A Review on Trip Generation Modelling Phase of Sequential Travel Demand Analysis

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Abstract— This paper presents a literature review on Trip generation process .Transportation planning is the process that leads to decisions on transportation policies and programs .A number of past research studies have been done on trip generation modelling using various modelling methodologies. Number of trips produced from a particular zone and attracted to a particular zone are dependent on various factors considered in modelling .Different modelling methods provide different accuracy in trip generation .Multiple linear Regression is the common method to adopted in trip generation modelling for estimating future trips. 

Key words: Trip, Trip Generation, Trip production, Trip attraction.

I. INTRODUCTION

A. Transportation Planning:
Transportation planning is the process that leads to decisions on transportation policies and programs. It is involved with evaluation, design and siting of transport facilities such as streets, highways, bike lanes and public transport lines. Years of experimentation and development have resulted in a general structure which has been called the classic transport model. This structure is, in effect, a result from practice in the 1960s but has remained more or less unaltered despite major improvements in modelling techniques since then .The analytical procedures constituting the transport planning process can be broken down into trip generation, trip distribution, modal split, and trip assignment. Although the four stages are clearly inter-related, the traditional approach has been to treat each stage more or less as a separate entity. This is true of trip generation, which is the subject of this paper. Trip generation is important in that it establishes the scale of movement and hence has an important bearing on the level and cost of transport infrastructure which needs to be provided in order to cater for the anticipated demand. To date most of the studies on trip generation have been concentrated on person trip generation, primarily at the home end of the trip, using either regression analysis or category analysis as the mathematical technique.

The trip generation stage of the classical transport model aims at predicting the total number of trips generated by (Oi) and attracted to (Dj) each zone of the study area. This can be achieved in a number of ways: starting with the trips of the individuals or households who reside in each zone or directly with some of the properties of the zones: population, employment, number of cars, etc. The accuracy of the future trip distribution in forecasting design year trip interchange cannot be any better than the accuracy of the trip generation forecasts, except due to chance. The ultimate purpose of the trip generation analysis is to arrive at an estimate of the trip ends generated at each analysis unit of the study area. Trip generation techniques try to establish a relationship between the demographic and socio-economic characteristics of the population of an analysis unit and its trip generation. Similarly, the intensity, character, and location of different land uses are related to trip making of the analysis units. These procedures are based on the hypothesis of a causal relationship between population characteristics, land use, and the trip making behaviour of people .Usually, trip generation forecasts are established independently of any direct consideration to the transportation network. This, of course, assumes that trips produced at, or attracted to a zone are a function only of the attributes of the zone itself; and are not directly a function of the transportation network which provides the roadway for the trips.

B. Some Basic Definitions:
1) Trip or Journey: This is a one-way movement from a point of origin to a point of destination with a single purpose. We are usually interested in all vehicular trips.
2) Home-based (HB) Trip: This is one where the home of the trip maker is either the origin or the destination of the journey.
3) Non-home-based (NHB) Trip: This, conversely, is one where neither end of the trip is the home of the traveller.
4) Trip Production: This is defined as the home end of an HB trip or as the origin of an NHB trip
5) Trip Attraction: This is defined as the non-home end of an HB trip or the destination of an NHB trip
6) Trip Generation: It is defined as the total number of trips generated by households in a zone, be they HB or NHB. This is what most models would produce and the task then remains to allocate NHB trips to other zones as trip productions.
7) Activity: An endeavour or interest often associated with a purpose as above but not necessarily linked to a fixed location. One could choose to go shopping or to the cinema in different locations.

C. Factors affecting Trip Generation:
1) Number of Employees;
2) Number of Sales;
3) Roofed Area of Firm;
II. LITERATURE REVIEW

T.Z Nakkash (1969) in his research examined the trip generation process with the specific purpose of evaluating the effect of activity-accessibility variables on trip generation. Another aspect of accessibility was studied by stratifying the zones of the study area by location. In contrast to the traditional trip generation procedures where the trips generated by a zone are considered to be a function of the characteristics of only the zone itself, the models proposed by this research take into account also the characteristics of all the other zones and the transportation network connecting them. The results of this research recommend that future relative accessibility of zones of the study area be considered in estimating future trips. The process would be iterative and would be terminated when equilibrium is reached between the forecasted demand for transportation (future trips) and planned for supply of transportation (future network).

Leake et al. (1979) studied trip generation of selected industrial groups. This paper determines the factors influencing commercial vehicle trip generation for selected industrial groups, and quantifies their effects using multiple regression analysis. Two methods of selecting the groups were adopted: one using eight of the Standard Industrial Classes; and one which attempted to put industries having similar vehicle generation characteristics into the same group, by subdividing SIC groups or by grouping together industries with similar manufacturing or trading processes.

