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# Analysis of Trip Generation Using Land Use Pattern

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**Abstract**

Transportation problem heighten with unbalancing of involvement and provision of transit system. Transportation system components attribute to continuously increasing travel demand, rapid urbanization, industrialization, haphazard growth of motor vehicle population, and unnecessary generating the trips. The termination of travel demand model is desirable simulation model for balancing the transportation system. Therefore, it is necessary to understand the several behavior of trip generation and four trip types respectively are work trip, education trip, business trip, and shopping trip calculated from home interview survey. The trip generation rates were determined for different purpose based on age, gender, profession, income, mode of transport, vehicle ownership, and starting time of trip. In this research paper present the trip generation model using land use pattern for metropolitan city.

Keywords: *Travel Demand, Trip Generation, Land Use Pattern, Transit System*

## 1. Introduction

Travel demand modeling is the process of urban transport planning. It is the four phase of transport planning process which consists of Trip Generation, Trip Distribution, Model Split, and Traffic Assignment. Travel demand had haphazard growth in metropolitan city as equating to supply. Unbalanced trips accounts the fall in transport planning due to drastic development in IT sector, Employment Opportunity, higher education, urban areas attraction, and Industrialization. It campaigns change in
production and attraction rate of trip varies with location, land usage, and behavior of influenced parameter. Trip attraction is art of planning to attract the trips from different land use occupy with different explanatory variables such as age, gender, income, travel cost, and purpose of trips like work, education, business, shopping, and others. Commonly work trips

are based on the category of profession like private employee, public employee, and labor. Educational trips involve only student, business trips involves only businessman, but shopping trips are the attracted trip dominated by all the trip makers. Objective of the research to understand the several behavior of trip generation and behavior of four types of trips like work trip, education trip, business trip, and shopping trip. The influencing parameters affecting on land use pattern when it generates the trips. When discrete behavior of parameter it generates the unnecessary trips that effect on whole transport system and transport system may be unbalanced i.e. causes disturbing the demand and supply of private and public transport system. Travel demand model is the process of urban transport planning which established the relation between travel and land use by Mitchell R.B. et al. (1954). They discussed traffic was function of land use. Travel demand model originally developed during 1954 then many research doing so theoretically but now a day's actual implement in recently. Kontadinos G. Goulias et al. (1991) discussed the different methods for estimation of trip generation and chaining assignment. They examine the behavior of trip generation and trip chaining between two areas had different land usage and transportation system. They worked on mandatory activity and discretionary activity based on trip purpose such as work, school, travel time, location. Author evaluates the independent different models using regression model based on activity. Ahmed Hamdy Ghareib (1996) evaluates the different travel pattern Intrazonal, Intrazonal, and external trips i.e. II, IE, EI, and EE which are detailed defined by Bryton in his research 1978. To estimate the travel cost in intrazonal and external trip using TransCAD 1990. Calibrate the cost variable using TransCAD with the Maximum likelihood model and doubly constraint gravity model and Elimination of RMSE and MAD error using Chi Square test for goodness of fits. Tae Youn Jang (2003) discussed the relation among travel mode, activity, and travel pattern. The result showed that select the travel mode based on decision factor to perform an activity on the basis of travel pattern. Allocate the travel modes based on influencing parameter by personal attributes and analysis using multiple regression and chi square and probability. Wen Huiying

