Chapter 14

A Specific Issue on Sustainability of Transportation Planning in an Urban Region: Ambulance Location Problem

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ABSTRACT

In this study, ambulance location problem, which is a significant research field in transportation in healthcare, is focused on. It is assumed that travelling time of vehicles between two demand points is uncertain and this uncertainty is represented as a crisp and as well as convex set. In order to deal with this uncertainty, robust counterpart approach, which is capable of providing conservatism, is employed. According to results of the simulation process, which is designed for the sake of benchmarking robust and nominal solutions, it can be easily claimed that conservative robustness is able to be achieved with significantly sufferable costs, even with no costs in most of the scenarios, by the proposed model. Ultimately, since robustness is one of the most important keywords for sustainability, on which discussions can be found in several parts of the text, this chapter is concluded with the claim that, by the proposed model, sustainability of transportation in healthcare is enhanced based on the adopted problem.

INTRODUCTION

In our day, there can be large-scale as well as small-scale disasters, terrorist attacks, and –in a more frequent manner- accidents in an urban region. Since those incidents may urgently require professional aiding, transportation in healthcare becomes a very important subfield of transportation planning. In point of a more general view, transportation in healthcare is essentially indebted its importance to having undeniable influence on lifesaving capabilities, standard of living, trustworthiness of the city, tourism incomes, etc.

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It is clear that transportation in healthcare must be sustainable for a more livable place. Robustness is one of the most important key words for sustainability, which will be discussed later in this chapter. And so, it can be said that in order to achieve sustainability in transportation planning, the current plan must be robust which is definitely valid for transportation in healthcare, also. In the literature, robustness has been drawing great interest in many areas. Robustness can be briefly defined as being invulnerable to the anticipated disruptive affects. Thus, a robust plan should be invulnerable to be disrupted caused by certain affects in some user-defined, specific limits.

Many aspects related to transportation in healthcare can be encountered in the literature. This study is focused on facility location problem for emergency vehicles, more specifically ambulance location problem, which is one of the most popular problems in this field. While facility location problem is the problem where facilities that are required for the system should be established, ambulance location problem can be defined as finding places in a region for locating center(s) that ambulances stay and be ready. For sure, such a plan must be carefully designed in order to serve well since lifesaving is the point in question. Although location plan has been very carefully architected, even it has been optimized, there still can be disruptions due to uncertainties. This situation has a great potential of creating serious damages on sustainability. The main purpose of this chapter is to develop a model which provides a robust plan for ambulance location problem, and so, to contribute to sustainability of transportation planning in an urban region.

This chapter is organized as follow: related literature has been surveyed in the next section; then, possible relationship between robustness and sustainable transportation planning has been discussed; the proposed model has been defined after robust counterpart (RC) approach has been briefly introduced; then, the proposed model has been implemented on a real life problem with presenting the results; and finally, the conclusion part has been appeared.

RELATED WORKS

In the literature, lots of works which proposed model(s) providing a plan for ambulance location problem can be encountered. According to considering an environment under certainty or uncertainty, previous works can be classified into two main classes: i. works considering environment under certainty; and ii. works considering environment under uncertainty. In this section, the works that consider environment under uncertainty are tried to be given due to their capability of dealing with uncertainty, which is almost always inevitable.

Since 1970s, some works attempting to develop a robust model for facility location problem for emergency vehicles have appeared. And then, some researchers proceeded the previous studies in 1980s and 1990s with new ideas. And finally, with the recent developments after 2000, the literature in this field has been shaped as in our day. Some of the most cornerstone works are tried to be given below.

One of the earliest works in this field is Swoveland et al. (1973)’s work in which probabilistic branch-and-bound (B&B) procedure was developed for the ambulance location problem.

Aly and White (1978) assumed the locations of incidents were random variables. The probability distribution for rectilinear travel time between a new facility location and the random location of the incident \( P \) was developed for the case of \( P \) being uniformly distributed over a rectangular region. The impact of the proposed model was evaluated by outputs of the employed simulation model.