Equity in medical transportation

Maxime Agius[1], Nabil Absi[1], Dominique Feillet[1], Thierry Garaix[2]

[1] Ecole des Mines de Saint-Etienne, CMP George Charpak et LIMOS, Gardane, France
{maxime.agius,absi,feillet}@emse.fr

[2] Ecole des Mines de Saint-Etienne, CIS et LIMOS, Saint-Etienne, France
garaix@emse.fr

keywords : *medical transportation, equity, time horizon, numerical experiments*

1 Introduction

In medical services, some cares are performed at patients' homes but most of the time, they are performed at the hospital. The majority of patients can go back and forth to the hospital by their own to get cares. However, some disabled or old patients cannot go to hospital by their own. In this context, ambulance companies are involved and a service provider assigns patients' demands to drivers. The goal is to ensure a high quality of service for patients while maintaining good working conditions for drivers. There exists several service provider platforms to manage such assignments. Generally, these platforms are not very efficient (e.g. when the demand varies strongly) and need intelligent tools for responsive large scale transportation services to guarantee a smart assignment between patients and drivers. A common non-desired consequence of the current platforms is that the assignment creates inequities between drivers in terms of route balancing and difficulty of work. In addition, this equity should be ensured for a time horizon of several days. The purpose of our work is to provide models and solution methods to guarantee equity between drivers and integrate them to these platforms.

2 Problem statement

In the context of medical transportation, it is important to assign patients transportation requests to drivers while ensuring equity between drivers. This equity should be considered on a horizon of several periods (where a period represents a day) in order to provide more flexibility to the studied system. The studied problem can be defined as follows : A fleet of homogeneous capacitated vehicles serves a set of transportation requests to/from a single hospital. We distinguish two types of requests : pickup and drop-off requests. Pickup requests consist in transporting patients from their home to the hospital. Drop-off requests consist in transporting patients from the hospital to their home. A time windows is associated with each request. We study our problem on a time horizon of T time periods. At each period, a vehicle routing problem (VRP) is solved in order to assign requests to vehicles. We assume that transportation requests of period t are revealed at the end of period $t-1$.

In this work, we aim at scheduling routes for drivers in order to satisfy patients' requests while minimizing the total cost and guaranteeing equity between drivers. In the literature, most of papers dealing with equity in VRPs define bi-objective models on a single period and mainly consider equity only in terms of route balancing (Matl et al. [1]). In our context, it is important to balance the difficulty of work since requests do not have the same difficulty. It is important to note that considering a bi-objective model can artificially deteriorate the total cost of routes in order to guarantee equity in terms of route balancing (Halvorsen-Weare et al. [2]).

In this study, we propose some numerical experiments in order to study the impact of considering equity (difficulty of work and route balancing) on a long time horizon basis. The main objective is to minimize the total cost. Our goal is to ensure equity on a time horizon without drastically deteriorating the total routing cost by allowing non equitable allocations on single periods but balancing it on a long time horizon. Our study consists in experimenting different solution methods on a set of realistic instances and compare them.

3 Conclusions and perspectives

Our preliminary experiments show that we can obtain fair assignments on a long time horizon by slightly increasing the total cost. Our single-period models are currently solved using a standard solver. We aim at developing a Branch-and-Price algorithm to solve larger instances. The next step consists in defining a more complex problem to be more realistic (dynamic or stochastic approach).

Acknoledgments

This work is part of project FITS - “Flexible and Intelligent Transportation Systems”, supported by the French National Research Agency (ANR - Agence Nationale de la Recherche) under grant ANR-18-CE22-0014.

Références

[1] Piotr Matl, Richard F. Hartl, and Thibaut Vidal. Workload Equity in Vehicle Routing Problems : A Survey and Analysis. *Transportation Science*, 52(2) :239–260, 2018.

[2] Elin E. Halvorsen-Weare, and Martin W. P. Savelsbergh. The bi-objective mixed capacited general routing problem with different route balance criteria. *European Journal of Operational Research*, 251 :451–465, 2016.