Transport Policy 69 (2018) 49–64

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Modelling urban freight generation: A case study of seven cities in Kerala, India

Agnivesh Pani[a], Prasanta K. Sahu[a,*], Gopal R. Patil[b], Ashoke K. Sarkar[a]

[a] Department of Civil Engineering, Birla Institute of Technology and Science Pilani, Pilani, Rajasthan, 333031, India
[b] Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai, 400076, India

ARTICLE INFO

Keywords:
Freight generation
Regression
Establishment based freight survey
Employment
Floor area
Location interaction

ABSTRACT

This paper presents a set of freight generation (FG) models for seven cities in Kerala, India. Models were formulated by considering business size variables that capture establishment freight activity. Model estimation results revealed that business size indicators such as number of employees and gross floor area explained the freight generation well. Number of years in business (*YB*) was identified as another variable and considered in model specification to estimate FG. Detailed investigation of single variable FG models suggested that employment-based models are suitable for cities with dense commercial activities and higher land value, while area-based models better represented FG in cities with medium level of urbanization. Area appears to be a skewed indicator for representing business size in cities with dense commercial activities. In this case, where acquiring area is difficult, employment may be a better representative of growth in freight activity. As an extension of city specific FG models, three types of combined FG models were developed to provide quantitative statistical evidence for differences in model specifications across the cities. The statistical findings from these models suggest that freight activities are influenced by the interaction of establishment characteristics and its location. Interaction effect is more prominent when area is used to represent the business size. Since a systematic commodity flow survey practice is absent in India, planners and policy makers can be benefited from this study while making decisions on freight specific investment schemes and freight operation strategies. The interaction FG models discussed subsequently in this study may be utilized in transportation planning application for the state, regional and corridor level network capacity needs.

1. Introduction

Efficient freight transportation system plays a crucial role in national economic growth, optimizing generalized cost of goods and services, and globalizing industrial competitiveness. Freight transport flows have been growing continuously due to: 1) increasing population; 2) increasing consumption and production levels; 3) customization of products and services; 4) falling trade barriers, etc. This growth has been facilitated by major infrastructure extensions including roads, railways, waterways, ports, warehouses and trans-shipment activities. India has witnessed significant growth (13.4%) in freight movements during the last decade due to economic restructuring and globalization of trade and commerce (Novonous, 2015). Annual freight volume in India is expected to reach over 13000 BTKM in 2031–32 from 2000 BTKM in 2011–12 with an observed average yearly growth rate of 9.7% (NTDPC, 2014). Thus, effective integration of freight demand in the overall transportation planning process is exceedingly important. This is particularly relevant for urban areas with dense population, increased rate of industrialization and high level of congestion. It is also worthwhile to note that about 65% of freight movements within the country rely upon road networks. Lack of integration and connectivity issues in road network is leading to increased generalized cost of moving goods which was about 13% of national GDP during 2013–14 as compared to European Union (8.2%), USA (9.4%), and Japan (11%) (McKinsey and Company, 2013). One of the reasons for this is the lack of studies that quantify freight activities in urban areas. This paper contributes to this need by studying freight generation from different types of establishments in the State of Kerala, India.

With the emphasis of Government of India on 'Make in India' as the economic strategy, it is expected that freight transport will grow at 13.35% by the year 2020 (McKinsey and Company, 2013). This will also increase the freight flow in urban areas. Absence of urban freight demand models might result in unsystematic and inefficient policy decisions affecting the regional economy negatively and worsening traffic congestion and road safety. While macro-level freight flow information can be obtained from vehicle traffic counts, aspects of freight

* Corresponding author.
E-mail addresses: agniveshpani@gmail.com (A. Pani), prasantsahu222@gmail.com (P.K. Sahu), gpatil@iitb.ac.in (G.R. Patil), aksarkar@pilani.bits-pilani.ac.in (A.K. Sarkar).

https://doi.org/10.1016/j.tranpol.2018.05.013
Received 3 July 2017; Received in revised form 17 January 2018; Accepted 28 May 2018
0967-070X/ © 2018 Elsevier Ltd. All rights reserved.

demand generation from establishments at disaggregate level are scarcely studied in India. Accurate prediction of freight demand is not only essential for development of freight specific facilities (i.e., dedicated freight corridors, exclusive truck lanes, loading bays) but also for implementation of traffic management and city logistics strategies. The key challenges faced in absence of these strategies are: 1) traffic congestion, 2) logistics sprawl, 3) road capacity reduction, 4) pavement deterioration, 5) higher logistics cost, 6) higher levels of pollutant emissions, 7) reduction in inter-city trade activities. For example, average truck distance covered per day in India is reported to be 250–400 km, associated with a diminutive average speed of 20–40 kmph as opposed to 500 km reported in other BRICS countries and 700–800 km in USA and Europe (Ernst & Young LLP, 2013). As a result, Urban Metropolitan Transportation Authorities under Government of India have increasingly become concerned about the lack of availability of tools to forecast freight transport and understand the possible effects of policy changes (Ministry of Urban Development, 2014). While extensive research efforts have been carried out in data collection methods and modelling of passenger travel patterns, limited attention has been paid to its freight counterpart in developing economies like India. Most of the studies in different aspects of freight transportation planning can be traced back to the last 5 years. Patil and Sahu (2016) and Sahu and Patil (2015) projected freight generation (FG) for Indian seaport system up to 2024–25. Patil and Sahu (2017) developed a dynamic regression model to forecast cargo demand simultaneously for Indian ports. Cantillo et al. (2015) proposed a freight transportation modelling framework in which a set of aggregate FG models were developed for Colombia. In addition to these recent studies, another study was conducted by Dhingra et al. (1993) to forecast daily truck traffic in four highway corridors in Mumbai. This suggests that there is a concerning absence of disaggregate FG models for quantification of surface freight transportation in India at all spatial levels (National, State, Regional or Urban level) of planning. Research efforts in developing FG models in developing economies are inherently difficult as they are highly data driven and are usually collected by establishment-based freight surveys (EBFS) which are expensive in nature. This research carried out EBFS in seven cities of Kerala, a Coastal State in India to develop a set of statistical FG models based on regression analysis. The study cities are Cochin, Calicut, Palakkad, Thrissur, Kannur, Malappuram and Kottayam. These models have practical implication towards estimating freight generation at regional level while planning for intercity freight transportation.

