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Modeling urban goods movement: How to be oriented with so many approaches?

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Abstract

This paper proposes an analysis of the different model construction and development approaches in the context of urban goods movement (UGM). We focus on the model development issues more than on the mathematical tools applied in these models. First, we explore the main UGM models in the field, identifying their main construction schemas and their features limits. From this analysis, we propose a classification of UGM modeling frameworks, synthesizing them on a table that illustrates their construction schemas. Second, we analyze their limits and find a first set of synergies between the different thinking schools. This analysis allows us to highlight the strong points and override their weaknesses, and to propose a set of recommendations for planners and modeling schools in order to find co-operative schemas that improve the models' efficiency.

Keywords: Urban goods movement; modeling approaches; systematic review; multidisciplinarity

1. Introduction

It is usually considered that urban goods transport implies a complex system, including a transport system, infrastructures and urban planning, and the logistic strategies of shippers (including forwarding and supply chain activities, land use and the community environment). The main stakes of urban goods movement (UGM) can be considered from the angle of different standpoints and scales: the reliability of different logistic chains, local traffic growth, local traffic congestion, the economic fabric of urban centers, environmental nuisances (noise, pollutant emissions), the optimal location of urban logistic

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centers, greenhouse gas savings, and also the effects of urban sprawl and changes in consumer behavior. In order to solve the different problems relating to these stakes, many different modeling approaches are implemented and, as can be seen from studying several works, there is no standard method used for modeling UGM 00000. Some recent reviews explore the modeling issues related to UGM, but they focus on the mathematical tools used by the authors and not on the construction schemas and the relation between the modeling approaches and the object the authors want to model.

The aim of this paper is to analyze the different model construction and development approaches in the context of UGM. To this goal, we will explore the main models in the field in order to identify their main construction schemas and their limits then we will discuss their synergies and their articulation to reach common targets. The paper is organized as follows. First, we make an analytical review of the literature, in order to identify the main structural elements that define their construction and development. Then, we will synthesize the UGM models into a table that illustrates their construction schemas. Finally, we propose to analyze their limits and find a first set of synergies between the different thinking schools, in order to highlight the strong points and override their weaknesses.

2. The main approaches for UGM modeling

All modeling approaches consist in reducing the object studied in order to understand the mechanisms involved. The first thing to be done is therefore to identify this object clearly. This identification entails defining the model's scope of application, by stating the objectives, which then makes it possible to determine one or more fundamental variables of observation according to which the model will be built. On the basis of this identification, it is then possible to implement mathematical and computer processing methods to build a model adapted to the object concerned. Here we propose to describe the different models applied to Urban Goods Movements known to us though this scheme of interpretation.

2.1. Function of the model

Several authors have cited and studied urban goods models [2][5][6][10][19][21][31][32][33]. However, the lecture and interpretation of what is a urban goods models is still difficult to unify. For example, several authors mix demand estimation models and vehicle routing optimization approaches [11][28]. Other authors cite optimization and simulation techniques but do not give a special attention to demand estimation [5]. Other authors focus on policy oriented [2]. As we observe, these models have different functions and are not easily comparable without taking into account these fundamental differences. The main categories of models, related to their function, are the following:

- Demand estimation models. Their main aim and function is to estimate the demand of freight in a urban area and to relate this demand to the socio-economic and spatial characteristics of the chosen area.
- Fixed-demand optimization models. These models are related to linear programming and optimization research. Their function is not to estimate the demand to distribute but to optimize the transportation processes and other associated operations. Note that in many works related to city logistics, models of the second category are cited [5][13][31][32]. These models derive from the well-known families of location-routing and vehicle routing problems [13]. The demand is known or estimated with other categories of models.
- Multi-actor simulation models. Like the optimization models, their main function is not to estimate the demand but to simulate the behavior of the involved stakeholders.