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TRIP GENERATION MODEL FOR THE CORE AREA OF THIRUVANANTHAPURAM CITY

Navya S V., S. Sanjay Kumar, Gymmy Joseph Kattoor

M.Tech Student, Govt.Rajiv Gandhi Institute of Technology, Kottayam Kerala, India

Scientist C, NATPAC, Trivandrum, Kerala, India

Professor, Govt. Rajiv Gandhi Institute of Technology , Kottayam, Kerala, India

ABSTRACT

The travel demand in Thiruvananthapuram city is continuously growing due to its employment in software sector, higher education and commercial activities. With intense developments in residential use and work centres spread over the city of Thiruvananthapuram there has been steep rise in mobility pattern of the people, putting the transport infrastructure of the city to great stress. Despite these prevailing problem, effort to make an empirical study on the city's urban transportation is significant. This paper attempts to develop a home-based trip generation model to examine the factors influencing the trip generation rate in the study area. A mathematical model is developed and the results show that trip generation rate is highly dependent on the employment status of the people.

Keywords: Trip generation model, Trip production model, Trip attraction model.

1.INTRODUCTION

The demand for transport derives from the needs of people to travel from one place to another to carry out the activities of their daily lives. Due to rapid growth in urban centers, the urban- transportation scenario faces a host of chronic problems like increase in accidents, ineffectiveness of public transport systems and increase in pollution.

Thiruvananthapuram, the capital city of Kerala is the second largest and most populous city in Kerala. The travel demand in the city is continuously growing due to its employment in IT sector, higher education and commercial activities. With fast-growing economy and spatial distribution of major activities, travel needs of people increase at a rapid pace. People in the city depend on various transportation modes to satisfy their needs. In order to understand the present transportation scenario of the city and to solve the allied transportation issues, there is a need of systematic transportation planning. The travel demand modeling starts with the process of development of trip generation models, which helps in understanding the pattern of trips developed in the study area and t has to estimate the same for a future year. The most common methods for trip generation are cross-classification (also referred to as category analysis) and multiple regression analysis. Regression analysis estimates the number of trips generated by a zone (dependant variable) as a function of a series of independent variables. Trip-generation refers to the production and attraction of trips between the internal and the external zones of the study area. The objective of the trip generation stage is to understand the reasons behind the trip making behavior and to produce mathematical relationships to synthesize the trip-making pattern based on observed trips, land use and household characteristics

2. SCOPE AND OBJECTIVES

The scope of the present work is confined to development of trip generation models for the Central Business District (CBD) area of Thiruvananthapuram. The following are the objectives:

- Collection of information on the project area, in detail, with regard to zonal data and household data
- Performing preliminary studies on trip making characteristics of various zones with regard to trip production and trip attraction
- Understanding the independent variables that affect the trip generation rate.
- Development of trip generation models for the study area based on household regression technique

3. LITERATURE REVIEW

An important part of the transport system planning morphology is the travel demand forecasting process. This process consists of four stages which are trip generation, trip distribution, choice modal split and traffic assignment. A basic assumption of the travel demand forecasting process is that there is a stable relationship between transport demand and urban activity system. (B.G. Hutchinson, 1974)

The merging and interaction of three disparate planning perspectives (the facility orientation of intercity highway planning, the traffic operations - oriented traffic engineering approach, and social consciousness of urban planning) produced the basic elements of the contemporary urban transportation planning process, incorporating technical analyses, widely based citizen participation, and a concern for a large variety of social, economic, and environmental impacts in addition to connectivity and accessibility.(C. S. Papacostas 2006)

Sarna et al (1992) adopted the traditional four-stage planning process of trip- generation, trip-distribution, modal split and trip assignment stages for the transport analyses and for the projection of transport demand for New Delhi. They adopted operational models for the purpose of transport analyses because operational models require minimal data for forecasting which is easily available and they developed trip-generation models based on the least-square regression analysis method. They concluded that the road-system would be insufficient to handle the future traffic. They recommended the use of Mass Rapid Transit Systems including High Capacity Bus-ways as the best alternative for future demands.

Anderson and Olander (2002) examined the practicality of using a single internal trip purpose to generate the production and attraction values for traffic analysis zones in small urban-community travel-models. This work focused on the reduction of data requirements, and complexity of the trip generation analysis. He concluded that, for modeling smaller-urban communities, there is no significant advantage in adopting multi-purpose modeling approaches, since the trip-productions and attractions for the traffic zones remained almost the same.

4. **STUDY AREA DETAILS**

The Thiruvananthapuram city region is selected as the study area. The study of transportation planning for the entire city is a tedious one and hence the CBD area of the city which encompasses two major stretches of the main city corridor, i.e., Ulloor to LMS stretch of NH 66 and MG road (from East Fort to LMS) was selected for the study. This area is selected by considering the route of the upcoming monorail (proposed Mass Rapid Transit) also.

The following thirteen wards form the study area and all have got having direct access to the test stretches as well.

