

Preface

In the past few years, there has been an increased interest in the planning and execution of military logistics operations. Military logistics is the basic supporter responsible for sourcing and providing nearly every consumable item used by military forces worldwide. The latter is also responsible for providing the Department of Defense and other governmental agencies with comprehensive solutions in procurement, demand forecasting, inventory control, warehousing, and transportation operations in the most effective and efficient manner possible.

Military logistics operations are essential for armed forces to be able to support an ongoing deployment or respond effectively to emergent threats or natural disasters. For that reason, the military segment aims at accelerating logistics improvement, as the latter may enhance the support to the war fighter and tackle accordingly operational demands.

This edited volume is aimed at highlighting recent advances in the development of effective modeling and solution approaches to enhance the performance of military logistics. The objectives of this edited volume can be summarized as follows:

- conduct advance research in global defense-related topics, including military operations, governmental operations and security, as well as nation support
- foster high standards in the practice of military operations research
- promote the global exchange of information and ideas amongst developers and users of military operations research tools and techniques

Significant issues in military logistics that are addressed include the following: (a) Restructuring processes via OR methods aimed at improving the efficiency and effectiveness of the military logistics, (b) Sense-and-Respond logistics prediction and coordination techniques that provide competitive advantage, spanning the full range of military operations across the strategic, operational and tactical levels of war, (c) Procurement and auctioning, (d) Inventory and stock control theories and applications, (e) Military transport and logistical equipment, and, (f) Maintenance, repair and overhaul on operational capability in general and equipment availability.

To this end, the nine (9) chapters included in this edited volume aim towards:

- the provision of a relevant platform for the latest contributions of operations management, operations research, and computational intelligence towards the enhancement of military logistics,
- the creation of a reference for practitioners and army related personnel interested in integrating scientific rigor to improve logistics management within defense organizations & agencies,
- the collection of useful insights into new trends and interesting research avenues that promote the contribution of operations research, computational intelligence and operations management to the improvement of defense logistics,
- the bridging of the gap between the abundant literature on commercial logistics and its scarce defense & combat counterpart.

Chapter 1 deals with Unmanned Aerial Vehicles (UAVs) planning techniques. The latter are important assets for information gathering in Intelligence Surveillance and Reconnaissance (ISR) missions. Depending on the uncertainty in the planning parameters as well as the complexity of the mission and its constraints and requirements, different planning methods might be preferred. The first two planning approaches presented in this chapter, deal with uncertainty in fuel consumption of the UAV. The third planning approach is designed for an even more uncertain and dynamic situation in which travel and recording times are stochastic, time windows are associated to target locations and new targets become of interest during the flight of the UAV.

Chapter 2 presents a supplier selection methodology for Military Critical Items (MCI). A Fuzzy Analytic Hierarchy Procedure (FAHP) is developed in the supplier selection area of MCIs. Furthermore, Principal Components Analysis (PCA) is applied into real-life data, related to MCIs, collected within members of the Hellenic Armed Forces. Competitive Intelligence (CI) oriented mostly to financial data is also used to assist in shaping the supplier selection model.

Chapter 3 describes demand estimation methodologies of repairable items for the F-16 aircraft. The flight hour parameter is used for computing the initial support requirements of repairable items in the United States of Air Force (USAF) whereas the usage parameter is used in that of repairable items in Turkey. Based on these calculations, a new parameter called SORTIE, which is the one cycle of take-off and landing, is generated. Taking into consideration the flight hour, usage and SORTIE parameters, 24 scenarios (8 for each parameter) are created by using real data set of F-16 with a quantity of 894 repairable items. In addition to the traditional approach that tries to find the best parameter common for all data, two new approaches are formed up. The first approach requires grouping the repairable items according to the supply group corresponding to the first two digits of NATO Stock Number (NSN). The other approach treats each NSN independent from each other.

Chapter 4 presents a combined inventory and lateral re-supply model for repairable items. This chapter focuses on the first part of the proposed model that deals with the modeling of an Air Force Logistics problem. The authors consider a network model composed of multiple depots that face uncertain demands for repair-

able items. The chapter describes the joint problem of determining how many units to repair locally, hold in inventory, and how many to ship to other depots, so as to minimize system-wide inventory storage, shortage and delivery costs. The formulation of the problem extends the Federgruen & Zipkin's combined vehicle-routing and inventory-allocation model by including local repair and lateral resupply capability.

Chapter 5 presents the solution of the problem presented in Chapter 4 by using the generalized Benders' decomposition technique. The results show that the additional Benders' cuts generated by this formulation significantly save the total operational cost, consisting of inventory, shortage and delivery cost. The authors, through five propositions and sample runs, show that Benders' decomposition algorithm is one of the most effective methods in solving these types of problems even in real-life military scenarios.

Chapter 6 deals with the critical role of armed forces in natural disasters especially in transportation of relief material. Indeed, their involvement in disaster response and relief actions is significant as their role is primarily in response to the immediate requirement of human resources and technical equipment for rescue and relief operations of the affected area. While commercial freight transport operations typically focus on minimizing costs, moving relief material is more concerned about satisfying demand for emergency supplies and saving lives. This task is particularly challenging given that emergency managers must operate under strict budget restrictions. To this end, this chapter presents the design, implementation and testing of a web tool that supports armed forces in freight transport planning during natural disaster relief operations. The proposed system is tested and the results show an increased performance in service provision with parallel reduction in administrative and transportation cost.

Chapter 7 describes the use of plane tessellation algorithms to optimize military resource allocation. Voronoi Tessellations are one of the most common approaches to divide a plane into cells such that parts of the plane closest to specific points belong to each cell. Using the cell areas to determine resource optimization is a powerful logistics tool. The aim of this chapter is to describe a method to use a weighted Voronoi diagram to allocate resources efficiently. The method can be used for any number of resources including, but not limited to, troops, ammunitions or medical supplies.

Chapter 8 presents a metaheuristic reconstruction algorithm for solving bi-level vehicle routing problems with backhauls for army rapid fielding. The latter is the process by which new equipment is distributed to soldiers either at dispersed homeland or theatre of operations units. To this end, this chapter addresses Vehicle Routing Problems with Backhauls and Time Windows (VRPBTW) with linehaul and backhaul military units in the context of military operations. The primary objective is the minimization of the required number of vehicles and the secondary objective is the minimization of the total cost of the routes. First a mixed integer programming formulation of the problem is analyzed. Since the VRPBTW is NP-Hard, a metaheuristic algorithm is proposed for the solution. Initial solutions are produced through a tour construction heuristic scheme and evolve through a variation of the

Threshold Accepting method, which is based on a special destruction-reconstruction scheme. The method has been tested on numerous problem instances with favorable results.

Finally, Chapter 9 presents a reliability study of several speculative military scenarios and some initial results concerning well-known reliability systems. More specifically, four different consecutive type of systems are investigated and treated as operational tactics of defensive or offensive military schemes. Structural properties of these scenarios, such as the signature vector or the reliability function, are studied in details and several conclusions concerning the effectiveness of the aforementioned military operations are deduced. In addition, some recursive relations for the calculation of the signature coordinates of well-known reliability structures are also proved. Finally, for illustrative purposes some figures are also displayed in order to depict the operation rules of the reliability structures that are under investigation.

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