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Cost and Operational Evaluations of Centralized vs. Distributed Class IX Inventories

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NPS NRP Executive Summary
Title: Cost and Operational Evaluations of Centralized vs. Distributed Class IX Inventories
Report Date: 12/31/19 Project Number (IREF ID): NPS-19-M093-A
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COST AND OPERATIONAL EVALUATIONS OF CENTRALIZED VS. DISTRIBUTED CLASS IX INVENTORIES

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EXECUTIVE SUMMARY

Project Summary

The United States Marine Corps (USMC) faces the critical issue of setting their inventory policies to meet the Class IX repair-parts demands facing its Divisional Supply Management Units (SMUs). Specifically, the USMC seeks to improve its logistics operations for repair parts at the SMUs. USMC Installations and Logistics has partnered with the Defense Logistics Agency (DLA) to investigate whether increased collaboration with DLA could make the SMUs more efficient and effective.

Efficiency is measured by reduced inventory at the (SMU), and effectiveness is measured by reduced customer wait time. The goal in this research is to find the best efficiency-effectiveness tradeoff, which is determined by the balance between distributed inventory at the SMUs and concentrated inventory at the DLA. Based on time-phased demand data collected at the SMU of the First Marine Expeditionary Force (MEF I), we developed a simulation mimicking the requisition-supply cycle. Our simulation, implemented on six repair parts, facilitates an analysis of the distribution-concentration balance regarding these items. The analysis produces plots visualizing efficiency-effectiveness tradeoffs, which can help decision-makers choose the right distribution-concentration balance. We comment about the results of the simulation and offer some recommendations regarding inventory policies. For some of the analyzed repair parts, we show that the MEF I SMU can reduce the inventory levels of several parts by relying on DLA support, while maintaining adequate customer wait time.

Keywords: *logistics, inventory, customer wait time, centralized vs. distributed*

Background

Operating under an efficient and effective inventory policy is important for the USMC, as shortages of critically needed parts at certain locations and times could mean the difference between mission success and mission failure. By setting an optimal inventory policy, decreased inventory costs and customer wait times would positively affect mission performance and cost. The status quo, however, could force the USMC and, more importantly, the warfighter, to operate with a less than optimal system. By supporting the various requirements from MEF customers, the SMUs play a key role in supporting the Marine Corps warfighter.

The DLA is the SMUs main wholesale source of repair-parts, and a reorder policy by the SMU is determined by two main parameters: reorder point (RO) and reorder up-to point (ROP). RO is the threshold level of inventory in the SMU that triggers a reorder; ROP is the "up-to-level" of a reorder. That is, a reorder size = ROP – current inventory.

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The values of a (RO, ROP) pair may well be the critical point between a shortage of an item, and unused surplus, however, historically, SMU forecasting miscalculations have periodically caused parts to be ordered at the incorrect time and/or in the incorrect amount. These inaccuracies have led to various problems, including increased inventory costs and shortages of critically required parts. Moreover, customer wait times (CWT), the time from when the part is first ordered to final receipt by the customer, were adversely affected by this type of incorrect demand forecasting. Establishing a correct inventory policy is critical. Therefore, in seeking a possible solution, USMC and the DLA have embarked on a series of trials to examine if increasing USMC-DLA logistics integration can provide it. The results of these trials were inconclusive, which triggered our research – seeking an analytic solution for the question of effective and efficient inventory policy at the SMUs.

Findings and Conclusions

This research develops modeling and simulation tools to analyze the USMC logistics system from the SMU perspective and its interaction with the regional DLA supply depots. In addition to developing a tailored simulation for the resupply cycle, the research examines the advantages and disadvantages of possible modifications of the current system, such as enhanced decentralization or greater collaboration with DLA, which leads to centralization. Inventory management policies such as reorder frequency and amount are also examined. Details are as follows:

The USMC resupply cycle comprises five main stages:

- **Identifying** shortage in the inventory of an item,
- **Generating** a requisition by a customer or SMU,
- **Processing** a requisition by routing it in a specified order to a potential supplier,
- **Handling** the requisition at the supplier, a stage that may take from few hours to a few days,
- **Shipping** the supply and receiving it by the customer or SMU.

Note that there are two main resupply cycles: one that is initiated by and terminated at the customer (a USMC tactical unit), and another that is initiated by and terminated at the SMU when the inventory level of an item reaches its RO.

Our simulation follows the five stages described above, and the demand frequency and size are simulated based on real demand data collected from the SMU of MEF I. In addition to the RO and ROP described in the Background section, we also analyzed a third parameter—frequency of inspection (FoI). This parameter determines how often the inventory level of an item is inspected as excessive inspections may lead to unnecessary requisitions, while sparsely scheduled inspections may lead to undetected and severe shortages.

The simulation is implemented on the data of four reparable stock items that vary in the frequency and size of requisitions. The analysis examines the tradeoff between the ROP and CWT. ROP is a proxy for the cost of inventory – higher ROP implies larger inventories that occupy storage space and lock in purchase funds. CWT is a measure of service quality: how long needs a customer to wait to receive its order. This

tradeoff is analyzed while varying the FoI, which is a proxy for a control parameter, and the value of the RO, as a percentage from the ROP.

Comparing the results of the analyses with current practices at the SMU of MEF I, we conclude that for certain items the ROP could be reduced, thus saving inventory costs, while maintaining acceptable CWT. We also recommend, for some items, new RO values and specify efficient FoIs. Specifically, for items that have a moderate level of demand that an ROP of two months of demand, we find that a RO equal to 20% of ROP, and an FoI of two weeks strikes a reasonable balance between CWT and inventory cost.

Recommendations for Further Research

The model developed in this research assumes vertical flow of supplies where repair parts move along the hierarchy: DLA to SMU to customer. While still more of an exception than a rule, lateral flow between SMUs are possible, and perhaps even desirable. As this flow is not captured in our model it could be part of a model extension. A second model extension would be to expand the scope of the model to include third SMU (MEF III), other forward deployed logistic units at the operational level, as well as modeling in detail the DLA operations with all its relevant installations. Finally, the current model touches on budgetary considerations only thorough the ROP proxy. Further research would involve estimations of inventory, handling and shipping cost so that the tradeoff between effectiveness (CWT) and efficiency (cost) will be more realistic.

Acronyms

customer wait time	CWT
Defense Logistics Agency	DLA
frequency of inspection	FoI
Marine Expeditionary Force	MEF
reorder point	RO
reorder up-to point	ROP
Supply Management Unit	SMU
US Marine Corps	USMC