Development of a Freight Demand Model with an Application to California

Robert Lim[1,*], Zhen (Sean) Qian[2] and H.M. Zhang[3]
[1]San Francisco Municipal Transportation Agency, San Francisco, CA, 94103
[2]Heinz College, Carnegie Mellon University, Pittsburgh, PA, 15213, Tel: 412-268-7202
[3]Department of Civil and Environmental Engineering, University of California, Davis, Davis, CA, 95616

ABSTRACT
This paper discusses the disaggregation of the Federal Highway Administration's Freight Analysis Framework (FAF) database (version 3.0) on freight origin-destination data and the development of linear regression equations to describe the relationships between commodity-based freight trip productions/attractions to specific economic variables. Instead of generating a production/attraction equation for each commodity, commodities are grouped in certain ways to simplify model development and application. We consider three grouping methods and two model selection criteria (with and without intercepts), which are compared in terms of goodness of fit with two data sets (FAF versions 2.0 and 3.0). Furthermore, the freight generation models are validated using county-level economic data in California and applied to predict year 2015 commodity outputs. The results of this study can help city, county, metropolitan and state level planning agencies develop their own customized freight demand generation models without performing costly large-scale surveys.

Key Words: Freight transportation; Trip generation model, FAF3; Commodity flow

1. INTRODUCTION
Demand in freight transportation and the movement of goods continues to rise with the increase in population at state, domestic and global levels. Increased freight demand brings challenges such as added stress on already congested transportation networks

[*]Corresponding Author Email Addresses: Robert.Lim2@sfmta.com (Robert Lim), seanqian@cmu.edu (Zhen (Sean) Qian), hmzhang@ucdavis.edu (H.M. Zhang)

and negative impacts to air quality. In order to address these challenges there needs to be a greater understanding of freight and its impacts on the transportation network.

Many sources exist to describe goods movement but information available at the public level is mostly aggregated to the state level. The Federal Highway Administration (FHWA) maintains the Freight Analysis Framework database (FAF3, released in 2010) to estimate commodity flows and related freight transportation activity among states, regions, and international gateways. While useful, the data needs to be disaggregated to a finer level in order to perform an analysis on state and county-level goods movement. Once disaggregated, the FAF3 database in combination with other data sources will be used to develop a model to predict the demand for specific commodities by the county or state level, similar to that of a trip generation model.

Since disaggregation of national-level data to county-level data is necessary to produce meaningful and accurate predictions at these lower levels, much research has been done on the disaggregation process [11, 14]. In addition, there exists a private firm that specializes in this research, IHS Global Insight. This company maintains the TRANSEARCH database, which describes freight flows across the US at the national, state, and county levels. However, the use of such service is costly. Also in a comparison of the TRANSEARCH database with other disaggregation methods, the data do not match up [11].

This paper establishes freight demand generation models for trucks using the FAF3 database and other publicly available data sources. The proposed models will allow users to predict how much of a specific commodity in tonnage is produced (exported) from or attracted (imported) to any region (for example, city or county). This model by no means provides a "one-size-fits-all" freight generation model. Instead, this model provides insights on how one can go about creating their own version with data validation and how to adapt the model to the region for which the analysis is being done. Three models depending on the grouping of commodities that are carried by trucks will be presented in this paper, but there will not necessarily be an argument for which model is "better". The models differ from one another by how the commodities are grouped together, in which way the freight demand may be validated and an analysis of how the results are affected by these different groupings is provided.

A better understanding of goods movement across the network can be achieved via data analysis. By knowing what the demand of goods is to the specific location along with trucking characteristics such as load factors per good, truck flows can be mapped across the network. The information of where trucks go, and how often they go and what they are transporting can allow us to improve goods movement efficiency. The problem however lies with knowing what type of data to acquire and from what sources.

The idea for this paper is refined through a review of current practices in the goods movement field. Freight-specific generation models are often developed using methodologies that are applied to passenger forecasts [13]. In general, there are two approaches to truck trip generation estimation, commodity-based and trip-based [6]. The commodity-based method involves estimating the commodity flow tonnage and then converting it to the number of truck trips using a payload conversion factor.