et al. (2010) developed the trip distribution model using potential theory like as gravity model and calibrates the influenced parameter using calibration method. Verify the cogency of model using binary regression analysis in SPSS 9.0 statistical software packages. Evaluation and calibration of trip distribution model in gravity model and Furness method. Meiwu AN et al. (2012) formed the household and employment distribution model and introduced the new transportation modeling framework. Land use model test using iterative approach for the fits best with various variables influencing to distribution of trips in small urban areas and calibrate the model using base year data used for future trip distribution estimation. Leta F. Huntsinger et al. (2013) describe worked on temporal stability model for future period using cumulative logistic regression model for trip generation analysis. In his research introductory part discuss the different analysis methods are zonal and household regression model and cross classification model for allowing the analyst considering relation of multiple independent variables i.e. socio economic, demographic, and individual characteristics for evaluation. Balazs Horvath et al. (2015) present the TDM application in urban public transport system helps in estimation of sample size for forecasting the travel demand. Author discussed in his PhD, estimate the obligatory sample size for analysis of travel demand in urban areas. Multivariate regression analysis applied to prepare the traffic demand prediction model for public transport corridor by matrix estimation obtained with good result. Xueyan wei et al. (2015) considering interaction effect among several paths of corridor are not taken in to consideration of predict separately in each direction. Research found associative regression prediction has higher accuracy than individual regression prediction. Benjamin R. Sperry et al. (2016) developed the rates for medium and small sized travel demand model. Research carried activity based approach such as HBW, HBNW, and NHB for small and medium city of Texas. From his research finding the trip attraction rates varied across area types and indicated that population density contributed to the trip attraction characteristics of workplace establishments. They concluded population density in the location surrounding the establishment also plays a role. Multi-linear regression model used to estimation the trip generation model. In this research paper presents statistical data based on household characteristic and socio-economic characteristic of the four zones of Nagpur city. The trip generations models are develop for different trip purpose. The multi-linear regression equations are developing for predicting future trip generation rate.

## 2. Mechanism and Methodology

### 2.1 Sample size and area

Travel demand had spectacular growth in metropolitan city due to development in IT Hub, growth in employment Opportunity, higher education, urban areas attraction, and Industrialization it causes change in production and attraction rate of trips varies with location and land usage. Research selected Nagpur Metropolitan city as a study area. Nagpur urban area developed according to local government body Nagpur Municipal Corporation (NMC) and Nagpur improvement Trust (NIT). Nagpur urban had 364.66 sq.km out of 986 sq.km area which divided in 10 zones and select only 4 zones for research such as Laximi Nagar (Zone 1), Dharampeth (Zone 2), Hanuman Nagar (Zone 3), and Dhantoli (Zone 4). Road network of city is spread in radial and peripheral pattern. For evaluation of deportment of different parameter, research is conducted through household survey by face to face interview for data collection. In this survey, the home of the respond and the questionnaires are filled. According to Bureau of public road, the procedure manual provides the guideline, Vol. 2B.Washington, 1956. As population of four zones are in between 150,000 to 300,000 based on guideline minimum sample size taken 1 in 35 households. As household found to be 8407 numbers in Laxmi Nagar and home interview survey carried 240 households, in Dharampeth zone found 16172 household and survey carried 462 households, in Hanuman Nagar found 9485 households and survey carried 271 households, in Dhantoli zone found 21216 households and survey carried 606 households.

