NPS-LM-19-003

ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

Navy Expeditionary Logistics

8 October 2018

Dr. Uday Apte, Distinguished Professor

Graduate School of Business and Public Policy

Naval Postgraduate School

Approved for public release; distribution is unlimited.
Prepared for the Naval Postgraduate School, Monterey, CA 93943.

Acquisition Research Program
Graduate School of Business & Public Policy
Naval Postgraduate School

The research presented in this report was supported by the Acquisition Research Program of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact any of the staff listed on the Acquisition Research Program website (www.acquisitionresearch.net).

Acquisition Research Program
Graduate School of Business & Public Policy
Naval Postgraduate School

Abstract

The U.S. Navy, with its expeditionary warfare and logistics capabilities, is increasingly playing a critical role in conflicts involving non-state actors. Given the difficulties faced in expeditionary environments, managing expeditionary logistics is particularly challenging yet critically important today. In this research, we use case study methodology to better understand the current practices and challenges of expeditionary logistics at Explosive Ordnance Disposal (EOD), a subordinate entity of Naval Expeditionary Combat Command (NECC), and develop a set of concrete recommendations for improving expeditionary logistics processes at EOD. Finally, after studying the current definitions of expeditionary logistics and analyzing the similarities and differences between expeditionary logistics and commercial logistics, we develop concepts for successfully managing expeditionary logistics operations.

Keywords: Expeditionary Logistics; Military Operations; Process Improvement; Supply Chain Management.

THIS PAGE LEFT INTENTIONALLY BLANK

About the Author

Dr. Uday Apte is Distinguished Professor of Operations Management at the Graduate School of Business and Public Policy (GSBPP), Naval Postgraduate School, Monterey, CA. Previously he served as the Associate Dean of Research and Development at GSBPP. Before joining NPS, Dr. Apte taught at the Wharton School, University of Pennsylvania, Philadelphia, and at the Cox School of Business, Southern Methodist University, Dallas. He is experienced in teaching a range of operations management and management science courses in the executive and full-time MBA programs. Prior to his career in academia, Dr. Apte worked for more than 10 years in managing operations and information systems in the financial services and utility industries. Since then he has consulted with several major U.S. corporations and international organizations.

Areas of Dr. Apte's research interests include service operations management, supply chain management, technology management, and globalization of information-intensive services. He has completed more than 10 sponsored research projects for the U.S. Department of Defense and has published more than 60 articles, five of which have won awards from professional societies. His research articles have been published in prestigious journals including *Management Science, Interfaces, Production and Operations Management (POM), Journal of Operations Management (JOM), Decision Sciences Journal (DSJ), IIE Transactions,* and *MIS Quarterly.* He has co-authored two books, *Manufacturing Automation* and *Managing in the Information Economy.* Dr. Apte has served as a vice president of colleges at Production and Operations Management Society (POMS), as a founder and president of the POMS College of Service Operations, and as guest editor of POM journal. Currently he serves as the senior editor of POM and as associate editor of DSJ.

Dr. Apte holds a PhD in Decision Sciences from the Wharton School, University of Pennsylvania. His earlier academic background includes an MBA from the Asian Institute of Management, Manila, Philippines, and Bachelor of Technology (Chemical Engineering) from the Indian Institute of Technology, Bombay, India.

THIS PAGE LEFT INTENTIONALLY BLANK

NPS-LM-19-003

ACQUISITION RESEARCH PROGRAM
SPONSORED REPORT SERIES

Navy Expeditionary Logistics

8 October 2018

Dr. Uday Apte, Distinguished Professor

Graduate School of Business and Public Policy

Naval Postgraduate School

THIS PAGE LEFT INTENTIONALLY BLANK

Table of Contents

THIS PAGE LEFT INTENTIONALLY BLANK

Introduction

In recent decades, the United States and its coalition partner countries have increasingly engaged in conflicts involving non-state actors, and it appears that these conflicts are unlikely to subside in the foreseeable future. As a powerful maritime force, the U.S. Navy plays a critical role at sea and on land in these conflicts through its expeditionary warfare and logistics capabilities. The critical requirement is to enable operational units to carry out a short-duration mission autonomously without the routine support of a base network. Given the difficulties faced in non-permissive expeditionary environments, managing expeditionary logistics is particularly challenging, yet critically important, today.

However, our prior research shows that there exists a scarcity of research literature or Department of Defense (DoD) documentation and guidance available on this important topic. The proposed research project will therefore begin to address this gap by developing conceptual frameworks and concrete recommendations on designing and successfully managing expeditionary logistics in non-permissive environments.

In this research, we adopt a two phased approach. In the first phase, we study a specifc instance of current expeditionary logistics (ExLog) operations in practice to (1) better understand the key elements and critical success factors of ExLog, and (2) develop recommendations for improving logistical processes being studied. In the second phase, we build on the results of the first phase to develop concepts useful for optimally designing ExLog processes and successfully managing them. The following are the specific research questions we address in the second phase: What is expeditionary logistics and what are its key components? What are the similarities and differences between expeditionary logistics and the traditional commercial logistics? What are some of the best practices of the traditional commercial logistics that Exlog can benefit from? What magerial actions will lead to successful Exlog operations?

As a starting point in this research, we conducted an extensive literature survey of relevant research on expeditionary logistics published in journals and books as well as documents published by the DoD on the topic. As indicated earlier, we found that there

is a scarcity of research and publications available on the topic of expeditionary logistics. We provide comments on the relevant material we found at several suitable points in this report. We should mention that we have undertaken research on the topic in the past few years. Here is a brief overview of that research and the results. In fiscal year (FY) 2014, we worked on an exploratory research project sponsored by the Office of Naval Research (ONR) on the topic of expeditionary logistics (Apte & Kang, 2015). A team of MBA students assisted us in that research through their MBA project to study the logistical challenges faced by the Explosive Ordnance Disposal (EOD) and Naval Special Warfare (NSW) communities (Kundra, Brown, & Donaldson, 2014). The study indicated that the main shortcoming of logistical processes was in the information systems support, and the capture and analysis of information regarding the supplies, materiel and equipment used in expeditionary logistics. In a follow-up project funded by International Military Education and Training (IMET), we developed a case based on our earlier research for use in an advanced logistics course (Yoho & Apte, 2018). This case is currently used in the capstone course of the logistics curriculum at GBBPP. Finally, continuing with our research on the same topic, two MBA students under our guidance studied the details of logistical processes supporting the deployment cycle of a Mine Countermeasure (MCM) Platoon at EOD (Reeves & Baker, 2017).

This research report consists of five sections. The current introductory section is followed by the second section describing the organization and the mission of EOD, the specific instance of ExLog processes we studied. The third section presents details of the logistical processes supporting the deployment cycle of a (hypothetical) MCM Platoon at EOD, and the fourth section provides the analysis, conclusions, and recommendations concerning the management of those logistical processes at EOD. We complete the paper in the fifth and final section with our initial thoughts on the charaterization and definition of expeditionary logistics as well as the comparison of expeditionary and commercial logistics.

