

TRIP GENERATION ANALYSIS: “A CASE STUDY OF VADODARA CITY”

¹Krupali Rathod, ²Amit A.Amin, ³Dr. L. B. Zala

¹M. Tech. Student, ²Professor, ³Professor & Head of Department

¹Department of Civil Engineering (Transportation Engineering)

^{1,2,3}BVM Engineering College, Vallabh Vidyanagar-388120, India

Abstract: Trip generation estimates the number of trips to and from a traffic analysis zone. This process is the first stage of the conventional four-step travel forecasting framework. Although many approaches have been suggested for this step, regression and category analyses have been widely applied. The two methods have generated an acceptable level of performance from the perspective of transport planning. The cell-by-cell calculation in this method also increases the concerns about unreliable estimation of trip rates. Censored regression, count data, and discrete choice models have been visited for the alternative of regression approach while the multiple classification method has been conceived for the substitute of the category analysis. Three representative models – regression, Poisson, category, and multiple classification analyses – were applied to the homebased work trips in the Vadodara.

Index Terms - Transportation models; Travel demand; Trip forecasting; Data analysis; Data collection; Traffic surveys.

1. INTRODUCTION

Transportation engineering is the application of scientific principles to the planning, design, operation and management of transportation system. The transportation system in the reference to society because it provides a service for the movement of goods and people from place to place. Transportation is the backbone to development of urban areas. It enables functioning of urban areas efficiently by providing access and mobility. Passenger transport has an overriding influence on the functioning of the city.

Transportation planning is more than listing highways and transit projects. It requires developing strategies for operating, managing, maintaining and financing the area’s transportation system to achieve the community’s long-term transportation goals. It looks for ways to solve current transportation problems while anticipating and addressing issues likely to occur in the future. Transportation planning and development of infrastructure for the system is one of the most crucial factors particularly for urban areas, where in high level and rapid urbanization is taking place. Transportation planning process plays an important role in construction of new transport facilities. The basic purpose of transportation planning and management is to match transportation supply with travel demand.

It is an important part of overall town and country planning, since it deals with the transport network which is an important channel of communication. Any change in this system is reflected in number of impacts. The transport planning process starts with the decision to adopt planning as a tool for achieving certain desired goals and objectives.

Transportation planning process includes four stages i.e. Trip generation, Trip distribution, Modal split and Traffic assignment. For a city like Vadodara which already facing the problem of traffic it is very important to know about Future traffic condition. With increase in population, Vadodara started facing problems of traffic, parking, pedestrian’s safety, congestion in the city.

the solution may include

- Land use and city planning controls
- Transportation studies are to be carried out and plans for new roads and reorganization of existing network are to be formulated.
- Traffic restraint measures like restriction in parking, road charges etc.

2. LITERATURE REVIEW

Elizabeth Johnson (2017) Trip generation models exist for a wide variety of land uses, including apartment housing, a model specific to off-campus college student housing apartments does not exist. Student-oriented apartment housing is believed to have different trip patterns than general-purpose apartments due to students’ unique schedules and travel patterns.

Michael D. Anderson (2002) This topic presents an application of the urban transportation planning processes that has limited data collection and cost requirements, developed specifically for application in smaller urban areas. The objective of this research was to develop tools and procedures to assist in the development of travel models for smaller urban areas based on readily available data. The uniqueness of this approach is the use of a single trip purpose to forecast internal-to-internal trips and the ability to include external-to-internal and external-to-external trips.

Justin.S.Chan(2014) The trip generation estimation procedure employs mathematical models that associate each purpose with demographic characteristics of the trip generation analysis of zones, such as population, households, employment, vehicle ownership, and income. Current information on these variables may be obtained from household surveys or census reports

Taeseok Kang (2012) The main objective of this is to find out the effect of mall on trip generation area. This study gives a idea about the factors affecting trip attraction i.e. floor area of mall, number of stores, food court capacity towards the shopping malls. The parking facility at mall is major factor affecting trip attraction. The influence of mall in the trip attraction on an average ranges above 6.0 km radius.

