Chapter 4

Assessing the Performance of a SAR Boat Location-Allocation Plan via Simulation

Mumtaz Karatas
National Defense University, Turkey

Nasuh Razi
Turkish Naval Forces, Turkey

Hakan Tozan
Istanbul Medipol University, Turkey

ABSTRACT

Maritime search and rescue (SAR) operation is a critical process that aims to minimize the loss of life, injury, and material damage by rendering aid to persons in distress or imminent danger at sea. Optimal allocation of SAR vessels is a strategic level process that is to be carried out with a plan to react rapidly. This chapter seeks to evaluate the performance of a SAR boat location plan using simulation. The proposed methodology in this chapter works in two stages: First, an optimal allocation scheme of SAR resources is determined via a multi-objective mathematical model. Next, simulation is used to test the performance of the analytical solution under stochastic demand. With the heaviest traffic and maritime risk, the methodology is applied to a case study in the Aegean Sea.

INTRODUCTION

Each year the Turkish Coast Guard (TurCG) receives hundreds of calls and distress signals from the vessels in danger. As the time difference between life and death can sometimes be measured in minutes, quick response to these signals plays a vital role in reducing fatalities and physical damage (Razi and Karatas, 2016). However, an average SAR operation requires substantial amounts of time, effort and money as well. Hence, emergency response operations should be planned with care and foresight. SAR operations planning can be counted as an emergency system planning. As discussed by Green and Colesar (2004),

DOI: 10.4018/978-1-5225-5513-1.ch004
despite many challenges, operations research and management science applications play an important role in decreasing the negative outcomes of emergencies. This argument is particularly applicable to SAR operations conducted by the TurCG.

TurCG conducts SAR operations in the Turkish Maritime SAR Zone, which is divided into four sub-responsibility areas as follows: the Black Sea, the Sea of Marmara and Adjacent Straits, the Aegean Sea and the Mediterranean Sea. Of all those sub-areas, the Aegean Sea has the heaviest marine traffic due to maritime transportation from and to the Black Sea, shipping, cruise tours, yachting, windsurfing and enormous illegal-border crossing activities.

As a consequence of the heavy maritime traffic, the Aegean Sea has an increased level of risk in maritime safety, which is as much high as the maritime incident rate. Together with (UNHCR Global Appeal, 2015) and (Giuliani, 2015)'s works, Razi and Karatas (2016)'s study show that the number of incidents tend to increase in the Aegean Sea responsibility area each year due to a number of reasons such as:

- Presence of narrow waters and dangerous routes among 3000 islands of various sizes
- Increased vessel traffic passing through the region as an outcome of the turmoil in Syria and Iraq
- Being the main route for immigrants to illegally cross EU borders
- Increased number of vessels carrying hazardous cargo
- Lack of designated shipping lanes

In 2014 alone, TurCG conducted 842 SAR operations, and 716 of them (85% of all operations) were in the Aegean Sea. The data provided by TurCG reveals that during those operations, 12,901 victims were saved, 190 boats were recovered undamaged and 154 lives were lost, while 62% of all operations were related to illegal-border crossing activities.

Considering the abovementioned risks related to the increasing traffic density, Razi and Karatas (2016) detailed the problem of establishing well-planned SAR organizations for the TurCG and they developed a decision support tool named as the “Incident Based-Boat Allocation Model (IB-BAM)”. IB-BAM is a three step methodology designed to allocate search and rescue resources. The methodology first ranks and assigns a weight to each incident type observed in the region. Next, utilizing deterministic historical incident data, a Zonal Distribution Model (ZDM) generates aggregated weighted demand locations. Finally, it employs a multi-objective mixed integer program (mo-MIP) model to determine locations and responsibility zones of each SAR boat. Using IB-BAM, the authors attain a more efficient utilization of boats considering multiple objectives.

Although IB-BAM is a powerful and flexible tool in the sense that using real-world data and subjective decision maker assessments on the severity of incident types, it generates effective boat allocation plans, it also has some drawbacks. Currently, IB-BAM does not consider variability in the demand, that is, it generates allocation plans for deterministic incident data. In real-world the nature of the demand is stochastic, hence the performance of IB-BAM should also be evaluated for stochastic incident data. Secondly, IB-BAM aggregates the incidents to concentrated demand points, called superincidents, by applying a weighted $k$-clustering algorithm. Such aggregation techniques bring out some potential errors which may affect the accuracy of the results.

For those reasons, in this study we develop a discrete event simulation (DES) to (1) measure the performance of boat allocation plans given by IB-BAM under stochastic demand and (2) measure the error introduced by aggregating demands to superincident locations. The simulation model basically
Related Content

Effect of Migration Fear on Sectors: Case of Developed European Markets
www.igi-global.com/chapter/effect-of-migration-fear-on-sectors/221779?camid=4v1a

Distribution and Selection of Ornamental Fishes' Issues on a Koi Fish Pond Using Krill Algorithm to an Order Picking Model

Variable Neighborhood Search Algorithm for the Variable Cost and Size Bin Packing Problem
www.igi-global.com/chapter/variable-neighborhood-search-algorithm-for-the-variable-cost-and-size-bin-packing-problem/227155?camid=4v1a

A Fuzzy Logic Classifier for the Three Dimensional Bin Packing Problem Deriving From Package Delivery Companies Application
www.igi-global.com/chapter/a-fuzzy-logic-classifier-for-the-three-dimensional-bin-packing-problem-deriving-from-package-delivery-companies-application/227182?camid=4v1a