Explosive Ordnance Disposal (EOD)

The Explosive Ordnance Disposal (EOD) is a subordinate entity of the Navy Expeditionary Combat Command (NECC), which is the Navy's expert command regarding expeditionary operations and logistics. The NECC exists to man, train, equip, and sustain the Naval Expeditionary Forces (NEF) by bridging the gap from operations at sea to sea–land joint operations. While the NECC command is relatively new, created by the Chief of Naval Operations (CNO) in January 2006, the NEF is old. The NECC is composed of eight subordinate entities that are their own respective commands which deliver unique capabilities to the United States and its allied forces in the expeditionary realm: Costal Riverine, Explosive Ordnance Disposal, Naval Construction (Seabees), Expeditionary Intelligence, Combat Camera, Expeditionary Logistics, Maritime Civil Affairs and Training, and Expeditionary Combat Readiness.

The Explosive Ordnance Disposal is the Navy's technical expert in locating, identifying, rendering safe, and explosively detonating foreign and domestic ordinance. Ordnance includes conventional, nuclear, biological, chemical, underwater, and improvised types of devices. The ability to control and dispose of these various types of dangerous devices enables theater access for Carrier Strike Groups (CSGs), Expeditionary Strike Groups (ESGs), Naval Special Warfare, and Army Special Forces (SF).

EOD is a history-rich, proud community that serves alongside many special operations (SPECOPS) forces, as well as traditional Navy mission communities such as ships and submarines. The EOD technicians risk their lives to perform complex, technical defusing of mines, bombs, and improvised explosive devices (IED) and, of necessity, are required to be physically fit, superior swimmers, and athletes. EOD technicians undergo rigorous schoolhouse training prior to arriving at their commands and then complete operationally challenging tours filled with deployments and stressful workups due to the high operational tempo (OPTEMPO).

EOD Group ONE, based in San Diego, CA, and EOD Group TWO, based in Little Creek, VA, are the two U.S.-based EOD elements. Each EOD group has five battalions

and various shore detachments, platoons, and companies within it. The groups provide specially-trained, combat-ready, highly mobile EOD forces to support CSGs, amphibious ready group (ARG)/Marine Expeditionary Units (MEUs), MCM task forces and groups, NSW forces, Army SF, Military Sealift Command, unified theater commanders, continental United States (CONUS) Navy Region commander, and Homeland Defense and Contingency Operations.

EOD Expeditionary Support Unit (EODESU) ONE and TWO follow the same geographical structure as their fellow expeditionary forces. EODESUs provide total logistics support to the EOD forces through financial, supply chain, and logistics management, as well as operational planning and global force support. Prior to the formation of EODESU, ExLog was performed by the EOD teams while simultaneously experiencing stressful OPTEMPOs and very dangerous deployments stacked one after the other. The purpose of the EODESU was to relieve the EOD mobile units of logistics and maintenance duties so they could focus on their demanding operational duties. Also, the EODESUs are staffed with logistics and maintenance experts in order to perform those functions more efficiently and with increased precision, ultimately adding greater value to the Navy and improving the result provided to the warfighter.

While ESU commands are not tasked with executing any of the highly technical and versatile missions the EOD teams are tasked with, they are tasked with supplying those teams with the proper gear and equipment to successfully execute the mission. In order to know what is required and understand the details necessary to complete these difficult missions, the ESU must be knowledgeable about the EOD missions and the gear and equipment EOD teams need.

Mine Countermeasure Platoon at EOD: A Case Study

This case study focuses on EOD Mobile Unit (EODMU), in particular on one of its Mine Countermeasures (MCM) Platoons. The case begins with an overview of the logistical processes and information systems used by EODESU TWO to provide the necessary support to a (hypothetical) MCM Platoon 1201. That is followed by a description of the MK-16 equipment—an underwater breathing apparatus—since it is a piece of critical gear heavily utilized by the MCM Platoon. The case then tracks the logistical processes used to support the activities of the MCM Platoon throughout its deployment cycle. The case thus provides a realistic insight into the operations of the EODMU MCM Platoon and the logistical support operations of EODESU TWO.

EODESU Supply

The ESU units supply their teams as part of the services they provide. While the process by which the individual units perform this function may be slightly different, relatively speaking, the same outcome is delivered. The EOD units supported by EODESU receive a variety of supplies and euipment, including expeditionary logistics overhaul (ELO) and general logistics and supply chain support. ELO is similar to the integrated logistics overhaul (ILO) process aboard ships but is specifically designed for expeditionary forces where they identify the gear needed to be repaired, reconditioned, or replaced.

ESU teams issue the following types of gear to the EOD teams they support:

- Personal Gear Issue (PGI) includes items such as uniforms, undershirts, socks, and other items that require some specificity to a member's body and measurement.
- Table of Allowances (TOA) consists of specific gear, equipment, systems, and materiel related to expeditionary missions. TOA includes items such as inflatable boats, generators, and specific wetsuits. The EOD teams keep this gear with them from the start of the Fleet Readiness Training Plan (FRTP) to the post-deployment return. TOA gear represents a challenge to the cost savings efforts due to constantly changing and non-standard nature of the gear allowed or allotted to the expeditionary teams based on their specific missions.

- Consolidated Shipboard Allowance Listing (COSAL) include items that the ship normally carries onboard. The COSAL contains nomenclature, operating characteristics, technical manuals, and equipment descriptions as described in allowance parts lists (APL) and allowance equipage lists (AEL).
- Other non-COSAL material.

The expeditionary requisition processes are unique when compared to the standard fleet requisition processes. In the standard fleet requisition processes, more than 95% of the requisitions are filled through the Navy supply system using National Stock Number (NSN) items, while less than 5% are open purchases. In comparison, in expeditionary logistics, approximately 70% of the requisitions are open purchases and only 30% are NSN requisitions (Kundra et al., 2014). The expeditionary missions involve unique variables such as distinctive operating environment, hence they need to stay current with technology and have a greater need for speed. The unique expeditionary environments also force expeditionary units to rely heavily upon open purchases for commercial off-the-shelf (COTS) or local procurement products.

To track and store information regarding the above gear the ESU units use multiple information systems, including the following:

- WASP: a warehouse and inventory management system,
- RCRP: a readiness and cost reporting system,
- R-Supply: a system that provides the U.S. Navy with on-line inventory, logistics, and financial magement tools, and
- DPAS: a DoD-required system that tracks property valued greater than $5,000.

The WASP, RCRP, R-Supply, and DPAS are distinctly different IT systems that are used to organize the same type of information. In some cases, the information is actually the same, and duplicate efforts are being made to track and store transactions in different systems because the systems are not able to automatically share information with each other. For example, ESU tracks a transaction first in WASP and then manually enters the same information in RCRP. Another example is when supply parts are received from vendors at the ESUs and are automatically confirmed in R-Supply. Subsequently, the ESU members manually enter the same information that was just confirmed in R-Supply into WASP because the ESU teams use WASP as their internal inventory

management system, and because there exists no interface to automatically share information between the two systems. A factor that further complicates the matter is a requirement to store information on an Accountable Property System of Record (APSR) system and since WASP is not an APSR system.

