AN OVERVIEW OF TRIP-GENERATION MODEL AND FUTURE PERSPECTIVES: FOCUS ON THE FREIGHT TRANSPORTATION

by Ji-Taek Seo**, Kazuhiko Ishiguro***, and Hajime Inamura****

1. Introduction

In the past several decades, the movement of freight in the urban areas has become an important transport planning issue. There are a number of reasons for this, including the current emphasis on traffic restraint in urban areas, environmental factors, and the stress now placed on the economic appraisal of transport plans. For these reasons it is arguable that, in urban areas, freight forecasting is now of more importance than modeling person movement. But little has been studied concerning the freight trip-generation phase of the continuing urban transportation planning process.

The approach in this study to forecasting freight transport has been, in essence, to adopt the fundamentals of the paradigm used for the modeling of person movement. However, any attempt to formulate the generation model of freight transportation will necessarily start by considering the extent to which the techniques available for forecasting person trips can be utilized for this purpose because over the years, a considerable amount of modeling work has been done in person trip-generation model. From the above reason, the models for person are suggested and reviewed for use in the models for freight transport.

2. Purpose of study

The objective of this study is to review the techniques used in the trip-generation models of transportation planning, which is the first step, the backbone of the travel estimation process, and to build realistic the most appropriate model based on the actual case studies. In fact, perhaps the emphasis of our present work should move more toward the creation of new ideas and alternatives model base on the precision and sophistication of trip-generation analysis focus on freight transportation. This study's procedure is shown in Figure 1.

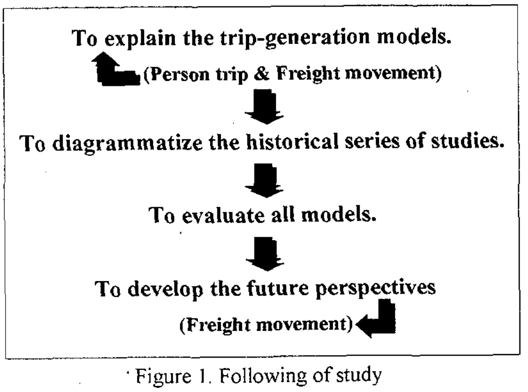

Figure 1. Following of study

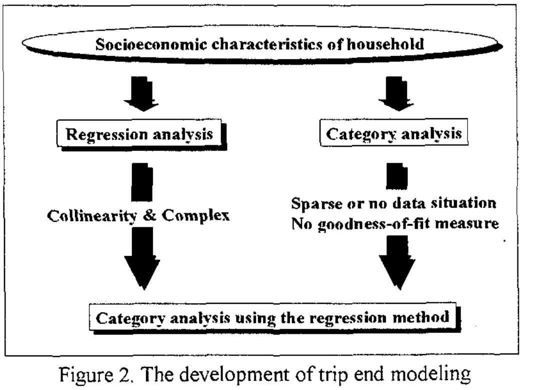

Figure 2. The development of trip end modeling

*Keywords: Trip-generation model. Aggregate data, Disaggregate data

**Student Member of JSCE, M. Info. Sc., Graduate School of Information Sciences, Tohoku University
(Aoba 06, Aramaki, Aoba-ku, Sendai, 980-8579, Japan, Tel: 022-217-7497, Fax: 022-217-7494)
***Member of JSCE, M. Info. Sc., Graduate School of Information Sciences, Tohoku University
(Aoba 06, Aramaki, Aoba-ku, Sendai, 980-8579, Japan, Tel: 022-217-7497, Fax: 022-217-7494)
****Fellow Member of JSCE, Dr. Eng., Graduate School of Information Sciences, Tohoku University
(Aoba 06, Aramaki, Aoba-ku, Sendai, 980-8579, Japan, Tel: 022-217-7497, Fax: 022-217-7494)

3. Trip-generation models

The trip-generation analysis, which are based on the person movement, are usually grouped into one of five categories; land-area trip-rate model, regression model, disaggregate model, category model, growth-factor model, and input-output model for the person and freight transportation.

(1) Land-area trip rate model

Sharpe. et al.[1] attempted to develop the trip-generation rates using the land-area trip rate analysis. This approach to trip-generation analysis has been the development of person and freight trip rates, usually trip ends per acre. Application of these developed land-area trip rates rests not so much in long range strategic planning on a regionwide, urban, or even networkwide basis, but rather in the short-run tactical planning area.

This approach has advantage on a local level and may prove valuable in the impact of trip-generation activities in localized sections of an urban area. But time and costs consuming are expensive to collect data for land-use analysis.

(2) Regression model

Because trip ends must be related to various socioeconomic and demographic characteristics of a traffic analysis zone, regression analysis was selected as the tool best suited to the development of trip estimates for trip-generation analysis through a mathematical modeling procedure.

Regression model is quite complex and involves a variety of independent variables, some with possible high inter-correlation damage to predict trip rates. This model, associated with long-scale areawide forecasting, can not be more refined than that associated with land-area trip rate analysis technique. This analysis is divided into two analysis modeling; linear regression and nonlinear regression; according to factors, independent variables.

(3) Disaggregate model

Most current methods of trip-generation analysis rely on areally aggregated data. The level of aggregation is generally the traffic zone and occasionally the traffic district. The underlying assumption of areal aggregations is that continuous households exhibit some similarity in family and travel characteristics, thereby allowing them to be grouped or aggregated with mean parameter values used for each group. Statistically this implies that the mean value of any particular parameter is reasonably representative of all households within the specific areal unit.

It is generally felt that a family's travel behavior is, in part, a product of the unique characteristics of that family. These relationships lose their meaning if they are aggregated. Monitoring of the aggregate relationships, however, gives little information on the components of change. If the subtle changes in household travel behavior are to be understood, it will be at the disaggregate level and not at the aggregate level.

