Chapter 43

Using an Agent–Based Behavior Modeling for Finding Humanitarian Relief Center Location in an Earthquake Zone

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ABSTRACT

Every year many different disasters occur in the world. The numbers of disasters has increased, especially in recent years. Emergency management of contingency has attracted by many researchers, who used analytical methods to find the optimal locations of humanitarian relief distribution center(s). This study sets up a model for humanitarian relief center facility location problem. This model considers some characteristics such as earthquake risk index, population density index, and transportation index to determine the optimal facility location center to respond the victims when an earthquake or disaster occurs. The method is based on a mathematical model for locating facility center. The author applies this model in a city in Turkey, and then the model is solved as an agent based behavior modeling according to the particle swarm optimization. Finally, the results are presented.

INTRODUCTION

A disaster is an event that damages human beings and human property. Earthquakes are the most dangerous among disasters. Also the earthquake time and date cannot be estimated

and its severity cannot be predicted or known previously. Therefore, preparatory activities for earthquakes are much more expensive than for other types of disasters. Earthquake has economic and social costs. Losses of property constitute the economic costs and loss of life and psychological disturbances generate the social costs. To reduce both the loss of property and

the loss of life some preparatory activities are done before disasters. Disaster management is a management tool that determines the preparation of the pre-disaster and the post-disaster periods. The disaster management takes precautions before disasters so that it can reduce the severity of damages. Humanitarian relief is also accepted activities in the disaster management system. The humanitarian relief involves many actors and operates in highly unpredictable and uncertain environments. The uncertainties and variability in the relief environment leads to most logistical decisions being made after the disasters. Facility locations (or humanitarian relief centers) are critical components of disaster preparedness and require long term planning to reduce the losses of property and life. The primary role of distribution centers is to supply necessary relief items to victims. Supplies consist of consumables and non-consumables (Ergun, et al. 2010). Consumable relief items (e.g. water, food, medication) need to be continuously transported to the victims' communities. Non-consumable items (e.g. shelter, mobile phones, and blankets) usually may require just on-time distribution. Consumable relief items cannot be stored very long in distribution centers. These types of items have a certain amount of useful life and require immediately transporting them after the disaster has occurred. Non-consumer relief items can be stored in the distribution centers before the disaster occurs. Also, the demand of relief items depends on the population at the affected area. The needs change according to the disaster type (e.g. flood, earthquake) and the disaster time (summer, winter). Immediately afterwards a disaster urgent items are usually required such as medicine, food, water and shelter. In the post-disaster term recovery items such as infrastructure repairs and construction equipment are required. The pre-disaster demands are based on forecasting, so the demand is not clear before known. The post-disaster demands become more

predictable because it is possible to collect real data from the disaster area (Duran et al. 2010).

The federal or local governments are responsible to cope with emergencies such as hurricanes, flood and earthquake disasters. These disasters are accepted as tremendous magnitude and low frequency of large-scale emergencies (Jia, et al. 2007). In such cases, emergency relief operation may need to cover thousands of victims in a short period time. In a matter of hours a large number of injuries require water, meals or medical care to prevent serious health hazard and death. Emergencies relief supplies need to be delivered to disaster injuries on time to protect the health and lives of the victims. Therefore, when determining of relief centers is considered various factors that are important because they will influence the lives of many people. For example the first 48 hours, known as the critical time (Claude de Ville de, et al. 2010), is very important for the people who injured an earthquake disaster. In this research, we focus on developing a humanitarian relief distribution center location to improve the effectiveness and efficiency of earthquake relief items delivery after disaster for humanitarian responses. We describe a model which considers a special kind of constraints such as earthquake risk index, transportation index, and population density index to find the nearly optimal facility location center.

The remainder of this chapter is organized as follows: In Background section, we give a review about humanitarian relief location studies. In Model Description section, we explain model constraints, in model formulation section, we formulate relief decision center location problem and specify that this model is NP-hard. In Model Solution section, an agent based model that was inspired from flock of birds' movement behaviors for solving the proposed model is described. In Example section, a real application of the model is presented. Finally, we conclude the chapter with Feature Research Directions and Conclusion.

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