Upon completion of the mission, training, or cycle, the gear that is not meant to be kept by a member is returned and inventoried. The gear return process is more than simply stacking and counting specific clothing articles or ammunition boxes. Given the nature of EOD missions, many times the gear gets returned, but in a heavily damaged and potentially unusable state. Therefore, ESU inspectors must know what separates returned, quality gear, from gear requiring minor maintenance or depot-level repair (DLR).

In addition to managing the inventory of existing gear, ESU is required to properly document missing gear and gear that is damaged beyond repair. The Navy must determine, based on DD Form 200 (the Navy's form for financial liability investigation), the reason the equipment was lost or damaged and who should be responsible, if anyone, for the cost to repair or replace. DD Form 200 is required as per DoD Directive 7200.11 for lost DoD-controlled property. It is a form that is filled out electronically, but ultimately a hardcopy is also kept and entered into the ESU IT systems manually. ESU members are required to physically search archived DD Form 200s when they need to find information.

DD Form 1149 is another DoD directive form that is required when shipping through certain seaports or airports. The DD 1149 is specifically known as the Requisition and Invoice/Shipping Document to verify what was issued against the electronic records in WASP. This document is also manually entered into systems, and the hardcopy is kept for storage or later use when searching for information. There is a large collection of files at EODESU TWO of stored hardcopy forms that are necessary to conduct business.

The MK-16 Underwater Breathing Apparatus

Navy EOD is the only service manned, trained, and equipped to perform underwater render safe procedures and conduct EOD dive operations. Typical EOD mission sets include MCM, salvage diving, ship's hull diving, search and rescue (SAR)

operations, and other necessary diving missions. With such a variety of technically challenging and highly dangerous diving missions, EOD technicians are trained to perform and be successful at nearly any diving mission. The MK-16, therefore, is a common piece of equipment used in the EOD teams, and all EOD technicians are well-versed in its use and capabilities.

The MK-16 was developed to reduce magnetic and acoustic signatures emitted by diving EOD technicians. The mission of EOD technicians is one that is highly technical, diverse, and dangerous. Under such tense work conditions, a superior diving suit is required that allows full range of motion but still provides protection from the natural and enemy hazards present in the area of operation (AO). The MK-16 breathing medium is maintained at a predetermined partial pressure of oxygen (PO2) which is monitored by sensors and controls to ensure diver safety. The reason divers are required to maintain a safe level of oxygen and are monitored so heavily is that depending on the mission, they may use more or less oxygen and cannot follow a standard timetable for bottom time.

Along with MK-16, a diver's other essential equipment include knife, hook knife, strobe, smoke or flare, thermal protection, fins, and a weapon as required. The knife has many uses but one of its main uses is to help free a trapped diver from any number of hazards. The MK-16 equipment must withstand these conditions and not puncture, disconnect, or break easily. Strobes, smoke, and flares are essential safety gear for EOD technicians because at the depths required for some of the EOD missions, there is absolutely no natural visibility and those pieces of equipment could prove to be life-saving. A weapon is a necessity depending on the mission and the AO in which the dive will take place; this is a harsh reminder that the mission is not a recreational dive but is highly important and dangerous.

EODESU TWO has a team of maintainers as well as a General Schedule (GS) civilian employee who accounts for and maintains the MK-16 system inventory. The GS civilian employee is known as the resident expert on the system. The benefit to having a civilian expert versus a military member is that ideally, the civilian remains the expert point of contact for a longer period of time, providing a long-term persistent presence as

opposed to the routine rotations of assigned active duty personnel. This ensures retention of critical corporate knowledge regarding program supply and maintenance history.

The Logistical Support of the MCM Platoon

This case study focuses on MCM Platoon 1201 which is a primary end-user of the MK-16. The case follows the supported unit through its training cycle, deployment, and ultimate return to the home base.

Pre-Deployment

Preparation for any deployment begins with a FRTP, a codified training cycle. Concurrent with the assigned deployment schedule, the MCM platoon undergoes a FRTP cycle like most other Navy units. The purpose of this process is to train, equip, and certify unit mission preparedness. FRTP consists of various milestones, including inspections, evaluations, training, and exercises. Each one of these events helps to build unit skill and cohesion, starting with basic, individualized training, and working toward more advanced, integrated training with external units. The process is designed to prepare the unit for the upcoming deployment based on available intelligence data (Intel) gathered prior to heading into theater. This same Intel is what EOSESU TWO uses to prepare supply and logistics support. EODESU TWO outfits the units during ELO and issues all of the required gear aside from what has already been issued for the team to be successful on deployment.

The FRTP for a MCM Platoon begins with a tightly packed schedule of training events (also referred to as “workups”) lasting roughly 11 months from the start. Upon completion of the workup cycle, the Platoon stays in a six-month sustainment phase, when they are certified for operations, and thus may be deployed early if necessary. Otherwise, they maintain their availability status until departing on a six-month deployment, which completes the 24-month deployment cycle.

Prior to FRTP, the Platoon receives ELO from EODESU TWO and begins workups. Part of the workups include successful completion of the requirements of the Training and Evaluation Unit (TEU). TEU does not completely oversee the FRTP process for the Platoon, but provides training, classes, study materials, equipment, and some

evaluation for how the unit is able to perform against the various elements of the deployment they are likely to face. At times TEU directly issues some duplicate equipment that is required during the training. This prevents the Platoon from utilizing primary issue equipment, and thereby avoids any potential damage or loss to mission-essential gear, which in some cases can delay deployment or reduce mission capabilities of the unit. The TEU has its own supply of gear that it accounts for and purchases via EODESU TWO to support the unit training and evaluation process. ESU controls the budget used by TEU to purchase their course gear, which they acquire via DoD e-mall, GSA Advantage, GSA Leasing Support vendors, prime vendors, or other government sources of acquisition. The gear issued by TEU is generally the same as what is issued by ESU, but a slight variation is possible.

ELO/Gear Issue

At the start of the deployment cycle, the Platoon undergos ELO to get outfitted with the gear required for training and subsequent deployment tasking. This ELO process facilitates the issuing of a baseline of standard gear that EODESU TWO has developed over time based on coordination with the EODMUs and their historical tasking. Scheduled 6 to 12 months in advance, and based on long-term deployment rotations that are often available two years prior, the Platoon's ELO takes approximately three weeks to fully transfer the ownership of thousands of required pieces of gear from the ESU to the Platoon. The process starts with coordination between EODESU TWO and EODMU, to determine an appropriate start date, based on all units that may need similar support.

To start preparing for the ELO, EODESU TWO typically designates four Internal Airlift/Helicopter Slingable Container Unit 90 (ISU 90), along with a mini flyaway dive locker (FADL), for storage of all ELO gear issued to the Platoon. At the completion of ELO, the ownership of these storage units is transferred to the Platoon. Before the gear is moved from the warehouse to the storage containers, EODESU supply personnel generate a DD 1149 listing all of the items required for transfer. Each commodity manager is responsible for populating a DD 1149 with the appropriate items under his purview. These documents serve as the official inventory record for equipment ownership, and in

the interim, also serve as an inventory checklist utilized by both ESU personnel and the Platoon commander, for verifying all items transferred.

