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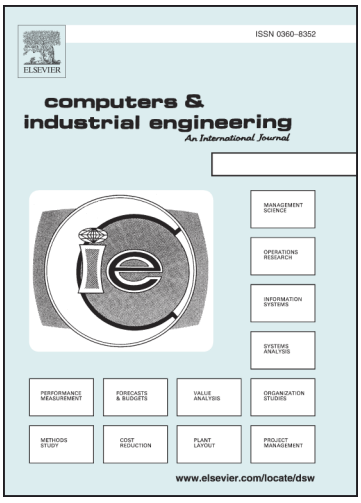

Capacitated Network-Flow Approach to the Evacuation-Location Problem

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Capacitated Network-Flow Approach to the Evacuation-Location Problem

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Abstract

Evacuating people to the safe zones is the most crucial operation in managing many disasters. A mathematical model is presented in this paper, combining locational decisions with the max-flow problem in order to select safe destinations which maximize the number of dispatched people. The existing frameworks for emergency logistics usually model the evacuation process based on fixed and pre-determined destinations with a strategic perspective. The unpredictable and turbulent nature of a disaster may; however, disrupt the predictions. Furthermore, the primary goal in emergency situations is to dispatch people from the danger zone to a safe place, no matter where. A mixed integer linear programming model is developed in this paper for selecting one or more destinations in a capacitated network. The special structure of the model and its similarity to the max-flow problem allow us to develop exact algorithms and heuristics both for the multiple and single destination location problem. The solution methods are based on existing algorithms for the max-flow problem. Our proposed heuristics use the idea of adding a super-sink to the network to generate upper bounds very fast. The exact algorithms as well as the heuristics are tested on randomly generated instances as well as a real world network. The most important statistics of their computation times are reported. They are also compared according to their performance (gap to optimality) and their behavior amongst different categories of the graphs. Finally we have presented a real-case addressing the problem of choosing a number of destination locations from a fixed set of pilot pre-determined locations. The problem of deciding on the destinations is considered under 5 grades of disaster severity and the related impacts on choosing the safe zones are analyzed.

Keywords: Evacuation, Location Problem, Emergency-Logistics, Max-Flow Problem

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