AshishVerma(2010) Most of Asian cities _Delhi, Mumbai, Tokyo, Hanoi, Astana, Bandung etc., to name a few_ are typically characterized by high density urban areas, absence of proper control on land use, lack of proper roads and parking facilities, poor public transport, poor infrastructure for non -motorized transport, lack of road-user discipline, etc. This results in transportation problems, including accidents, congestion, and pollution, taking a very different and more severe shape than those in cities of developed countries.

DongjaeJung(1999) The main objective of this paper is to examine the possibility of using different techniques, to determine the traffic percentages. This will use three different models to determine the activity base for the city, and compare the models with the results given by the regression equation and a cord on line origin-destination study.

Arkady Borisov (2002) The objectives of this are to study regression analysis (Rate methods) for trip generation models and to evaluate “smart growth” tools to increase the accuracy of generated trip calculations with mixed-land use and transport infrastructure availability (public transport, pedestrians) Transport trip generation models are considered with an aim to improve the accuracy of transport generated trips. Information systems are reviewed, and “smart growth” criteria that could affect the accuracy of trip generation models are also identified.

Angela Quintero(2002) The main objective of this is to find best trip generation model per hour per school. The trip generation rates based on the best variables for private, semi-private and public schools could be applied to the different modes, but the car (particular vehicle, school van, and taxi) is which most impact has on adjacent streets to the schools. The trip generation rates adjusted to a normal distribution with more reliability were: cars in private and semiprivate schools, and public transport and walking for public schools.

S. C. Wong (2005) The main objective of this is to presents a procedure for the estimation of multiclass origin-destination ~O-D! matrices for a highway network. The system consists of a number of vehicle classes. Demand is assigned to the network in a user equilibrium manner. Estimate the O-D demand matrices of all vehicle classes, which are consistent with the multiclass traffic counts that are observed directly in the network.

3. TRIP GENERATION ANALYSIS

The first phase of transportation planning process deals with surveys, data collection and inventory. The next phase is the analysis of the data so collected and building models to describe mathematical relationship that can be discern trip making behaviour. The analysis and model building phase start with the step known as trip generation. The trip generation aims at predicting the total number of trips generated and attracted to each zone of the study area. In other words this stage answers the questions to “how many trips” originate at each zone, from the data on house-hold and socioeconomic attributes. Here figure 1 shows types of trips.

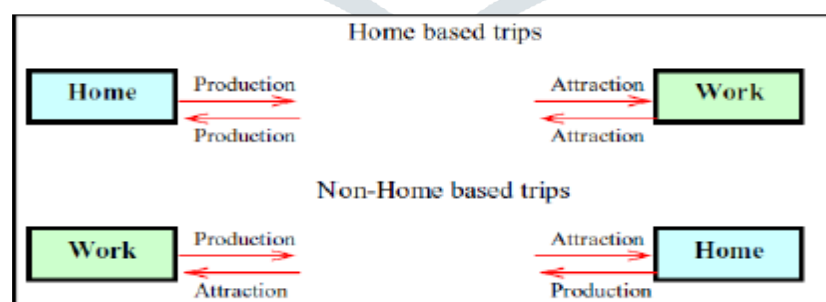


Figure 1 types of trips

3.1 TYPES OF TRIP GENERATION MODELS:

Figure 2 shows various types of trip generation models.