The DD 1149 information must be entered in two separate systems. First, all items must be properly accounted for in the warehouse. The IT system utilized in maintaining an accurate warehouse accounting is Wedge Advanced Software Product (WASP). WASP is a standalone warehouse management system. ESU personnel must go into WASP to update the ownership/location status of each item, as it is transferred to the storage containers. Additionally, this same supply/inventory information must be entered into the Navy's Readiness and Cost Reporting Program (RCRP), which is the approved system of record for use in official reporting up the Navy chain of command, and which is not connected to WASP. Though WASP is not an approved system of record, it is used locally for the convenience and simplicity it provides in managing the local inventory.

DPAS warehouse is another inventory management system that is available to the supply community that satisfies about the same requirements as WASP, but adds data entry efficiencies such as bar code scanners. EODESUs have yet to implement the new system. WASP is utilized for the majority of ELO transfer items, but not for underwater items. Due to the much smaller inventory of underwater items, the dive locker works primarily with RCRP (for ownership transfer), Organizational Maintenance Management System (OMMS) (for repair/maintenance), and spreadsheets (for ad hoc local tracking). Once the containers have been filled, and ESU and the Platoon commander have verified the transfer, the Platoon commander signs the DD 1149, accepting ownership of the containers and their contents.

While the Platoon usually receives the entire complement of gear required for deployment, at times, adjustments to the process are made based on supply availability and community demand for limited equipment, such as the MK-16. For example, the dive locker may delay issuance of the MK-16 if there is excess demand for use at the TEU in preparing other units for their own deployment schedule. Additionally, since mine countermeasures is a primary mission of MCM Platoons, they are typically outfitted with MK-16 at the start of workups, regardless of needs of others. However, other Platoons that treat mine countermeasures as a secondary mission, may experience a delay in

issuing the MK-16 during workups. However, in case of delay, they are provided equipment on a short-term basis as they commence specific MK-16 training evolutions during the workup cycle, and receive the full issue prior to deployment.

After about 18 months of training and sustainment, the MCM Platoon is deployed. During sustainment and deployment, the process for acquiring repair and replacement equipment is essentially an a la carte version of the ELO process, which is discussed below.

Deployment

Upon completion of the training cycle, any training-specific gear issued by the dive locker is returned, and any outstanding ELO gear requirements is fulfilled by the ESU prior to departure. The unit then embarks on the deployment to support real-time tasking from theater commanders, execute pre-planned missions, or operate independently, depending on theater demands. MCM Platoon 1201 is tasked with conducting a dive mission to clear a port in the Persian Gulf. This is a routine anti-terrorism/force protection (ATFP) mission to ensure safe passage for a naval surface action group (SAG), scheduled to arrive soon.

This EOD MCM Platoon is made up of eight EOD technicians. As part of their standard complement of gear, they are issued five MK-16 units and one operational support kit (OSK), which should be enough to handle the job. After four days of dive operations, two of the MK-16 units are in need of servicing. Several O-rings need replacement and one of the units needs an oxygen addition valve replaced. Until they are serviced, these MK-16s are not safe for use. In order to meet the necessary pace of operations and to avoid any extended time on station, they need to get the equipment repaired. Fortunately, these items are available within the OSK. After a quick repair evolution, all MK-16 units are fully operational. This allows the Platoon to meet the mission requirements as scheduled, and more importantly, this allows a follow-on naval SAG to pull into port safely and on time.

The use of parts from the OSK, along with a subsequent replenishment request from the Platoon, create a demand signal for execution back at EODESU TWO. The goal

is to maintain a fully-stocked OSK, to provide some maintenance capacity on-site. With other commodities, the Platoon typically coordinates with the Expeditionary Support Element (ESE), based in the theater. The ESE routes these requests through the appropriate commodity manager at ESU TWO for processing. However, in the case of underwater commodity items such as the O-rings and oxygen adition valve, they typically send e-mail to the dive locker personnel directly to request the necessary items. From a supply standpoint, this current request can be fulfilled in two different ways. The routine expendable items (the O-rings), are available immediately from the supply warehouse. The commodity manager enters the request in OMMS, which routes the request through the chain of command for approval. Once approved, the request goes to the warehouse to tag the O-rings for distribution to Platoon 1201. The oxygen addition valve however, is considered a depot-level repair (DLR) item, and therefore is handled somewhat differently. DLR basically means that the item cannot be locally serviced, and must be sent to a dedicated repair facility. The oxygen addition valve is requested in similar fashion as the O-rings, using e-mail and an OMMS job order. However, the Platoon must also send the failed part back to the ESU for exchange. The exchanged part is turned in to the depot repair facility, where it is refurbished or discarded if unserviceable. The repair facility provides a replacement part to ESU, likely a refurbished item from a previous repair. The dive locker at the ESU then generates a DD 1149 to document the parts delivery, make any necessary updates required in RCRP, and ship the O-rings and oxygen addition valve out to Platoon 1201. Upon receipt, the Platoon has a DD 1149 for their records, and the OSK is back to full operational status. This process repeats throughout the deployment, to facilitate repair and replacement activity on the MK 16.

Post-Deployment

Upon return, the Platoon 1201 follows up with EODESU TWO, to conduct all necessary equipment turn-in, along with associated documentation processes. The purpose of this effort is to reconcile supply-related activity that occurred throughout deployment and close out any outstanding logistics support requirements. While Platoon 1201 is able to turn in its equipment with a materiel loss of about 5%, the record of the

past turn-ins show that it is not uncommon to experience a materiel loss of as much as 30%.

Just as when the Platoon received initial gear issue, the primary process for gear return is ELO. This involves presenting any remaining gear to the supply warehouse for reconciliation. ESU personnel receive the gear, accept functional or repairable gear into inventory, and properly account for other equipment that is either unusable or lost. Functional gear may be cleaned and prepped for immediate redeployment, while repairable gear will be processed for repair or refurbishment before being returned to mission-capable status. ELO and associated data reconciliations to RCRP are important steps in the process for ensuring accountability for inventory levels. These steps support the ongoing financial improvement and audit readiness (FIAR) initiative across the DoD.

For TOA and PGI gear, Platoon 1201 returns to the supply warehouse at EODESU TWO, to transfer ownership of the preponderance of ELO. The process takes approximately three weeks to complete. Using the original DD 1149 document from ELO issue, along with accumulated DD 1149s generated throughout deployment for parts orders, the Platoon 1201 commander works with ESU personnel to inventory all returned items. All equipment is designated as mission-capable, serviceable, unserviceable, or missing. After accounting for all items, ESU personnel return to WASP and RCRP for appropriate electronic transfer of ownership. In the case of unserviceable or missing items, a form DD 200 must be generated, to account for the loss. It is the responsibility of Platoon 1201 to generate the DD 200 and route it through their chain of command for review. A copy is provided to EODESU TWO to facilitate recordkeeping, and to ensure inventory items are appropriately removed in WASP and RCRP, to avoid overstating the value and quantity of existing inventory.

Occasionally, due to operationally constrained deployment timelines, there is pressure to expedite the ELO process between deploying and returning Platoons. A solution employed by EODESU TWO is a modified ELO. Requiring a surge of personnel and a tightly coordinated schedule, this allows a returning Platoon to transfer inventory directly to another Platoon starting workups. This also requires coordinated commitment

from both Platoons and ESU, and can reduce the typical three-week process down to one week.