From this reason, the linearity assumptions of aggregate regression analyses also present some difficulty. If, for example, there is a nonlinear relationship at the dwelling unit level, bias is introduced by an aggregate regression analysis. It is possible to avoid this problem by working at the disaggregate level and employing a different method of variable definition.

Stowers. et al.[2] suggested a possible alternative approach. Dummy variable regression technique allows such qualitative variables to be used and circumvents the restrictions usually associated with linearity. The application of the dummy variable technique is identical to the usual dwelling unit regression methods, except that the number of households associated with each household type is required. The general utility of this method and its use of behavioral data make it an extremely useful tool.

(4) Category model

The methodology of this model is the same as regression analysis using the dummy variables. In practice, this matrix method may be less complex and more efficient in the monitoring of change to a full dwelling unit analysis. This technique makes particularly full use of the household travel survey data as independent variables and, by its nature, offers the analyst the opportunity to work closely with data. It is also not bound by the usual assumptions of linearity, the technique is straightforward and efficient and offers none of the problems often encountered with curvilinearity and the treatment of qualitative variables.

For these reasons, the same positive comments made about the data efficiency associated with dwelling unit analysis apply here. Perhaps the greatest limitations imposed by the amount of data required for adequate representation and statistical stability.

(5) Growth factor model

Growth factor model, simple method, can be used to forecast the changes in trip due to change in the level of economic activity or other related factors. The growth factors approach is classified two types, such as based on historical traffic trends and based on forecasts of economic activity.

The first approach involves the direct application of a growth factor, calculated based upon historical traffic information, to the baseline traffic data. The second approach is derived from underlying economic activities (e.g. employment, population, income, etc.). In this approach, forecasts of changes in economic variables are used to estimate the corresponding change in freight traffic. In this model, it is difficult to estimate traffic patterns about the changes of study area, for example the changing to industrial area from residential area.

(6) Input-output model

Any forecasting and modeling work that has been done in the past in relation to freight movement has been geared to projecting the number of freight vehicles rather than the actual freight themselves. This model suggested that if casual factors regulating the nature and amount of freight are to form the basis of a forecasting procedure, the analysis should start with a consideration of the actual freight and not of the vehicles used to transport them. It is felt that the lack of published results using this techniques.

4. Summary

The techniques of trip-generation analysis are reviewed and showed advantages and disadvantages respectively.

Table 1. Summary of trip-generation model

Feature	Aggregate data				Disaggregate data	
	Land-area trip rate	Regression	Growth factor	Category	Dummy variable	Category
Application to transportation studies	△	◎	△	△	△	◎
Demands on sample data	×	◎	×	◎	△	◎
Forecasting stability	×	×	×	×	○	○
Significance of individual explanatory variables					◎	×
Shape of the response surface					×	◎
Ability to incorporate new variables					◎	×
Simplicity of concept					○	◎
Intercorrelations among independent variables					×	△

◎:Very good & Widely used, ○: Good, △: Generally used & Some problem, ×: Poor & Problem

Table 1. provides the summary form a comparison of the attributes and features of the trip-generation techniques, which have been considered in this paper. The arguments presented earlier in this paper lead to the firm recommendation that trip end models based on zonal data should be rejected. Such models have been shown to be unstable from one area to another; hence there is little reason for assuming that they will be stable over time. Future work should concentrate on the disaggregate models using the household as the basic unit of analysis, in order that all of the important parameters affecting trip-generation can be isolated.

Table 1. shows the weaknesses associated with both household regression and household category analysis models. In the context of category analysis, not only cross-classification cells with total non-availability but also cells with sparse data damage the reliability of trip rate estimates. Hence, it is necessary to provide an operational methodology that provides reasonable estimation of the trip rates.

In the present study a statistical method of analysis of trip data based on a linear model framework is provided. Rengaraju. et al.[3] developed to study category analysis to overcome several disadvantages, which are common to all traditional cross-classification methods. Figure 2. shows the development of trip end modeling[4]-[5]. Sparse or no data situations, which as a drawback for category analysis, can be overcome using a linear statistical model omits them while model is developed. The model is calibrated using a combination of categorical and continuous variables as independent variables.

The methodology derived is suitable in situations where there are cells having insufficient or no data. The simplicity of the procedure lies in the fact that raw data can be effectively used for calibrating the model and the analysis helps to identify the variables that most influence the trip rates.

Very few freight transportation forecasts were studied compare with person trip forecast. There is reason, which technology and the state of the economy are so difficult to collect data. In addition, freight transportation forecasts become more detailed and smaller. From the above reason, the trip generation technique is needed to develop alternative methodology for the freight transportation forecasting. The alternative methodology, category model using a linear statistical model, will has to conceptualize freight transportation to understand how freight affects and is affected by economic activities, sensitive to important state economic activities in the study zone by identifying major industry sectors, and estimate freight transportation using the statistical characteristics.

References

1. Sharpe, Gordon B., et al.: Factors affecting trip-generation of residential land-use areas, Highway research board bull No.203 and Public roads Vol.30, No.4., pp.20-36, 1958.
2. Stowers, Joseph R., et al.: The use of behavioral in forecasting transportation requirements, Highway research record No.106., pp.44-51, 1966.
3. Rengaraju , V. R., et al.: Structuring category analysis using statistical technique, Transportation engineering 120, pp.930-939, 1994.
4. Tardiff, Timothy J., trip-generation as a choice process, Transportation engineering., ASCE, 103(2), pp.337-348, 1977.
5. Said, Galad M., et al.: A general linear model framework for estimating work trip rates for household in Kuwait, Transportation research Vol. 24A, No.3., pp187-200, 1990.