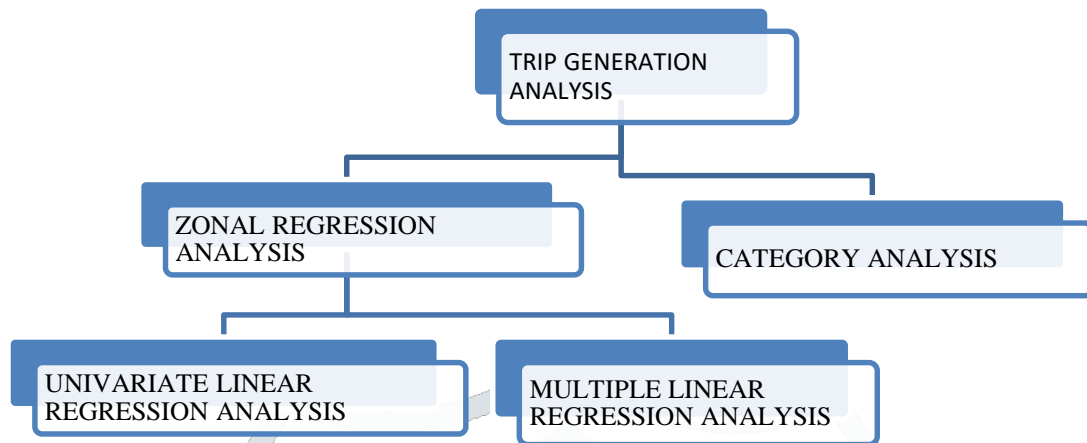


Figure 2 : trip generation model

3.2 REGRESSION MODEL FOR TRIP GENERATION :

If linear relation exist between dependent variable with one independent variable, then it termed a univariate linear regression analysis.

The independent variable can be the planning factors such as total population, number of households, family size, car ownership, etc. The dependent variable can be the no of zonal trip ends by mode and trip purpose.

If x and y are two variables, the linear model between x independent and y the dependent variable is of the form:

$$Y = a + bx \quad \dots (a) \quad \text{Where a and b are constants.}$$

This equation is also a type of curve and it can be solved by using the method of curve fitting.

The summation of equation (a) gives

$$\sum_{i=1}^n y_i = na + b \sum_{i=1}^n x_i \quad \dots (b)$$

Multiplying equation (a) by x

$$xy = ax + bx^2$$

its summation is

$$\sum_{i=1}^n x_i y_i = a \sum_{i=1}^n x_i + b \sum_{i=1}^n x_i^2$$

Multiplying equation (b) by $\sum_{i=1}^n x_i$

$$\sum_{i=1}^n x_i \sum_{i=1}^n x_i = na \sum_{i=1}^n x_i + b(\sum_{i=1}^n x_i)^2 \quad \dots (c)$$

Solving equation (b) and (c) we get

$$b = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2}$$

$$a = \bar{y} - b\bar{x}$$

$$r = \frac{\sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{\sqrt{(n \sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2)(\sum_{i=1}^n y_i^2 - (\sum_{i=1}^n y_i)^2)}}$$

if ,

r = 1, perfect relationship between variables.

r = 0, no relationship between variables

3.3 MULTIPLE LINEAR REGRESSION ANALYSIS :

Multiple linear regression technique is well known statically technique for fitting mathematical relationships between dependent and independent variables.

In the case of trip generation equations, the dependent variable is the number of trips and the independent variables are the various measurable factors that influence trip generation, like total population, number of households, family size, car ownership etc. The general form of the equation obtained is :

$$Y_p = a_1X_1 + a_2X_2 + a_3X_3 + \dots + a_nX_n + U$$

Where ,

$$Y_p = \text{number of trip generated for purpose } p$$

$X_1, X_2, \dots, X_n =$ independent variables (planning factor like total population, number of hh, family size etc.

$a_1, a_2, a_3, \dots, a_n =$ regression coefficient of the independent variables

U = disturbance term, which is constant

4 STUDY AREA PROFILE :

Vadodara, 3rd largest city in state of Gujarat with an area of around 300 sq. km and population of 16,66,649 as per the census 2011. The city has 3 flyovers and railway under bridges. The river Vishwamitri has 11 bridges interconnecting the city areas. The road network within the city is well developed in almost 70% of the area and caters around 80% of the city's total population. Also increased vehicle population has resulted in increased vehicular traffic on the roads. The major roads and intersections experience traffic congestion during peak hours. The vehicle population of 1.5 million census 2011 is expected to grow at a very high rate by year 2021. It may be due to the inadequate and inefficient mass transportation system.

Increase in vehicular population will further create problems of pollution and parking.

The study area is divided into 19 wards based on population data and ward size data. After conducting HH survey we came to know that there are internal trips (having both origin and destination within the study area), intra zonal trips (having both origin and destination in the same zone) and interzonal trips (trips travelling between two different zones). zoning of Vadodara city done in TransCAD software.

Figure 3 showing digitize 19 ward map using transcad.

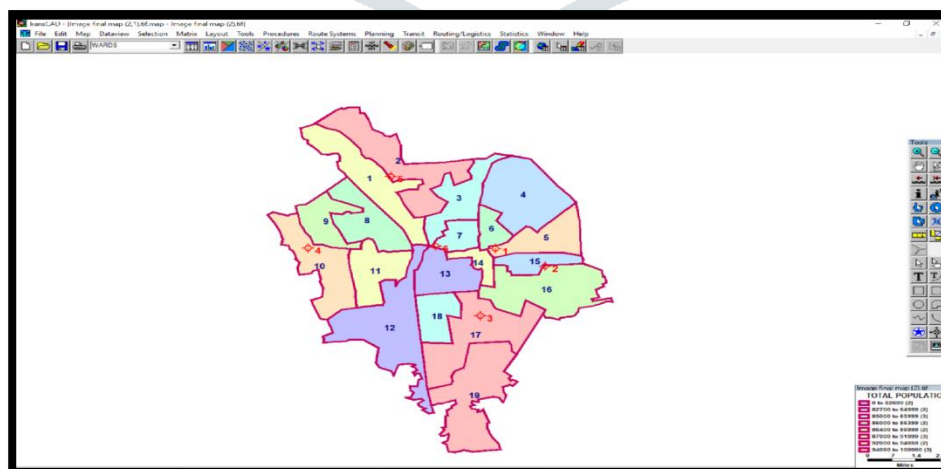


Figure : 3 zoning map of Vadodara city

4 DATA ANALYSIS :

In this study trip generation model is developed using linear regression analysis from the data collected. In the regression analysis , a dependent variable (Y) – total no of trips is considered and total 10 independent variables HH size, population ,male , female , income , 4 wheeler, 3 wheeler, 2 wheeler, bicycle and expenses are considered. other parameters asked during survey are found not very significant for trip generation model. Analysis is carried out using trscad software.

1) TRIP PRODUCTION MODEL FOR TOTAL TRIPS .

Here dependent field is total no of trips and 10 independent fields. independent field include HH size, HH population , total no of male, Total no of female , Total income, 4 wheeler , 3 wheeler , 2 wheeler , bicycle, expenses etc.

Figure 5 showing regression model generated using trscad.

$$Y = a + b_1x + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + b_6 x_6 + b_7 x_7 + b_8 x_8 + b_9 x_9 + b_{10} x_{10}$$

Where ,

Y = total no of trips generated within the study area

a & b = constant

x = independent variables

Regression equation :

$$Y = 102.805 + 10.819 (\text{HH Size}) - 6.979 (\text{HH Population}) + 2.116 (\text{Total Male}) + 7.30 (\text{Total Female}) + 0.630 (\text{Income}) + 0.124 (4W) - 5.865 (3W) + 0.135 (2W) + 0.160 (\text{Bicycle}) + 6.454 (\text{Expenses})$$

5 CONCLUSION :

Analysis of Vadodara helps to draw following conclusion

- ❖ The population growth rate in the last decade (2001 – 2011) is 22.22%
- ❖ The total number of trips were 21693 which includes all purposes like work , business, education, hospital and health, recreational trips.
- ❖ Home based trips are 6403.
- ❖ Non home based trips are 4452.
- ❖ Temporal variation also affect the trip during morning peak hour around 42 % trips are generated from the total trips.
- ❖ During night peak hour 38 % trips are generated.
- ❖ During off peak hour 20% trips are generated.

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