THIS PAGE LEFT INTENTIONALLY BLANK

Analysis, Conclusions, and Recommendations Regarding the Logistical Processes at EOD

The problems and shortcoming of logistical processes described in the previous section were analyzed using selected tools of Lean Six Sigma (LSS), a process improvement methodology. Specifically, we used tools such as the Process Flowchart and the Cause and Effect analysis (resulting in a Fishbone Diagram). As a sample, the flow chart of ELO/Gear Issue process is provided in Figure 1. After preparing flowcharts of all processes, they were analyzed to identify root cause/s of various problems facing the expeditionary logistics operations. The Fishbone Diagram is provided in Figure 2 while a discussion of the cause and effect analysis is given on pages 19 through 24. It should be noted that the analysis is organized as per the major causes shown in the Fishbone Diagram.

Mobile unit submits requirement request using a DD Form 1149 (Requisition and Invoice/Shipping form). Supply department (for PGI) or Materiel department (for TOA) checks its WASP to see if the item is in stock.

(a) If the item is in stock, it is delivered to the unit

(b) If the item is out of stock, check to see if it is a Navy NSN item

(i) if Navy NSN item (30%)

Order through R-Supply

The order goes through Navy Supply System and funds are subtracted

When the item arrives, R-Supply is updated

The item is issued to the Platoon and WASP is manually updated

(ii) If Non-Navy NSN (70%)

If cost > $3,000 or performance period > 90 days, send to contracting

Otherwise, open purchase:

Order through R-Supply

Funds are obligated using GCPC and paid to the vendor

When the item arrives, R-Supply is updated

The item is issued to the Platoon and WASP is manually updated

Figure 1. ELO/Gear Issue Process

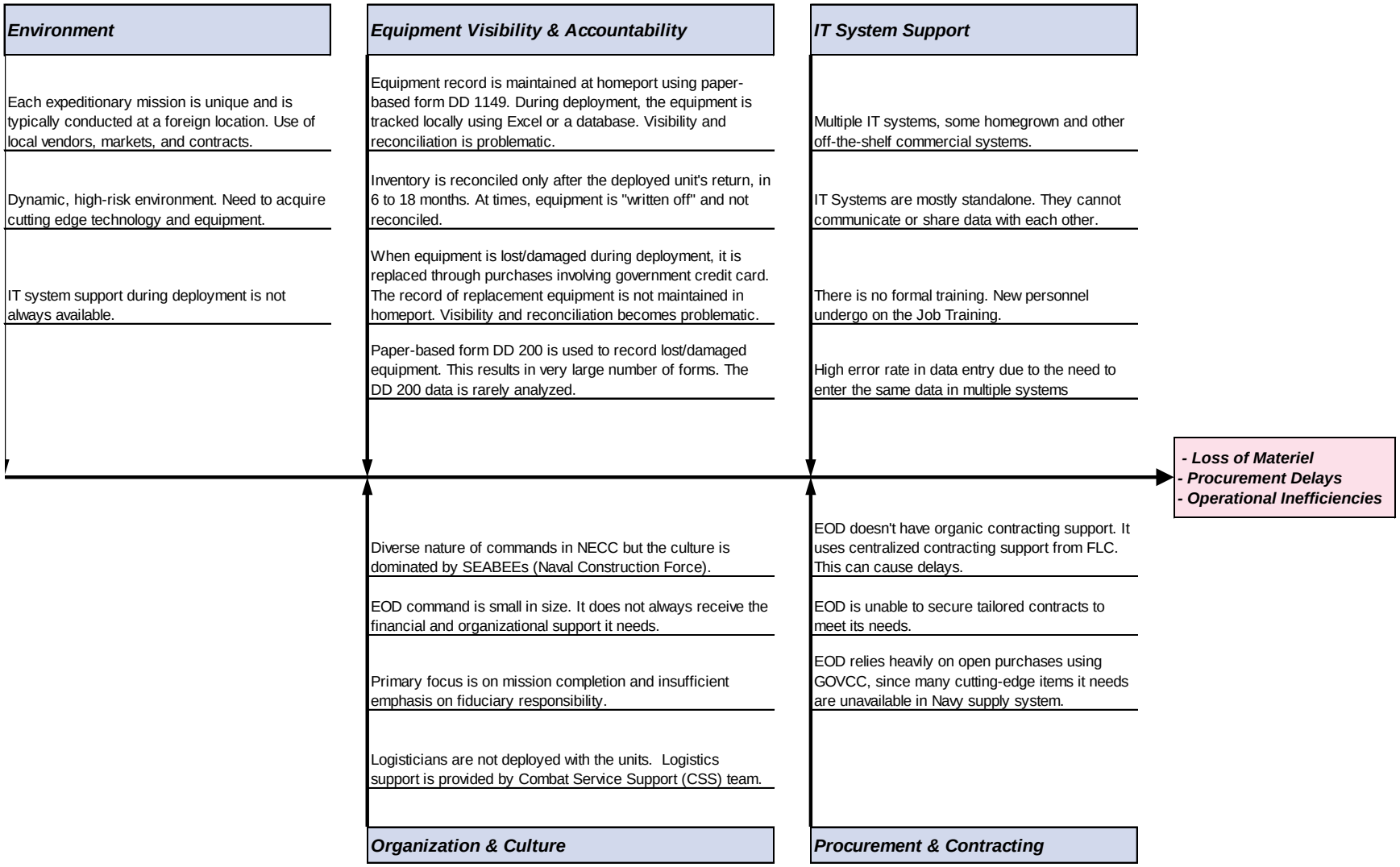

Figure 2. Fishbone Chart

Information Technology (IT) System Support

As previously mentioned, EOD represents a very small portion of the Navy's overall manning. Consequently, they are not always able to claim funding that would permit them to have a written contract tailored with an inventory management program to meet their needs. As a result, EOD makes do with the systems it has: the commonly available commercial products such as WASP for inventory management and Navy-approved systems such as R-supply for financial management. WASP was implemented as an inventory management system several years ago. It is an improvement over their previous methods of using Microsoft Excel spreadsheets. The use of multiple systems to perform inventory management results in an ad hoc inventory management system that requires double entries to maintain duplicate databases, as well as extensive, lengthy periods of on-the-job training to master the systems**.** Multiple systems are required to maintain equipment inventories and specific programs are required to be used for certain categories of equipment. Moreover, none of the databases for these inventory management programs are able to share information with the software used to track finances (R-Supply).

The effect this is having on the EOD logistics operations is reduced efficiency and effectiveness. For a typical Logistics Specialist, a tour in an expeditionary unit is unusual. The requirement to use multiple computer systems negates a key benefit of computer technology by multiplying the work required by the user. The need to perform repetitive data entries is also an invitation for natural human error. These inevitable errors introduce inaccuracies into the inventory and usage data, contribute to a loss of accountability, inability to optimally manage inventory, and reduce buying power for the taxpayer.

Most who serve in such a unit do so for only one tour and the majority in the Navy spend an entire career on sea-going ships. As a result, most systems that a logistician encounters in an expeditionary command are highly unfamiliar. These programs have no formal Navy training available and the sailor must learn through on-the-job training for up to 18 months. However, as we understand, the USMC utilizes logistics programs along with the associated schools. We recommend further research be conducted to determine if similar programs and schools could be adapted for use by Navy.

