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Task force deployment for big events

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Abstract

In the case of big events where hundreds or even thousands of people may gather together, task forces of police units, fire brigade units, medical corps units and so on are usually sent to the happening in order to ensure safety and help within short response time. Defining the number of required task force units and locating these task force units within the event area is a critical problem for the commanding decision maker. In this paper, we will first reveal how such decisions are usually made in practice today by reporting the result of interviews with practitioners who were in charge in such situations in Germany. Then we will provide mathematical models and report on computational studies to demonstrate how these decisions can be supported by operations research techniques. Finally, using data from a practical case in the city of Dresden where 50,000 people gathered together, we show that our models can indeed be used to solve real-world problems using commercial software.

Keywords: Task forces; Location planning; Event organization; Emergency management; Security management; Mathematical models

1. Introduction

Big events attract hundreds and thousands of people who gather together. A well-established definition in the mathematical sense of what a big event is does not exist to the best of our knowledge. But later in the text we will provide mathematical models where it becomes more clear what kind of input data is needed to apply the proposed methods. The organizers have to send task force units to these happenings to guarantee for safety and help. Depending on the event these task force units are from the police, from the fire departments, from medical corps, from the military, from civil organizations and so on. Defining the number of task force units and locating these task force units is an obviously important decision problem.

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In some situations, especially when events take place inside of buildings, the position of the task forces is predefined already, because some locations like rooms are dedicated for such units. In contrast to this, we are interested in events where the location of the task force units is not known in advance. Such situations usually arise, if the events take place outside. Also, we assume that the positioning of task forces is not permanent, but for a short time period of typically no longer than a few hours or days. The background of our work is described in more detail by Drechsel (2005). To the best of our knowledge, the literature on this type of location planning problem is sparse. A few references deal with the (long lasting) positioning of emergency service facilities in towns. We refer to Badri et al. (1998), Pirkul and Schilling (1988), Toregas et al. (1971), and Werners et al. (2001, 2002, 2003).

To motivate the need for optimization in this application area consider the following arguments. Once a big event has to be supported by task forces, one must decide upon the number of task force units and where to locate them. Since the event organizers have to pay for each single task force unit, they would like to minimize the number of units. But keeping the number of task force units too small might lead to critical situations and hence additional side constraints, which make sure the event is covered properly, are to be taken into account. This point of view defines

Problem 1. What is the minimum number of task force units and where should these units be located such that the event area can be covered in the sense that any place in the area can be reached within a predefined response time?

Some task forces do rarely have a manpower capacity problem, because they can employ large numbers of honorary members of their staff who use big events to train for future catastrophes where they might have to help. But many task forces do indeed have tight capacities mainly because it would be too expensive to maintain high capacities just because peak requirements occur once in a while. Then, it might be impossible to reach any place in the event area in a predefined response time. This leads to

Problem 2. Given the number of available task force units. Where should these units be located such that the event area is covered best in the sense that a maximum area can be reached within a predefined response time?

Similar to this problem, one may wish to solve.

Problem 3. Given the number of available task force units. Where should these units be located such that the event area is covered best in the sense that the response time needed to reach any place in the area is minimal?

Sometimes the organizer of a big event may have a freedom of choice regarding the type of task forces (e.g. nurses versus medical doctors, but not both). We assume that this decision is made in advance depending on the characteristics of the particular event. Our paper addresses the aforementioned problems assuming that the type of task force to be employed as already known. If several different types are to be employed, the proposed approach can be applied to all of them.

The paper is structured as follows: In Section 2 we report on current practice in Germany. Section 3 provides mathematical models and some results under the assumption that the event area can be represented by a plane. In Section 4 we study the case where the event area can be represented by a graph. Section 5 is devoted to the relocation of task force units. In Section 6 we describe a practical case from the city of Dresden, Germany. Some concluding remarks in Section 7 finish the paper.

2. Empirical findings in Germany

In Germany no legal requirements exist that are valid all over Germany and that define in detail how to organize big events with respect to task forces in order to guarantee safety and help. Many decision makers simply use experience instead of systematic procedures. Local authority districts may or may not have guidelines for such cases. The city of Dresden, for instance, which is the location of the practical case described in Section 6, has one (see Landeshauptstadt Dresden, 2004). It is based on a handbook for task forces where a non-scientific method to calculate the size of the task force is presented (see Maurer, 2001). Often, the task forces themselves have defined a set of rules which are applied (see, e.g., Malteser Hilfsdienst, 2000).