### 2.2 Statistical Data

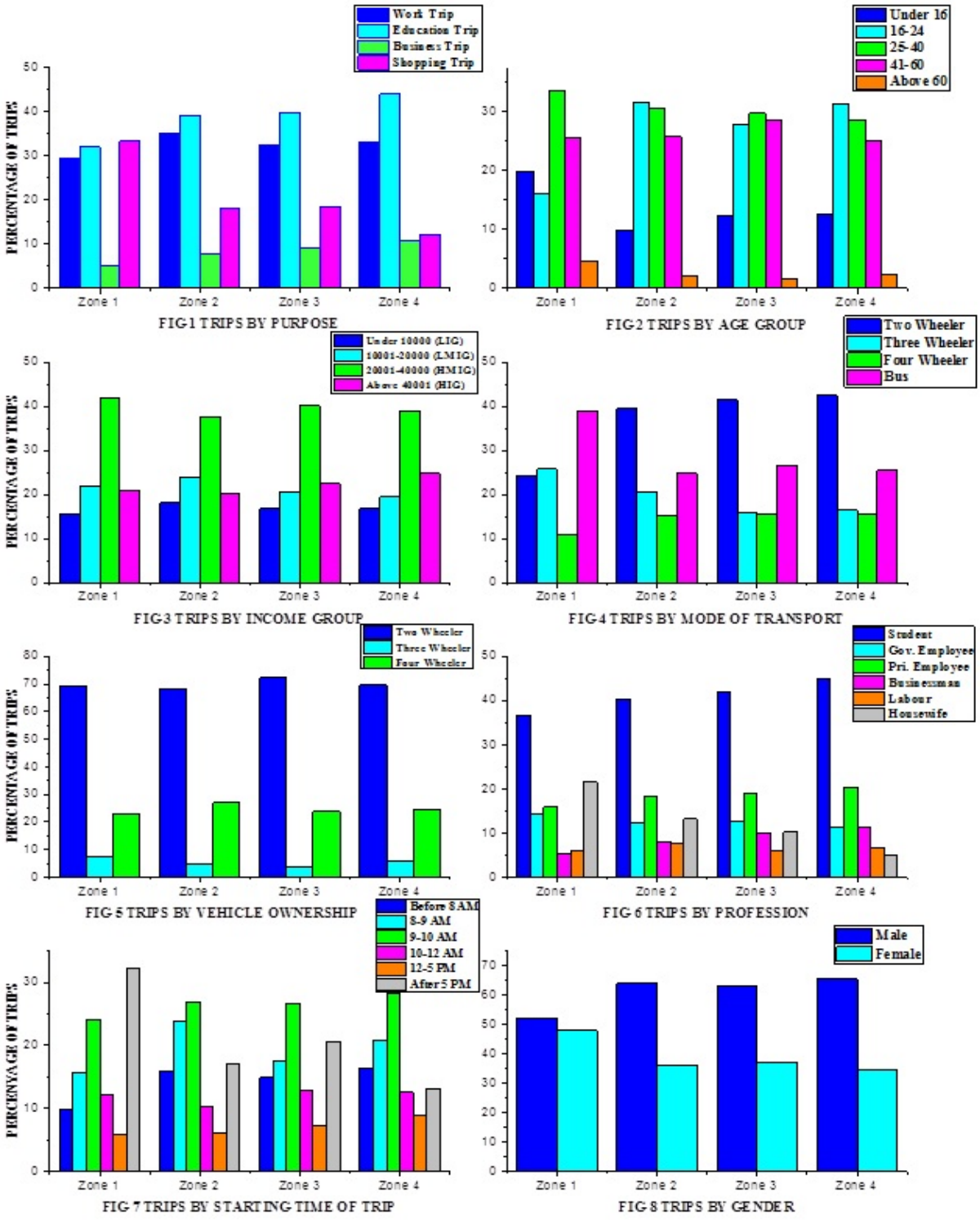
Various trips generate basically from home for different purpose like business, education, shopping, and work. These trips are distributed in different zones or land usage. Statistical figure depicts the fluctuation in trips due to different purpose from different zones. These trips generated due to gender, age group, and income group, mode of transport, vehicle ownership, profession, and starting time of trip.

In this paper evaluation of the dominated factors as socio-economic, household characteristic and establish the multi-linear regression model. Percentage of among the trips educational trip 38.58 % has highest percentage than other trips and follows work trip (32.53 %), shopping trip (20.83 %), and business trip (8.06 %) from all the zones i.e. Laxmi Nagar, Dharampeth, Hanuman Nagar, and Dhantoli.

The entire figure shows the variation in trips according to different purpose from different zones.

Educational trips generate mostly student who educate under the age of 16 to 24 age groups. Education trip have higher percentage from all the zones due to higher the student percentage in each zone and these trip are relevant between the ages 16 to 24 it means student trip significant only education purpose. Work trip have less percentage

than educational trip in all the zones. Most influenced variables to work trip are age group, income group, and profession of trip makers. Generation of trip for work purpose due to affecting different age between 25 to 60




Year old trip makers, 10001-20000 (LMIG), 20001-40000(HMIG), and above 40000 (HIG) and profession of trip maker such as government employees, private employees, and labors. Government employee, Private employee, and labor have more trips than businessman and housewife trip makers. Business trip has fewer trips than educational,