Procurement and Contracting

This study showed that EODESU relies heavily on open purchases using contracts or government credit card through the commercial sources. The goal is to have the gear fixed or replaced through the fastest means possible. Relying on the readily available product allows them to procure and stay current with technology advancement at a much faster rate in an effort to always stay ahead of the next potential threat.

During our research, we found that Naval Special Warfare (NSW) possess an organic ability to write and administer contracts. This greatly increases the speed with which equipment and services are obtained at NSW while reducing the workload on the unit's logisticians. In contrast, EOD is required to use the contracting services of the Fleet Logistics Center (FLC). This increases delays and administrative workload. Since EOD represents a very small portion of the Navy's overall manning they are unable to claim funding that would permit them to have a written contract tailored with an inventory management program to meet their needs.

There is a demand for cutting-edge equipment among members of the EOD community. This compels their logistics support units to rely heavily on the use of their government commercial purchase card (GCPC.) The Navy's supply system is best suited to providing parts and equipment to traditional ships and submarines. Relative to EOD, these platforms face threats and challenges that change slowly and, as a result the equipment and supplies they need are slow to change. This is not the case with expeditionary units. They operate in a much more dynamic environment. While a ship may have a service life of up to 50 years, much of the equipment used by EOD has a service life that is measurable in months. This timeframe does not permit economical parts support. Incorporating this into the traditional maintenance model of a sea-going ship could be meaningful. The GCPC permits these commands to obtain the required equipment quickly, but this does not come without consequences. The process of purchasing with a GCPC records purchases information in a form that is not readily accessible to external organizations. For example, you record the total dollar amount spent on a purchase in one system, however the list of purchased items gets recorded individually into a different system. The two systems are not compatible with each other.

The amount spent and the list of items on that purchase can only be reconciled manually by reviewing the original receipt. As a result, demand history is lost along with the ability to easily audit expenditures. Without any accurate demand history, the task of procurement and inventory management becomes significantly more difficult.

Equipment Visibility and Accountability

The process used to issue and maintain accountability of equipment is inadequate, particularly during a unit's deployment. Based on the preliminary information available at the time of this research and the interviews of subject matter experts, we estimated that loss of materiel accountability is, at times, as high as 30% for EOD. This is mainly attributable to the methods used to assign and record accountability for equipment, the relative ease with which equipment can be replaced, and the inability to detect trends in purchases and/or surveys.

Prior to deployment, accountability for the equipment is assigned to an individual or team using a paper DD form 1149. During the EOD deployment, no supply or logistics personnel from the team's unit are deployed with them to provide support to deployed equipment and, as a result, the responsibility for maintaining custody falls to the Expeditionary Support Element (ESE) in theater. The ESE is required to do this using possibly suboptimal methods such as Excel spreadsheets or a locally maintained database. It should be noted that even when the database is a familiar program, if the EOD unit is being deployed with another service, the unit is required to use that service's program. This introduces inefficiencies and reduces effectiveness in a manner similar to that previously described.

While deployed, the teams' focus understandably shifts to the successful accomplishment of the mission. Equipment, however, can be damaged or lost and replacements are obtained from respective in-theater logistics support units to ensure maximum readiness. This use of locally deployed support personnel helps the team maintain its capability to accomplish assigned tasks. It is likely, however, that by separating the functions that maintain accountability from those that use the equipment, helps create a culture in which containing materiel costs are not a major concern.

The paper DD 1149 records are maintained at the team's homeport and are unable to be updated when equipment is lost/destroyed and subsequently replaced. Additionally, because gear that is deployed with a unit is by definition "mission essential," replacing it is a high priority. Consequently, a given piece of equipment may be replaced several times during a deployment, but it is only upon the team's return to home port that its equipment and equipment inventory records are reconciled. Some gear is deployed and returns with an individual sailor or unit and discrepancies will be detected after the six-month deployment is concluded. As described previously, however, because these purchases are likely to have been made using a GCPC, the record of any replacements purchased during this time is largely obscured.

Additionally, a significant amount of equipment will only be reconciled after 18 months or may never be reconciled at all. Certain pieces of equipment are too costly to warrant purchasing in quantities sufficient to provide to each unit or too large to economically deploy and redeploy with a designated unit. This equipment is designated RIP/TOA and is turned over in theater as units are relieved. Although this equipment may have a high value, because it may be more than a year since accountability was first assigned and procuring replacements for deployed equipment is relatively easy, this equipment may never be reconciled but simply "written off."

Because the method required to document and track equipment loss/damage relies upon hardcopy paper documentation, it is likely that there is no effective means to accurately determine the cause of the loss/damage. Also, because of the nature of the control systems in place and the culture and attitudes it may engender, it is also unlikely that individuals with assigned accountability will be held accountable in the event of loss or damaged equipment. Lost, destroyed, and unserviceable equipment is properly recorded using the DD form 200. These forms, however, are produced at a rapid rate and the logistics units require several large binders to maintain a record of these forms. The documentation process is methodical. It is likely, however, that the sheer volume of paperwork makes it very difficult to assure accuracy in individual cases and to discern long-term patterns. Instead, the skill and memories of the unit's leaders and sailors become the primary means for detecting trends. The reliance on paper forms and the volume with which they are produced place a significant administrative burden on the

EOD logistics support commands while simultaneously obscuring trends in the information these forms record. It is probable that these factors make it unlikely that an individual sailor will suffer any consequences in the event of a loss of accountability. This is because the same factors also make it difficult to detect a loss due to negligence or theft. The systems may also create the perception that the forms are a "paperwork drill." With this perception, it is likely sailors prioritize their core mission responsibilities above any fiduciary accountability they may be assigned. In such an environment, it would also be inappropriate to punish the sailor for responding to the incentives which he has been given.

Organization and Culture

The case study identifies a number of areas that offer the possibility of improved financial and operational efficiency. When considering the nature of these opportunities and the circumstances that brought them about, it becomes apparent that several key factors are at work. First among these is the miniscule size of the EOD community relative to the size of the traditional Navy. Because the expeditionary community makes up a relatively small portion of the Navy in terms of both manning and the number of mission sets to which it contributes, it is likely that the community's requirements are naturally assigned lower priority than those of the maritime force. The Navy must make choices regarding how it spends its resources to obtain the most satisfaction from its large, but nevertheless finite resources. Consequently, it is plausible that an organization the size of the Navy would be unable to completely meet the needs of a minority of stakeholder organizations like EOD.

Another factor that contributes to the inefficiencies observed in the case of EOD is the diverse nature of the commands which make up NECC and their relative sizes. NECC is composed of ten separate commands with SEABEEs claiming more than half of NECC's personnel. At least on the West coast, this has resulted in the SEABEE culture dominating the NECC community and its requirements being given de facto higher priority.

Environment

Every expeditionary mission is different. While there are some similarities, the composition of the units deploying, the duration, and the environment where units are deployed can vary greatly. Following are some unique aspects of the operating environments the expeditionary units face that make providing logistical support more challenging.