This paper is organized in six sections out of which this is the first. Section 2 reports the state of the art in FG modelling and the key findings from previous studies. In Section 3, study methodology is described along with detailed information regarding study area, data collection process and preliminary analyses of data. Section 4 discusses model structure, city-specific FG model, combined FG model and model validation. In Section 5, implications of present study in urban freight policy context of India are reported. Section 6 presents the conclusions and applications of this study.

2. State of the art of freight generation modelling

This section introduces the concepts and the previous researches related to freight generation modelling that are most relevant to the present study. A brief introduction on freight generation modelling is given in the beginning, followed by a discussion on various statistical techniques adopted for developing freight generation models. Thereafter, a review of explanatory variables used in the past studies is provided.

2.1. Different approaches of modelling freight generation

Freight demand models are broadly classified based on (a) spatial levels and (b) dimensions of freight. Models by spatial levels are classified into three broad categories: global, regional, and urban (Regan and Garrido, 2001). Existence of two major dimensions for modelling freight generation makes modelling platform bi-conceptual. These concepts are freight generation (FG) and freight trip generation (FTG) (Holguín-Veras and Thorson, 2000). While FG models focus on the weight, FTG refers to the number of truck trips. FG has a notable advantage while developing models compared to FTG since the latter is not directly connected to business size but on logistical decisions (Tavasszy and de Jong, 2014). In practice, for a fixed amount of FG, establishments decide on the combination of shipment size and delivery frequency that minimizes the corresponding transportation and inventory costs. Irrespective of the truck load and truck type, any amount of shipment lesser than or equal to truck capacity produces one trip (Holguín-Veras et al., 2014). This premise of variable shipment sizes challenges the basis of FTG being a function of business size. On the other hand, modelling quantity of goods in tons (FG) can avoid the aforementioned latency in dependence on shipment sizes and logistical decisions (Tavasszy and de Jong, 2014). FG models are also better representative of the urban/regional/national economic activities due to the ability to reflect the intensity of production and consumption. However, contrary to number of FTG studies, limited research is done to model the freight quantity (i.e., FG) in tons. The possible reasons could be a) levels of difficulties involved in collecting freight weight data from establishments as opposed to truck trip data; b) relatively easy availability of truck trip data; c) absence of commodity flow survey (CFS) practice in developing countries.

2.2. Level of freight generation models

Freight generation models can be estimated either with zonal (i.e., aggregate) data or with establishment (i.e., disaggregate) data. While the aggregate approach predicts the freight generation from zonal economic characteristics, it conceals the causal relationships and differences concerning the fundamental trip making unit (i.e., establishment) characteristics. Ha and Combes (2016) recommends the usage of disaggregate data as it avoids aggregation biases. The authors also comment about the wider applicability of disaggregate models. For example, regional freight models can be disaggregated further and adopted for city level applications. The estimation of these disaggregate models require establishment based freight data; the data are obtained through surveys for the key freight generating facilities in a region, such as warehouses, wholesale and retail centers and manufacturing facilities. Kriger et al. (2011) summarizes the standard practices of establishment based surveys by various Metropolitan Planning Organizations (MPOs) in USA.

2.3. Statistical techniques for modelling freight generation

Several modelling approaches such as constant trip rate, input-output, growth rate, multiple classification analysis and regression and generalized linear models were used in previous researches (Alho and de Abreu E Silva, 2016; Bastida and Holguín-Veras, 2009; Campbell et al., 2012). Many of the studies considered a constant trip rate, such as Brogan (2002); Institute of Transportation Engineers (2008), Russo and Comi (2002) and Fischer and Han (2001). Despite its computational simplicity and limited data requirements, this technique is conceptually weak and can lead to significant estimation errors (Holguín-Veras et al., 2012). Some studies adopted input-output method based on economic tabulation of cost of input or raw materials that are required to produce one unit of economic output (Fischer and Han, 2001; Giuliano et al., 2010). Although conceptually solid, these models were not suitable for transportation planning in smaller areas with limited data (Holguín-Veras et al., 2012). Majority of the studies (see Table 1) utilized ordinary least square regression approach to model FG/FTG because of its ability to explain the relation between the freight activity and causal variables.

Download English Version:

https://daneshyari.com/en/article/7496833

Download Persian Version:

https://daneshyari.com/article/7496833

Daneshyari.com