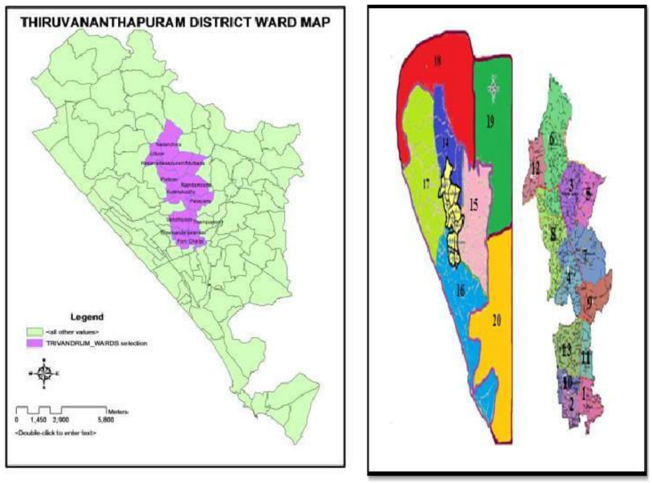

FIGURE1: STUDY AREA ZONING

TABLE 1 INTERNAL ZONES

ZONE NO	WARDNAME
1	Chalai
2	East Fort
3	Kesavadasapuram
4	Kunnukuzhy
5	Muttada
6	Nalanchira
7	Nandancode
8	Palayam
9	Pattom
10	Sreekandeswaram
11	Thampanoor
12	Ulloor
13	Vanchiyoor

5. ANALYSIS AND RESULTS

Software Used For Analysis

The analysis is done with the help of SPSS software. SPSS (Statistical Package for the Social Sciences) has now been in development for more than thirty years.

Preliminary Data Analysis

Various variables governing trip generation rates were identified from earlier studies. Those variables for each zone were sorted, coded and tabulated for analysis. The consolidated data showing average zonal household trips generated per day is given in Table 2. The employment opportunities in each internal zone are listed in Table 3. Population details of internals zones are listed in Table 6.

TABLE 2

AVERAGE TRIPS GENERATED PER HOUSEHOLD PER DAY PER ZONE

Zone number	Ward name	Number of houses interview ed	Total number of trips produced	Average Zonal Household Trip Generated per day
1	Chalai	50	342	7
2	Fort	30	402	13
3	Kesavadasapuram	30	318	11
4	Kunnukuzhy	30	224	7
5	Muttada	50	286	6
6	Nalanchira	50	394	8
7	Nandancode	30	286	10
8	Palayam	30	438	15
9	Pattom	30	334	11
10	Sreekandeswaram	50	330	7
11	Thampanoor	60	608	10
12	Ulloor	35	254	7
13	Vanchiyoor	50	414	8

TABLE 3 EMPLOYMENT OPPORTUNITIES IN EACH ZONE

Ward	Employment Opportunities
Chalai	9926
Fort	8640
Kesavadasapuram	2041
Kunnukuzhy	2279
Muttada	1275
Nalanchira	3534
Nandancode	3475
Palayam	14453
Pattom	3535
Sreekandeswaram	3871
Thampanoor	18392
Ulloor	1423
Vanchiyoor	1452

TABLE 4 POPULATION OF INTERNAL ZONES

Ward	Population
Chalai	13396
Fort	10444
Kesavadasapuram	22096
Kunnukuzhy	9708
Muttada	18880
Nalanchira	11648
Nandancode	14928
Palayam	9592
Pattom	28864
Sreekandeswaram	14576
Thampanoor	16752
Ulloor	10832
Vanchiyoor	9788

Trip Generation Model

Regression technique is a statistical method to fit relationship between one variable and one or more other variables. Once equation is developed using existing data, it can be used to predict the dependent variable. The salient features of this technique are:

1. The equation derived is purely empirical in nature.

2. The technique is based on the premise that the regression coefficients initially established will still remain unchanged in the future and can be used in the regression equation for predicting future travel.

Formulated Regression Models for Trip

Production and Attraction

The following types of models were developed as part of the exercise.

1. Disaggregated or household least square regression model
2. Aggregated or zonal least square regression models

i. Trip production model for all trips
ii. Trip production model for work trips iii. Trip production model for educational trips
iv. Trip production model for shopping trips
v. Trip production model for other trips

3. Trip attraction model

Trip generation models were formulated by taking two-third of the data obtained from household survey and the remaining one-third data was used for model validation. The formulated models are listed in Table 6.

TABLE 6
FORMULATED MATHEMATICAL MODELS.

	MODEL TYPE	MODEL	R Square
1	Disaggregated multiple regression model for trip production	$T=0.383+0.749A_{(5-20)} +0.466A_{(20-55)} + 0.354A_{55}+0.881H+0.062V+ 1.445E+0.573\ I$	0.541
2	Trip production model for all trips	$T_{all}=-9.661+5.208A_{(5-20)}+ 1.068A_{(20-55)}-0.502A_{55}+ 0.570H+0.577V+4.4165E$	0.988
3	Trip production model for work trips	$T_W=1.598+0.157V+1.068I+ 0.738X_3+0.896E+0.058\ A_{55}$	0.942
4	Trip production model for educational trips	$T_E= -0.855+2.496\ A_{(5-20)} - 1.0051\ A_{55}+0.671V$	0.917
5	Trip production model for shopping trips	$T_S= -0.305+0.109\ A_{(20-55)} + 0.434\ A_{55}-0.179V+0.215I$	0.615
6	Trip production model for other trips	$T_O= -1.597+0.230I +0.532H$	0.547
7	Trip attraction model	$T_A= -1.589+0.477C +0.130E$	0.573

T = Number of trips generated per household per day

T_{all} = average zonal household trip per day
T_W = average zonal household work trip per day
T_E = average zonal household educational trip per day
T_S = average zonal household shopping trip per day T_O = average zonal household other trips per day
T_A = % of trips attracted
$A_{(5-20)}$ = People in the household falling in the age group 5-20
$A_{(20-55)}$ = People in the household falling in the age group 20-55
A_{55} = people in the household with age above 55 H = household size
V = vehicle ownership per household
E = percentage of people employed per household I = household monthly income
C= Percentage of commercial establishments in the zones
E = Percentage of employment opportunities

Trip production model for all trips

Formulated trip production model for all trips is as in Eqn (1)

$$T_{all} = -9.661+5.208\ A_{(5-20)} +1.068\ A_{(20-55)} -0.502\ A_{55}+0.570H+0.577V+4.4165 \quad (1)$$

Findings from model

Average zonal household trip per day is found to be greatly influenced by people in the household falling in the age group 5-20 (student category), people in the household falling in the age group 20-55 (working group), household size, percentage of people employed per household and vehicle ownership per household. But the trip production rate seemed to be negatively influenced by the number of persons in the household having age above 55 (retired people). This is imperative to the study region as the area is occupied by a large number of people whose occupation is mostly in the service sector.

Comprehensive validation of the model

Overall model fit

The overall model fit is deemed good since R^2 = 0.988 which means 98.8% of the variance of the dependent variables can be explained by the model. Overall model fit is tabulated in Table 7.

TABLE 7
OVERALL MODEL FIT (MODEL 2)

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.994	0.988	0.964	0.3323

Goodness of fit

Samples from 13 samples are taken for validation. 't' test was performed for checking the goodness of fit. Observed value of't' was 4.2 against the tabled value of 4.303. Since the tabled value is greater than the observed t value, fitting of model is good. Figure 4 depicts the variation of predicted trips with observed trips.

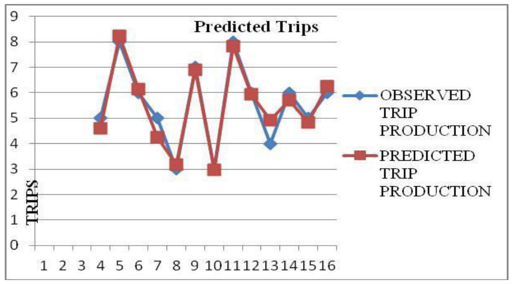

FIGURE 4 COMPARISON OF PREDICTED AND OBSERVED TRIPS PRODUCED

Trip attraction model

The formulated trip attraction model is as in Eqn (2)

$$T_A = -1.589+0.477C +0.130E \quad (2)$$

Findings from model

The percentage of trips attracted to each zones is found to be in a direct relationship with the number of commercial establishments and employment opportunities in that zone.

Overall model fit

The overall model fit is deemed good since $R^2 = 0.573$ which means 57.3% of the variance of the dependent variables can be explained by the model. Overall model fit is tabulated in Table 8.

TABLE 8
OVERALL MODEL FIT (MODEL 7)

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.757	0.573	0.402	4.0327

Goodness of fit

3 samples from 13 samples are taken for validation.

't' test is used for checking the goodness of fit. Observed value of't' was 0.993 against the tabled value of 4.303. Since the tabled value is greater than the observed t value, fitting of model is good.

Figure 4 depicts the variation of predicted trips with observed trips.

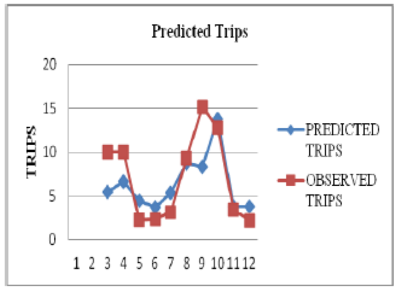

FIGURE 5: COMPARISON OF PREDICTED AND OBSERVED TRIPS ATTRACTED

6. CONCLUDING REMARKS

Trip production and attraction models were formulated and validated for the CBD area of Thiruvananthapuram. It has been found that trip production is a function of age group and employment rate while trip attraction is influenced by number of commercial establishments and employment opportunities of the zone. The models developed can be of effective use for a transport planner while formulating long term transportation options strategies for the city.

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