

Urban network design for parcel delivery at La Poste : the example of Paris

Johan Leveque^{1,2}, Gautier Stauffer², Walid Klibi¹

¹ Le Groupe la Poste, 75015 Paris, France
johan.leveque@laposte.fr

² The Centre of Excellence in Supply Chain (CESIT), Kedge Business School, Bordeaux, France
{gautier.stauffer,walid.klibi}@kedgebs.fr

³ Mathematics Institute of Bordeaux (IMB), University of Bordeaux, France

Keywords : *Network Design, Last mile delivery, green delivery, routing approximation.*

1 Problem context

With the exponential growth of the e-commerce industry and the slow decay of the mailing industry, postal and delivery companies have experienced a change in their core activities. The city of Paris took the engagement of removing every polluting delivery in its inner city by the Olympics in 2024. La Poste, the french national postal operator, is no exception. In particular, managing efficiently parcel delivery is becoming more and more crucial as this is the main vector of growth and competitors are entering the business. When the main problem in the mail delivery business was dealing with weight, the main issue with the parcel delivery is to manage light volumes and while pedestrians and bikes are mostly used to deliver mail in urban areas, parcels are still widely delivered with polluting vans. That's why La Poste needs to design a new parcel delivery network fitting the introduction of new clean and clever delivery methods.

2 Tackling the problem

In the design of a delivery network, we can clearly identify 3 different levels of decision : a long term strategic network design (flow decision, facilities), tactical medium term decisions (composition of vehicle fleet) and short term decision (vehicle routing)[2].

We discuss our development of a decision model that allows La Poste to solve a strategical problem of multi-echelon network design[1] that is the location of Micro Hubs within the city of Paris and the organization of parcels flows from the distribution centers outside the city to the final customer using intermediate urban delivery centers, so called, micro-hubs. The problem here is shaped as a location-allocation problem in which we need to decide what potential pre-identified sites are going to be used as micro-hubs, what will be their allocated catchment area and what fleet of green delivery method will be used.

Our model, based on a integer program, derives the optimal network delivery structure including possible direct delivery from the distribution centers.

One of the main challenge in this problem is estimating the price of vehicle routing according to La Poste's constraints in order to be able to determine the optimal fleet composition. That's why we also propose a new method, combining the work of several previous researchers[3][1], computing a vehicle-routing problem approximation and deriving the optimal fleet of vehicles to serve an area of demand from a distribution center or a micro-hub. This method is used

as a precomputing part in order to set-up our model, permitting us to decrease considerably the number of decisions variables usually used in literature by identifying independent optimal sub-decisions.

This approach allows us to model realistic very large scale problems, in a very high density of demand urban context, and to solve them optimally in a really short time. In particular in Paris, in which 50 000 parcels are distributed everyday. We base every computation on real-world data gathered with the help of La Poste's operational teams. These results leads us to the optimum number of Micro-hubs that needs to be open, their positioning, their associated delivery area and their optimal associated fleet.

We will discuss the impact of different scenarios on the final result such as the limitation of capacity of a micro-hub, the restriction of distribution to a postal code or the impact of sorting the directly parcels in the micro-hub or beforehand in the distribution centers.

3 Further work

The previously proposed network is tree-shaped, one of the future goal is to design a new hyper-connected network based on the concept of physical internet [4] in order to create a network that would provide new levels of services in a more sustainable way. We also want to challenge Daganzo's routing approximation[3] in order to take into account the traffic congestion. Finally, we want to take into account the success-rate of delivery in a stochastic way.

Références

- [1] Matthias Winkenbach, Paul R. Kleindorfer, Stefan Spinler *Enabling Urban Logistics Services at La Poste through Multi-Echelon Location-Routing*. Transportation Science, 2016. 50(2) :363-761
- [2] Bektas, T., Crainic, T. G., van Woensel, T. *From managing urban freight to smart city logistics networks*. Network Design and Optimization for Smart Cities (pp. 143-188). (Series on Computers and Operations Research; Vol. 8). (2017). Optimization by simulated annealing. *science*, 220(4598) :671-680, 1983.
- [3] Daganzo CF *The distance traveled to visit n points with a maximum of c stops per vehicle : An analytic model and an application*. Transportation Sci. 18(4) :331-350.
- [4] Benoit Montreuil *Toward a Physical Internet : meeting the global logistics sustainability grand challenge* Logistics Research 3 (2-3), 71-87