The survey combined an initial interview of firm’s management about the operations of the firm with a recording by the firm of their travel data, using a sample of firms in the West Yorkshire metropolitan area. Of 22 relationships developed, 15 were considered acceptable descriptors of the variations in trip making, but only in 3 cases did a single variable (such as total floor area or total employees) account for more than 70 percent of the variation, and no single variable type gave the best fit for the various groups investigated. In general with most work on industrial trip generation, the method of analysis adopted was regression analysis (in this case stepwise multiple regression analysis) linking total weekly one-way vehicle trips (Y) with measurable parameters of the firm (X’s).

Konstadinos g. goulia et al. (1991) An attempt has been made in this study to develop a model system that describes both trip generation and trip chaining in a coherent manner. The model system adopts a recursive structure in representing the generation of trips for different purposes. The number of trip chains is expressed as a function of the number of trips by purpose. The estimated coefficients of the recursive models have indicated the presence of negative correlation between employment and non-discretionary trips, suggesting the influence of time budgets. This study has shown that a model system can be successfully developed integrating trip generation and trip chaining. The theoretically supportable coefficient estimates of the trip chain model are extremely encouraging. The proposed model system can be incorporated almost immediately into the conventional travel-demand forecasting procedure. The trip generation models indicate the total number of trips made by trip purpose, including both home-based and non-home-based trips. A procedure can be developed to classify a predicted number of trips into these two types based on the coefficients of the trip chain model. The model system will then offer the same forecasts as does the conventional set of home-based and non-home-based trip generation models, in a logically coherent manner. However, the model system presented here is in its initial stage of development. Its validation and careful refinement remain as a future task.

Charles l. purvis et al. (1996) made efforts to include disaggregate work trip accessibility in models of non-work trip generation. Reported household-level one-way average home-based work trip duration is used in home-based shop/other and home-based social/recreation models for the San Francisco Bay Area. The survey data and models show an inverse relationship between work trip duration and home-based non-work trip frequency: as work trip duration increases, non-work trip frequency decreases. Hybrid trip generation models using multiple regression techniques, cross-classified by workers in household level and vehicles in household level, are estimated using data from the 1981 and 1990 household travel surveys. Work trip duration is excluded in models estimated for non-working households and is included in models estimated for single worker and multi-worker households. Elasticity analyses show that a 10 percent decrease in the regional work trip duration yields a 1.2 percent increase in regional home-based shop/other trips and a 0.9 percent increase in regional home-based social/recreation trips. This research helps to identify practical means to incorporate workplace accessibility in regional travel demand model forecasting systems, to better analyze the issue of induced trip-making, and to provide a better understanding of the linkage between congestion and trip frequency choice behavior.

S.V.C. Sekhar (1997) Accurate forecasting of transportation demand is a challenging task. Difficulties arise because individual behaviour and inner workings of economic system, both of which create the demand for transportation services, are not clear-cut. In trip generation analysis, relationships are established between the number of trips produced by, and attracted to, a given zone. The most common methods used in trip generation models are: i) Multiple Linear Regression models and ii) Category or Cross classification technique or category analysis. As a part of world Bank aided comprehensive Traffic and Transportation Study for the Madras city in India detailed household survey consisting of 22,250 households was conducted in the year 1993. Using this large database, trip end models were developed using both the methods and results are published in this paper.

D.A. Badoe1 and C. Chen (2004) investigated the possibility of developing trip generation models using data collected at two or more points in time in independent cross-sectional travel surveys conducted in the same urban area. Alternative methods for formulating a forecasting model based on the availability of cross-sectional data from two time periods are presented. Models are then estimated on the study data and the models assessed in terms of their ability to replicate the number of trips made at the disaggregate household level, and at the aggregate traffic zone level in the two model-estimation datasets, respectively. The
performance of these jointly estimated models is compared to the predictive performance of a conventional single cross-section trip generation model estimated on each period’s data only. The formulated models are then applied to forecast trips at the disaggregate household level, and at the aggregate traffic zone level on a third independent cross-sectional dataset collected in the same urban area but at a different point in time. Again, forecast performance of the formulated jointly estimated models is compared to forecast performance of the conventional model estimated on this third independent dataset. The results show that well specified joint models estimated on data from two time periods yield superior disaggregate and aggregate forecasts to those obtained from conventional forecasting models, which are estimated with data from a single cross-sectional survey.

Tae Youn Jang (2005) established count data models to overcome the shortcoming of linear Regression model used for trip generation in conventional four step travel demand forecasting. The study applies to non-home based trips at household level to perform efficient analysis on count data. The Poisson model with an assumption of equidispersion has frequently been used to analyze count data. However, if the variance of data is greater than the mean, the Poisson model tends to underestimate errors, resulting in problem in reliability. Excess zeros in data result in heterogeneity leading to biased coefficient estimates for the models. The negative binomial model and the modified count data models are established to consider overdispersion and heterogeneity to improve the reliability. The optimal model is chosen through Vuong test. Model reliability is also checked by likelihood test and accuracy of estimated value of model by Theil inequality coefficient. Finally, sensitivity analysis is performed to know the change of non-home based trips depending on the change in socio-economic characteristics.