- Local vendors are used to provide as many supplies as possible.
- Dynamic, high-risk environment requiring the latest technology to give the units that are deployed the best "edge" or competitive advantage possible.
- Information technology support is often unavailable during deployments due to the remote and/or austere environments.

Recommendations

The cause and effect analysis described earlier has led to the following set of recommendations for improving the logistical processes of EODESU.

- Information systems are highly inadequate and require multiple manual entry processes. Develop and introduce new information systems that will support expeditionary logistics. As an interim step, develop interfaces to enable single entry of data.
- Two important considerations to keep in mind before designing new information systems are (1) to first streamline the logistical processes and then design the information systems to fit the needs of that process, and (2) identify the data that will be needed to optimally manage the inventory and then design the information to capture those data elements.
- Currently, everything is on-the-job training with little knowledge capture or dissemination. Develop and deliver specific logistics training and education.
- When purchasing using a GCPC, the information is not tracked about which item is purchased, how many, or how often it is purchased. GCPC is a financial system and not a logistics system; it is used for tracking the amount of purchase but not what was purchased or its quantity.
- Given the large amount of money that passes through EODESU, having a full-time contracting official could possibly save money and time.
- There is a temptation to believe that because each expedition is unique and that the organization has always been able to "make it happen," there is no need to improve processes from both efficiency and effectivity perspectives. However, there are always some commonalities between different expeditions and those

commonalities should be identified and leveraged to achieve process improvements.

THIS PAGE LEFT INTENTIONALLY BLANK

Expeditionary Logistics: Preliminary Concepts

Joint Publication 4.0 defines *logistics* as "planning and executing the movement and support of forces" (Joint Chiefs of Staff, 2013). Expeditionary logistics falls on the line between the operational and tactical levels. There are several definitions for expeditionary logistics available in various military instructions and publications. NECC adopted the definition of *expeditionary logistics* as stated in Navy Tactical Reference Publication NTRP 1-02 (2017):

> The science of planning and carrying out the movement and maintenance of an armed force organized to accomplish a specific objective in a foreign county. In its most comprehensive sense, those aspects of military operation that deal with design and development, acquisition storage, movement, distribution, maintenance, evacuation, and disposition of materiel; movement, evacuation, and hospitalization of personnel; acquisition or construction, maintenance, operation, and disposition of facilities; and acquisition or furnishing of services.

The levels of logistics correspond directly to the three levels of war: strategic, operational, and tactical. Strategic logistics focuses on organizing, training, and equipping the special operations forces; whereas, operational logistics provides the link between tactical requirements to strategic capability in order to accomplish operational goal. They provide theater-wide logistical support, closely monitor in-theater shortfalls, communicate shortfalls to strategic sources, and continuously match tactical requirements with strategic recourses. Finally, tactical logistics primarily focuses on providing key services to support battles and engagements.

Two primary key areas of focus for ExLog are sustainment and combat service support. Sustainment provides forces the necessary equipment and services to maintain and/or prolong operations until successful mission completion. Effective sustainment allows combat commanders and expeditionary forces to have depth to seize, retain, exploit, and conduct decisive operations. Combat service support allows forward operating forces to have necessary supplies, equipment, transportation needs, and various services to support elements in theater at all levels of war.

Expeditionary logistics is challenged with the "tyranny of distance" since it often operates in areas far from Navy supply and distribution chains. Expeditionary logisticians often rely on host nations for support, and make heavy use of local contracts, vendor support, and commercially available supplies.

ExLog: Functional Areas

Expeditionary Logistics is comprised of six functional areas: supply, maintenance, transportation, general engineering, medical, and other service (food, disbursing, postal, Morale, Welfare and Recreation (MWR), etc.). The main three components of logistics are supply, maintenance, and transportation.

- *Supply* functions as a materiel and financial management support that is similar to Supply Department afloat. The functions include ordering, procurement, receipt, stowage, and inventory control of repairable and consumables items.
- *Maintenance* functions as a team responsible for developing and performing all maintenance policies and procedures. In addition, they are also responsible for all equipment maintenance that preserves, repairs, and maintains reliability
- *Transportation* takes care of movement of personnel and materiel from one point to another. They are well versed in worldwide ports of embarkation, debarkation, inter- theater, and intra-theater locations.
- *Expeditionary engineering* is primarily a function of the Naval Construction Force, commonly referred to as "Seabees." Seabees can be deployed independently or can be imbedded into other expeditionary units. Seabees are capable of a wide range of construction services such as combat engineering, rapid runway repair, facility damage repair, combat engineering, bridge and road construction, and facilities maintenance ashore. In addition, they also provide responsive support in disaster recovery operations and perform civic action construction projects to improve relations with other nations.
- *Health services* include medical, dental, and all health-related functions (combat and non-combat) including health maintenance, entomology, medical readiness of personnel, food service sanitation, treatment of casualties, and medical evacuation.
- *Other logistic services* function as a general area that includes services such as food, post, disbursing, exchange, billeting, legal, barber, laundry, and other administrative services and functions.

Comparison of Expeditionary and Commercial Logistics

Figure 3 shows comparison of expeditionary logistics and traditional commercial logistics along multiple dimensions. Expeditionary logistics often operates in foreign countries, in areas far from traditional Navy supply and distribution chains. Consequently, expeditionary logisticians often rely on host nations for support and heavily depend on local contracts, vendor support, and commercially available supplies.

Nature of Operation	Expeditionary Logistics	Commercial Logistics
Location	Foreign country	Domestic and/or foreign
Duration	Short term	Long term
Occurrence	Irregular	Routine
Demand	Variable	More predictable
SKU Variety-to-Volume Ratio	High	Low
Operational Tempo	Unpredictable	Steady
Level of Risk	High	Low
Desired Service Level	Very high due to low on-hand inventory levels	Medium to high due to the availability of local or regional distribution hubs
Distribution Dispersion	Low demand across many locations to serve few customers at each location	Use of large distribution centers or retail locations to serve many customers

Figure 3. Comparison of Expeditionary vs. Commercial Logistics

Expeditionary logisticians support expeditionary situations that are substantially different and challenging as compared to those faced by the logisticians supporting traditional commercial operations. The stock keeping unit (SKU) variety-to-volume ratio describes the ratio of the number of different types of SKUs relative to the total volume of demand—it is typically much higher in expeditionary operations, meaning the assortment of items is relatively high given the overall relatively low volume of logistical support demand.