work and shopping trips from all the zones. Businessman trip maker attribute all the trips for business purpose with respective to age group, income group, and profession. Based on age group generating the business trips by 24-40, 40-60, and above 60 years age occurs more trips for business purpose. Also trips are depends on income of trip makers such as under 10000 (LIG), 10001-20000 (LMIG), 20001-40000 (HMIG), and above 40000 (HIG). Higher the income, higher will be the trips by private mode of transport such as four wheelers, two wheelers and higher the percentage of vehicle ownership such as two wheelers and four wheelers. Shopping trips have fewer trips than education and work trip but more trips than business purpose. Shopping trips generated due to affecting most dominated variables are age, income, and profession. Generally, Housewife trips mostly generated for shopping purpose; these trips are generated in more attracting areas than other land use or zones. Gender wise trips generally male trips generated for work, education , and business purpose by using private mode of transport in peak hours and female trips mostly for shopping purpose using intermediate and public mode of transport in evening peak hour. The government employees and private employees are used private mode of transport and student, labor, and housewife are used intermediate mode of transport.

Various types of statistical software can be explored for data analysis. Statistical Package for the Social Sciences (SPSS) is one of the most broadly used in wide range of procedures and tests used in statistics. Regression analysis done using Enter method used for chooses the independent variable. In the statistics results set the 95 % of confidence interval level. In stepping method criteria use 0.05 entry of probability of F-values and 0.10 removal of probability of F-values. R2 = 0.98631which shows the 98.63% percentage of trips by explanatory variables depends on dependent variable.

**Table 1 general trip and its coefficients**

| Trips | Model (Y) | Intercept Coefficient | Influencing Variable Coefficient | | |
|---|---|---|---|---|---|
| | | $B_0$ | $B_1$ | $B_2$ | $B_3$ |
| General Total Trips ($T_{GTT}$) | $Y_{(WT)}$ | 6.253E+01 | 1.913 | 0.26 | 0.011 |
| | $Y_{(ET)}$ | 1.008E+02 | .089 | 1.630 | -.279 |
| | $Y_{(BT)}$ | -7.637E+00 | -.476 | 0.968 | -.187 |
| | $Y_{(ST)}$ | 1.140E+02 | 0.715 | -1.324 | 1.074 |
| $R^2$= 0.98631 | | | | | |

Table 1 show the general trip generation model coefficients of business trip, education trip, shopping trip, and work trip which developed in SPSS package software. Positive coefficients indicate that directly proportional to the purpose of trip, it means independent variable of coefficient increase with increasing purpose of trip rate. Negative coefficients indicate that independent variable of coefficients decrease with decreasing purpose of trip rate i.e. inversely proportional to each other. B0 is the constant of purpose of trip intercept.

The estimated general trip generation model using multiple linear regression analysis is as follows. Business Trips (BT), Educational Trips (ET), Shopping Trips (ST), and Work Trips (WT) depends on the predictors X9, X10, and X30 variables and their coefficients B1, B2, and B3 respectively and it mentioned in table 1

$$Y_{(GTT)} = B_0 + B_1 * X_9 + B_2 * X_{10} + B_3 * X_{30} \ldots (1)$$

Where, Y– the dependent variable (trips for Business Trips (BT), Education Trips (ET), Shopping Trips (ST) and Work Trips (WT) purpose); $X_9$, $X_{10}$, and $X_{30}$ – independent variables (10001-20000 (LMIG), 20001-40000(HIG), after 5 PM); $B_1$, $B_2$, and $B_3$ are the coefficients of $X_9$, $X_{10}$, and $X_{30}$ respectively of all the trips. $B_0$ is the constant of general trip intercepts

**Table 2 Gender wise trips and its coefficients**

| Trips | Model (Y) | Intercept Coefficient | Influencing Variable Coefficient | | $R^2$ |
|---|---|---|---|---|---|
| | | $C_0$ | $C_1$ | $C_2$ | |
| Trips by Gender ($Y_{TG}$) | $Y_{(WT)}$ | -5.336E+01 | 0.547 | .164 | 0.7781 |
| | $Y_{(ET)}$ | 1.896E+02 | 0.359 | -.229 | 0.9285 |
| | $Y_{(BT)}$ | 8.287E+01 | 0.076 | -.199 | 0.8187 |
| | $Y_{(ST)}$ | -2.192E+02 | 0.018 | 1.265 | 0.9954 |

General multi-linear regression model for gender wise trips with different purpose are estimated for Business trip (BT), Educational Trip (ET), