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Examining carrier categorization in freight models

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ABSTRACT

Travel demand models are used to aid infrastructure investment and transportation policy decisions. Unfortunately, these models were built primarily to reflect passenger travel and most models in use by public agencies have poorly developed freight components. Freight transportation is an important piece of regional planning, so regional models should be improved to more accurately capture freight traffic. Freight research has yet to fully identify the relationships between truck movements and company characteristics in a manner sufficient to model freight travel behavior. Through analyzing the results of a survey, this paper sheds light on the important transportation characteristics that should be included in freight travel demand models and classifies carriers based on their role in the supply chain. The survey of licensed motor carriers included 33 questions and was conducted in Oregon and Washington. Respondents were asked about their vehicle fleets, locations served, times traveled, time windows, types of deliveries, and commodities. An assessment of how the relationships found can be integrated into existing models is offered.

1. Introduction

State economies are served by the distribution of goods and services, i.e., freight, via the transportation network. For freight transportation planning to be efficient, state Departments of Transportation (DOTs) need informative freight models, and incorporating the relationships between transportation activity and characteristics such as commodity, shipment size, time windows, and origin and destination into these models can improve their ability to estimate the impact and policies on transportation activity.

Fig. 1 shows the Quick Response Freight Manual's simplified freight forecasting procedure (Cambridge Systematics, COMSIS Corporation, & University of Wisconsin-Milwaukee, 1996). This approach represents the state of the practice in freight demand modeling. At different steps of the procedure, simple categories of motor carriers are used to capture varying transportation characteristics. Different trip generation rates are often determined for different truck types such as four-tire and single unit trucks (Fischer & Han, 2001). Trip generation rates can also be categorized based on distance using long haul, short haul, local traffic, and through trips. Each distance category has different transportation characteristics; for example, long haul trips are made primarily by for-hire carriers and often originate from the manufacturing sector (Fischer & Han, 2001). Freight flows can be separated into truck trips that are classified as either private or for-hire. Depending on this classification, these trips take on different characteristics, such as the proportion that go to intermodal facilities and the allocation of trips into various truck sizes (Brinkerhoff, HBA Specto Incorporated, & EcoNorthwest, 2010). In the trip assignment step, analysts can do separate assignments for different categories of time, namely peak and off-peak times (Fischer & Han, 2001). One of the most common categories used in all steps of the freight forecasting procedure is commodity.

Commodity data is the basis of commodity flow models and provides a method of trip generation by translating tonnage flows into truck trips using commodity-specific truck payload factors (Fischer & Han, 2001). After trip generation, commodity-specific parameters continue to be used in models. Commodity can determine the percentage of shipments that are allocated to transshipment facilities, the percentage of trips that are long haul versus short haul, and whether the carrier operates on a for-hire or private basis (Çetinkaya & Bookbinder, 2003; Fernández, J. E., de Cea Ch & O, A. S., 2003; Fischer & Han, 2001; Picard & Gaudry, 1998; Samimi, Mohammadian, & Kawamura, 2010; Southworth & Peterson, 2000).

Garrido and Regan found that the choice between private and for-hire carriers is a critical shipper decision. The choice determines several factors: door-to-door transportation costs, time definitive delivery/pick-up services, freight loss/damage liability, geographical coverage, distribution patterns, shipment size, and driver availability (Regan & Garrido, 2001).

Carlos Bastida and Jose Holguin-Veras found relationships between carrier and receiver establishment characteristics and freight generation, documented in their Freight Generation Models report. In Brooklyn and Manhattan, industry segment, commodity type, facility type, total

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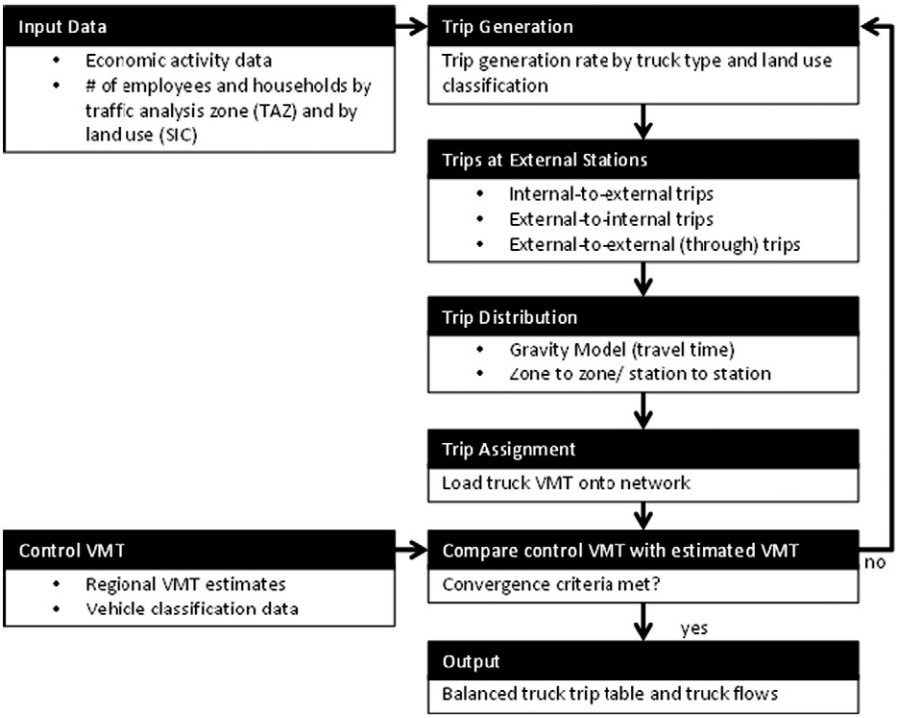

Fig. 1. Freight forecasting procedure. The procedure found in the Quick Response Freight Manual (1996) shows the main steps in freight modeling (Cambridge Systematics et al., 1996).

sales, and numbers of employees were statistically significant indicators of the number of deliveries generated per establishment. Because of insufficiently detailed data, Bastida and Holguin-Veras collected their own data from carriers and receivers (Bastida & Holguin-Veras, 2009).

Recently, a wave of second-generation models has begun to include some of the characteristics that researchers have found to be factors in freight movement. In Calgary, Canada, Hunt and Stefan developed a commercial vehicle movement model that, as it builds truck tours, distinguishes among vehicle types, trip purposes, establishment categories, and commodity NAICS codes (Hunt & Stefan, 2007). In Tokyo, Wisetjindawat et al. developed a model that considers each individual firm by taking into account location, number of employees, and floor area. By using these firm characteristics and delivery size, vehicle choice, and vehicle routing, the model converts commodity flows into truck trips (Wisetjindawat et al., n.d.). The GoodTrip model, used in The Netherlands, considers factors consistent with the aforementioned models, but takes an additional step by considering the roles of producer, carrier, and retailer as goods travel through transportation links (Boerkamps, van Binsbergen, & Bovy, 2000).

More recent research has hypothesized that incorporating supply chain thinking into freight modeling would better capture the complexity of freight transportation (Hunt & Stefan, 2007; Wisetjindawat et al., n.d.; Hensher & Puckett, 2005; Fischer, Outwater, Cheng, Ahanotu, & Calix, 2005; de Jong & Ben-Akiva, 2007; Boerkamps & van B., 1999). Supply chain thinking can aid commodity-based freight modeling when determining the percentage of trips that visit facilities such as manufacturing plants and retail stores. Knowledge of which supply chain nodes the goods are being moved between can provide more information about the shipment's transportation characteristics. For example, wood products (SCTG 26) moving between a raw production facility and a distribution center when compared to wood products moving between a distribution center and a retail facility may be moved in larger shipment sizes by a larger full-truckload vehicle making fewer stops.

When faced with the discrepancy between the number of factors affecting freight and the amount of data used in modeling, the initial reaction is to gather more data, create more categories, and add complexity to the models. The goal of this research is to determine whether categories of carriers (e.g., private/for-hire) used in freight models today are supported by industry data and whether informative novel categories exist that could replace or be used in addition to current categories. Should relationships be observed in the data analysis, this initial effort can provide support for specific model improvements; however, if these relationships are not observed, this work can help avoid developing more complex models. This article first describes the specific research questions and methods, including data collection via survey and statistical analysis in Section 2. The evaluation of current and novel categories is presented in Section 3. Lastly, the contribution to scholarly knowledge is discussed in Section 4.

2. Research questions and methods

The research question investigated in this article is whether empirical data supports the categorization of motor carriers into clear categories that have different transportation characteristics. First, the private/for-hire and commodity categories are studied to check if the data supports such a distinction. Then exploratory analysis is used to discover new categories that are data-driven. These new categories provide a potential new path forward in modeling research.

The first step in testing which categories provide statistically significant results is data collection. In order to collect relevant data, a targeted survey was designed and distributed specifically for this research. The data was then divided based on the current categories used today and tested on a variety of transportation characteristics.

2.1. Survey

The Commodity Flow Survey (CFS) and the Freight Analysis Framework (built on the CFS) are the primary national-scale publicly available datasets regarding freight transportation in the United States. They provide sub-state level tonnage by commodity and by mode, but they do not provide significant insight into carrier travel behavior. While there are numerous other sources of data, none is widely available that can provide detailed behavioral observations.