-bar, the greater the severity of duplicate ordering. Particularly noticeable was that DODAAC W5k9JQ which placed 763 orders, of which, 393 were duplicate orders. Also, PEGA5N had an 88.03% duplicate order rate, the highest within this Unknown COCOM. When looking at a DODAAC that orders correctly, such as R21345, one notices a much different trend. This DODAAC placed lumber orders 47 times with zero duplicate orders. This DODAAC represents a well disciplined unit whom uses the supply system correctly. Other units should pattern there behavior after this unit to allow for a more optimized supply chain.

Figure 93. Unknown COCOM total of duplicate orders to normal orders per DODAAC

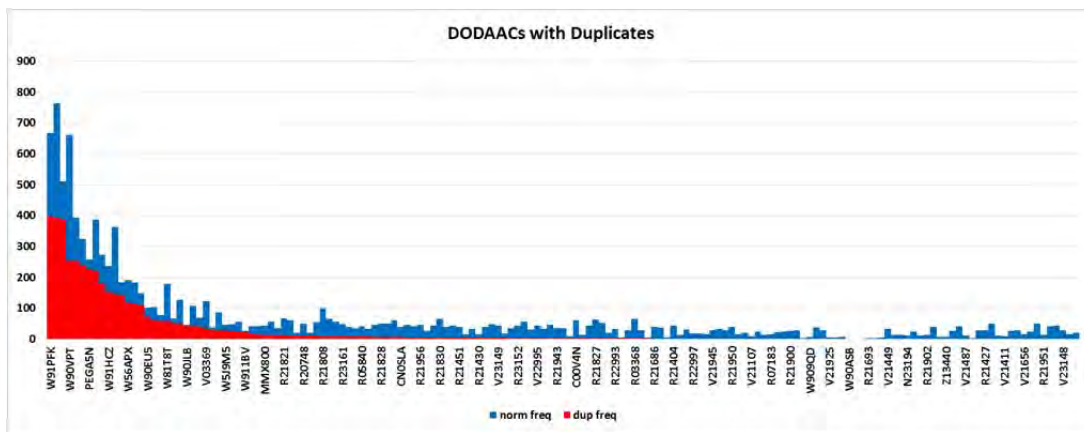
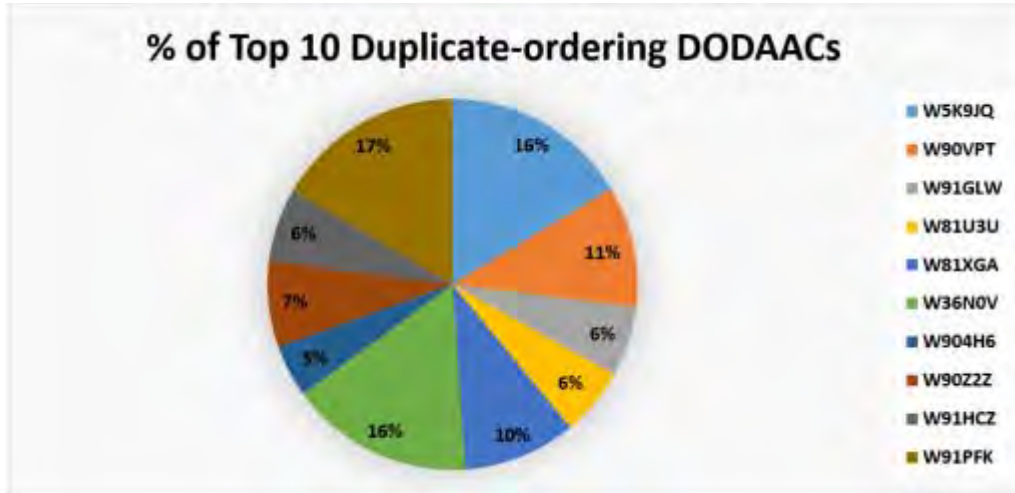


Figure 94 describes the top ten duplicate ordering units as represented by DODAACS. These 10 DODAACs are further broken down to show the percentage of the lumber duplicate orders each DODAAC is responsible for placing during the period

of study. The Unknown COCOM finds its DOAAC ordering problem to be largely evenly distributed amongst many DODAACs.

Figure 94. Unknown COCOM percentage of top ten duplicate-ordering DODAACs



(5) Overall trends of unknown COCOM by quantity

A trend emerges when viewing duplicate orders based solely on quantity of orders placed. In the case of unknown COCOM, there were 681 different quantities ordered. Of this amount, 113 were duplicate quantities, or just 16.59%.

(6) Summary of unknown COCOM

The identifiable trends in duplicate items indicates a high demand for particular types of lumber from unknown units. The identifiable 18 NIINs can allow DLA to anticipate commonly needed high demand lumber items. Further understanding where these orders belong can help alleviate many ordering problems for each COCOM. This Unknown COCOM orders are subject to the same trends and analysis derived from the previous COCOMs. Focusing on the individual DODAAC ordering, then the quantity that each DODAAC orders within a one week span can help reduce much of the duplicate orders.

Tables 72–75 show, based on the three years of data, what the average normal and duplicate order rates look like for the Unknown COCOM. Primarily, the best area to improve upon in the Unknown category is the 35.97% duplicate ordering rate of all

DODAACs. Improving in this area would ensure less duplicate orders, possibly with the potential to eliminate all duplicates if done correctly. Alternately, the best areas to improve in is creating policy or ordering procedures that ensures the top 18 NIINs are ordered properly. Data from the Unknown COCOM indicates a minority of duplicate orders when compared to NORTHCOM. Nevertheless, an emphasis should be placed on improving the ordering of each piece of lumber and reduce the duplicate rate.

Table 72. Unknown COCOM average order rate per day

Unknown	
Normal Orders	12.99
Duplicate Orders	4.78
% Duplicate	36.79%
% of total duplicates	12.14%

Table 73. Unknown COCOM average order rate per DODAAC

Unknown	
# of DODAACs	442
# DODAACs duplicate	159
% of duplicate DODAACs	35.97%
% of tot duplicate DODAACs	27.13%
Normal Orders	27.94
Duplicate Orders	10.28
% Duplicate	36.79%
% of total duplicates	9.76%

Table 74. Unknown COCOM average lumber items per day

Unknown	
Normal Orders	7395.49
Duplicate Orders	2130.32
% Duplicate	28.81%
% of total duplicates	7.69%

Table 75. Unknown COCOM average quantity of orders per day

Unknown	
Normal Orders	655.71
Duplicate Orders	513.36
% Duplicate	78.29%
% of total duplicates	10.88%

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