Practical Behavioral Freight Transportation Models for Policy Evaluation in Cities

Yin Jin Lee a, Edgar Blanco b, Christopher Zegras c, Moshe Ben-Akiva d

Massachusetts Institute of Technology, Cambridge (USA)

a Engineering Systems Division (yjinlee@mit.edu)
b Center of Transportation and Logistics (edblanco@mit.edu)
c Department of Urban Studies and Planning (czegrass@mit.edu)
d Department of Civil and Environmental Engineering (mba@mit.edu)

Extended abstract

Objectives and motivation

Transportation models are important tools for planners to evaluate infrastructure plans and policies. While there are many sophisticated travel demand models to evaluate policy impacts on passengers, most planners lack tools to evaluate the impact of policies on logistics before the policies are implemented. Policies that are implemented without careful analyses can be difficult to enforce, impose unsustainable logistics operation costs, (Benjelloun & Crainic, 2009; Dablanc, 2011; Danielis, Maggi, Rotaris, & Valeri, 2013) or have adverse environmental impact (Quak & de Koster, 2009; Zambuzi, Cunha, Blanco, Yoshizaki, & Carvalho, 2013), thus it is important to develop freight demand models that can be used to understand and predict policy impact on freight transportation.

General description

It is necessary to consider behavioral changes when policies have complicated impacts on stakeholders’ decisions. Microsimulations based on behavioral models are commonly used to understand how city planning and transportation policies affect traveling behaviors (Ben-Akiva & Lerman, 1985; Miller, 2014). In freight transportation, behavioral models had been used to understand stakeholders’ reactions to policies such as off-peak hour deliveries (Silas & Holguín-Veras, 2009) and mixed regulations (Stathopoulos, Valeri, & Marcucci, 2012). Behavioral models had also been used to understand and predict decisions related to freight transportation, such as warehouse and supplier choice (Wisetjindawat, Yamamoto, & Marchal, 2012), service type (Nuzzolo & Comi, 2014; Nuzzolo, Crisalli, & Comi, 2012), timing of deliveries, mode choice (Wang & Hu, 2012), and route choice (Hunt & Stefan, 2007; Ruan, Lin, & Kawamura, 2012; Wang & Holguín-Veras, 2009). However, to authors’ knowledge, no publication has proposed a complete disaggregate urban freight transportation model integrated with all the decisions that constitutes the system.

Behavioral models are heavily dependent on revealed or stated preference data. Such data may be easier to collect from passengers because an individual or household makes all the decisions, but on the other hand, the travel decision of a single freight vehicle is the result of a cascade of decisions of multiple actors who are informed with subsets of information. This cascade of decisions increases the complexity in developing behavioral freight transportation model because the interactions between actors (Lawon et al., 2012; Roorda, Cavalcante, McCabe, & Kwan, 2010), and the timeframes of the decisions may not be consistent across companies and businesses even if they belong to the same industry.

Currently few policy-oriented papers connect directly with freight transportation system simulation models. The objective of this study is to construct a framework of decisions that generates the freight transportation system, and define these decisions by their actors, time and geographical scales. The decisions would be dependent on quantifiable variables that are directly related to urban freight transportation policy levers, such as vehicle size restrictions, and wage levies. This model covers within-day routing decisions to monthly and annually strategies, such as the vehicle fleet and mode selection, taking longer term decisions such as location choice as given. It is not in the scope of this paper to prescribe policies or regulations to a city, and readers referred to (Center of Excellence for Sustainable Urban Freight Systems, 2013; MDS Transmodal Limited & Centro di ricerca per il Trasporto e la Logistica, 2012) for guidance.

Ideal outputs from the all urban freight transportation demand model for the purpose of policy evaluation, regardless of level of aggregation, are the estimates of the costs and benefits for firms and the society. These include the externalities generated from dynamic interactions between passengers and freight agents. Presently there are several microsimulation models that simulate passengers long term and/or short term decision patterns to understand and predict mobility preferences, such as ALBATROSS (Arentze & Timmermans, 2004), TASHA (Roorda, Miller, & Nurul Habib, 2008), SimAgent (Bhat, Guo, Srinivasan, & Sivakumar, 2004), and SimMobility (Lu et al., 2015). The freight transportation model framework proposed in this work will be compatible with the modeling structure of SimMobility. Advancing freight transportation modeling compatibility with comprehensive microsimulation model platforms like SimMobility will enable forward looking urban planning and mobility policy evaluations.

Results and conclusions

This model framework would benefit researchers and policy makers in multiple ways. Policy makers and researchers can (1) understand the mechanisms that generate freight trips (2) examine the freight transportation system as a whole during policy design, modeling and data collection process, (3) identify and justify the assumptions, strengths and limitations of analyses in the absence of good data.
References


Keywords: Disaggregated behavioural models; Policy; Conceptual framework;