Data-Driven Cargo Bikes Routing in Last-Mile Delivery

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1 Introduction

In the logistics and distribution sectors, e-commerce is considered as the source of the multiplication of goods transportation. In urban areas, the transportation of goods which is known as the last-mile delivery service suffers because of traffic and congestion. It causes a significant amount of pollutions due to the transportation mode that is used such as light vehicles. These later are the most widely used means of transporting goods and specifically for parcels.

For this reason, environmental protection agencies and associations are trying to find more environmentally solutions for last-mile delivery. A very attractive used option is the cargo bikes ([4]).

Delivering by electric cargo bike has many advantages. In the city, electric bikes allow to move faster than a vehicle. In addition, maintenance costs are much lower. It is an ecological transportation mode and it is the only way to reach the hypers city centers. In addition, all platforms accept bike couriers, but this is not the case for vehicle delivery drivers.

For the strategic and tactical planning decisions, researchers show the potential of cargo bikes in urban logistics. For example, Brotcorne et al [3] compare business models for urban parcel delivery including environmental effects and cost analysis of traditional vehicles, electric vehicles, and cargo bikes. Perboli and Rosan [7] propose a business models that integrate cargo bikes and provide a simulation-optimization framework to evaluate mixed-fleet urban logistics systems. Anderluh et al [1] study different variants of problem settings with cargo bikes in urban areas. Assmann et al [2] analyse the impact of transhipment points for cargo bike systems in urban areas.

Recently, Fontaine [6] addresses the operational planning problem for the cargo bikes tours as a Vehicle Routing Problem. He introduces a mixed-integer programming formulation and an adaptive large neighborhood search algorithm to solve the problem of last-mile delivery with cargo bikes. Also, he shows that the travel time can be reduced compared to the vehicle routing problem with time windows.

2 Work in progress

The French post office La Poste have started to use cargo bikes for parcel delivery in some cities. In this context our work is carried out within the framework of a project called (In-Vivo-Cyclo) which is based on the deployment of a fleet of electric cargo bikes instead of light vehicles for parcel delivery in the city center of Bordeaux.

We started this work by analyzing the operational and environmental performances of cargo bikes and light vehicles through the exploitation of historical tours data. The goal is to understand the behavior of the operators, to detect the defects of the current tours and the possible improvements.

The tours problem studied in this project presents the case where the agents (either with cargo bikes or light vehicle) start and finish their day at the urban depot, located in the city center, to perform the loading operations. Then, they carry out the distribution of the parcels by making rounds. The relatively low carrying capacity of cargo bikes may mean that they have to return to the city depot to carry out new loading operations associated with new rounds. For light vehicles, there is only one tour per day. The *VRP-Spreadsheet-Solver-v3* [5] open source tool is used to calculate the distance traveled on each tour.

In this work, our goal is to develop a decision support tool based on rules that will be extracted through descriptive analysis of the data to optimize the cargo bikes tours. Then, we will move on to the In-Vivo simulation stage of the project. The In-Vivo part relies on an iterative logic based on the precepts of machine learning by replacing the data, generally simulated, with real data. This simulation-based optimization scientific approach consists in evaluating in a precise and reliable way the environmental and operational performance of cargo bikes in a dense urban environment for parcel delivery.

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