Characteristics of Military Operations

We firmly believe that the design of the logistical system is necessarily driven by the logistical needs of the military operations being supported. One of the findings of our current research is that military operations can be characterized by seven important attributes, which in turn significantly influence the nature of logistical support needed by a given military operation. The attributes of military operations include the following:

- Nature of mission: short vs. long. Short-duration missions require consideration of the precise type and quantity of supply necessary for the specific mission without imposing the responsibility of foraging or *en route* self-resupply on the expeditionary force. Short-duration missions typically assume a sojourn time measured in days or weeks, not months. Raids, rescues, or short-term reconnaissance operations characterize short-duration expeditionary operations. Long-duration missions will require a dependable line of communication for continuous resupply, require foraging or *en route* resupply by the force, or some combination of both.
- Nature of mission: unique vs. repetitive. Missions that are unique differ from those that are repetitive in that they do not benefit from updated information in the future to continuously improve operations. Unique missions are similar to single-period inventory problems (Edgeworth, 1888; Morse & Kimball, 1951) in that there is a trade-off in costs and consequences between having too much or having too little of a particular good. This problem also has the characteristics of a knapsack problem (Dantzig, 1956), whereby only so many goods may be taken in a knapsack and each good has both a cost and a benefit. Unique expeditionary operations are those such as raids, rescue operations, reconnaissance, or exploratory endeavors. Long and repetitive operations begin with a forecast of what is needed based upon presumed demand for quantity and type of good needed.
- Scale of operation: small vs. large. A familiar truism in military strategy and operations is that mass has a quality all its own. However, not all expeditionary operations are large in material scale but are nonetheless complicated and not trivial to plan and execute. Small-scale operations may be constrained by the size of their geographic footprint, level of visibility, or geographic austerity, and therefore present special challenges of supply and resupply. Wars characterized by massing large armies require enormous logistical scale and scope and planning operations that ensure the orderly flow of materiel above all else; a bottleneck or logjam of any kind could cost battles and shift the outcome of the entire conflict. For small-scale operations, support must arrive precisely when and where needed; more of a "just-in-time" approach is required because there is little slack in the system in the form of excess supply and the size of the footprint, low-visibility, and/or austerity of the geographic conditions require supply to be coordinated within time-definite windows in precise locations.
- Scope of geography: small vs. large. The tyranny of distance (Bunge, 1961; Holmes, 2016) has been discussed at length in various ways by geographers, historians, and

political scientists. Naval operations have always faced the problem of supply and logistics when conducting operations far from its home waters. Hughes (2012) eloquently describes logistics as the operational level of war for the navy—that critical, enabling link between strategy and tactics Navy. For expeditionary operations covering vast geographic distances, the consideration of lead times and resiliency are important factors when considering how to maintain operations without interruption. Supporting a force at a distance, regardless of size, is a difficult logistical task. However, the larger the force being supported at a distance, the greater the imperative of consistent, reliable supply lines supported by reliable and repeatable logistical business processes.

- Economic development of area of operation: low vs. high. When operations are conducted in areas that are relatively developed, then supply and sustainment benefit from improved infrastructure such as roads, aerial or seaports as well as access to business or sutlers who may provide food or supplies. However, operating in a developed area also has the drawback of exposing forces to a civilian population that may be vulnerable and exposed to hostile actions or able to transmit the presence of the friendly force to belligerents or the public thereby compromising the mission.
- Level of risk: low vs. high. Operating in a permissible, low-threat environment has the benefit of reducing the necessary security footprint of operations as well as accommodating uninterrupted an unmolested supply. Operating in a high-risk environment brings with it not only direct operational dangers but also the potential of supply lines being disrupted.
- Operations tempo: low vs. high. When operational tempos are high, the rate of supply consumption goes up and therefore the supply and sustainment system must not only be responsive but also robust. High operational tempos consume large quantities of fuel to support movement, repair parts to sustain equipment, and ammunition to attrite the enemy.

Defining Expeditionary Logistics

Given the importance of the first two attributes listed above, we used them to develop a preliminary definition of expeditionary operations (see Figure 4). Though it is not always the case, missions that are short tend to be unique in that they do not conform to what the armed forces would consider regular or conventional combat operations. Likewise, missions that are long in duration take on a certain degree of repetitiveness in their logistical operations in that there is continuous resupply necessary. Large-scale, short missions might include the U.S. invasion of Panama in 1989 or the U.S. invasion of Iraq in 1990. Both of these operations concluded in a matter of months but they included large force sizes. By contrast, U.S. special operations ongoing on the continent of Africa are conducted by small force sizes and include reconnaissance and strike operations.

Scale of Operation	Nature of Mission: Short & Unique	Nature of Mission: Long & Repetitive
Large	Iraq–Operations Desert Storm (1990–91) Panama (1989–1990)	World War II Korean War Vietnam War Iraq–OIF (2003–2012) Afghanistan–OEF (2002–2014)
Small	Niger (Present) Libya (Present) Saudi Arabia & Yemen (Present) Somalia (Present) **Expeditionary Operations**	Iraq & Syria–Anti-ISIS (Present) Afghanistan–OEF (2001) Afghanistan–ORS (2015–Present)

Figure 4. Expeditionary Operation: A Preliminary Definition

Long and repetitive operations that are large-scale are best represented by the U.S. involvement in World War II, Korea, Vietnam, Iraq (2003–2012), and Afghanistan (2002–2014). Each of the conflicts included large deployment of forces, though there may have been beginnings—such as Afghanistan in 2002—that began initially with relatively small forces. Long and repetitive operations with small force sizes might be those involving the U.S. military in present-day Iraq and Syria where terrorist organizations such as ISIS (or Daesh) and Al-Qaeda are being fought. There have also been ongoing small engagements throughout Afghanistan that continue in an effort to achieve stability in that country.

In Figure 4, the lower-left quadrant represents small-scale, short-duration conflicts that require “expeditionary logistics” support. In our view, ExLog presents unique challenges for the current design and business processes of the conventional military logistics systems. In continuing with our research, we plan to explore the logistical implications across the varying characteristics of the conflict and forces employed with a specific focus on expeditionary logistics.

References

Apte, U., & Kang, K. (2015). *Naval expeditionary logistics*. Project report submitted to the Office of Naval Research, GSBPP, Naval Postgraduate School, Monterey, CA.

Bunge, W. (1961). The structure of contemporary American geographic research. *The Professional Geographer*, *13*(3), 19–23.

Dantzig, G. B. (1956). *Notes on linear programming part XXXV — Discrete-variable extremum problems* (RM-1832). Santa Monica, CA: RAND.

Edgeworth, F. Y. (1888). The mathematical theory of banking. *Journal of the Royal Statistical Society*, *51*(1), 113–127.

Holmes. (2016).”Two Words that Explain China’s Assertive Naval Strategy”, *Foreign Policy*, June 3, 2015.

Hughes, W. P., Jr. (2012). Naval operations: A close look at the operational level of war at sea. *Naval War College Review*, *65*(3), 23–47.

Joint Chiefs of Staff, Chairman. (2013). *Joint logistics.* Washington DC: DoD.

Kundra, S., Brown, L., & Donaldson, C. (2014). *Assessment of logistical support for expeditionary units* (MBA Professional Report). Naval Postgraduate School, Monterey, CA.

Morse, P. M., & Kimball, G. E. (1951). *Methods of operations research*. Hoboken, NJ: John Wiley & Sons.

Navy Technical Reference Publication NTRP 1-02 (2017). Navy Supplement to the DOD Dictionary of Military and Associated terms, United State Government, US Navy.

Reeves, D., & Baker, S. (2017). *Assessment of logistics effectiveness for expeditionary units* (MBA Professional Report). Naval Postgraduate School, Monterey, CA.

Yoho, K., & Apte, U. (2018). Navy expeditionary logistics. *The Case Journal*.

Acquisition Research Program
Graduate School of Business & Public Policy
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

www.acquisitionresearch.net