Hui (Clare) Yu and Peter Lawrence (2007) developed two trip generation models: a trip production model and a trip attraction model. The trip production model estimates the number of home based trips to and from zones where trip makers reside. The trip attraction model estimates the number of home based trips to and from each zone at the non-home end of the trip as well as the number of non-home based trips. In this study, these two models are based on the trip rates for individual sample households having the particular characteristics. Households and trips information were retrieved from the Australian Bureau of Statistics Census 2006, the Perth Strategic Transport Evaluation Model (presently calibrated to 2001) and the Perth and Regions Travel Surveys 2001 - 2005, since there were no suitable and available model output and survey data source in Albany. Multiple linear regressions are applied in analysing influential variables in these two models. In this study, considerable predictive power and accuracy have been gained by disaggregate analysis of influential variables in the trip generation.

Kimley-Horn (2009) in her research research established a database of empirical trip generation studies for various types of infill development, to standardize a data collection and analysis methodology, and to coordinate this research with the Institute of Transportation Engineers (ITE) with an objective to integrate the findings into a future ITE publication. The specific objectives of the second phase of this research were to:

1) Develop trip generation rates for common infill land use categories in urban areas of California,
2) Use methodology established in Phase 1 and continue to build a California urban infill land use trip generation database, and
3) Supplement ITE trip generation data.

Jesus Gonzalez-Feliu et al.(2010) studied on End-consumer movements, which is defined as the movements made by the consumer transporting the purchased goods, are identified with shopping trips. Whereas the logistics movements (freight distribution and urban part of the supply chain) are well studied in city logistics and urban planning, the end-consumer movements are usually related only to people movements. This paper presents a new modelling approach to characterise the shopping trips within a city logistics point of view, in order to connect these movements with those belonging to urban freight distribution in the supply chain. We present a trip generation model built from the data of recent household trip surveys, more precisely for the urban community of Lyon (France). We present the main results produced by the various simulations in a short-term planning horizon.

Jen-Jia Lin et al.( 2011) empirically analyzed the effects of built environment on leisure travel among children. Students of three elementary schools, namely Yangmingshan, Sanyu and Shilin, all located in the Shilin District of Taipei, were chosen to provide sample data. These negative binomial regression model and multinomial logit model were used to analyze trip generation and travel mode, respectively. This study reached the following empirical findings: (1) mixed land use, employment density, walkway quality, leisure facility supply and leisure distance encouraged generation of leisure trips for children; (2) intersection density, building density, employment density and walkway quality encouraged a child to use transit systems or non-motorized travel modes for leisure travel; and (3) vehicle density and leisure travel distance discouraged walking and biking but encouraged the use of transit systems for leisure travel involving children.

Abhishek Agarwal (2012) Sequential travel demand analysis consists of four phases, namely, trip generation, trip distribution, modal split and route assignment. Although, the later three phases are supported with quite sufficient number of efficient models; the first one, i.e., trip generation being completely based on human decision making is not supported with any efficient model. Existing models on trip generation are deterministic in nature and cannot capture the inherent vagueness of human mind regarding trip choice. Generally, the models of trip-generation include variables which reflect the number of potential trip-makers and the propensity of potential trip-makers to make a trip. However, none of the present models incorporate variables which reflect the accessibility factor. This is possibly the single largest factor as to why trip-generation models cannot very well predict the number of trips generated. It is intended to apply fuzzy logic, which is a linguistic tool to capture the imprecise nature of human mind regarding trip decision. Also, existing models on trip generation do not cover important premise variables.
controlling trip generation. In the proposed model it is intended to embed it properly. To validate the developed model empirical data is used.

Tomasz Kulpaa (2014) studied and developed Freight trip generation model at regional level. Data needed to construct trip generation equations are usually gathered at company level using the trip diary. Although this approach seems to be most suitable it may not cover all trips made by freight vehicles in analysed area. On the other hand, response rate may be unsatisfactory. Thus other methods of trip generation estimation should be explored. Based on results of roadside surveys O-D matrices for freight vehicles were estimated. In the next step, using large set of traffic measurements on national and regional roads, O-D matrices were calibrated. In order to calculate trip generations a step backwards was made. In addition, the results of comprehensive travel studies and secondary data were used. Developed data sets were used to estimate trip generation equations, applying linear and nonlinear regression as well as artificial neural networks (ANN). The aim of this paper is to develop freight truck trip generation equations at regional level using different data sources, secondary data and indirect approaches.

III. CONCLUSIONS

On the basis of studied literature, it can be concluded that the accessibility to the zones generate trips. It has also been concluded that detailed trip generation studies are necessary for the estimation of trips to/from industrial zones. Different types of methods for developing trip generation model gives different level of accuracy in estimating future trips. Also it has been concluded that cumulative logistic regression models are a good tool to estimate trip generation and for improving the temporal stability of model structure. Most of the studies used Multiple linear regression and cross-classification technique to develop trip generation model.

REFERENCES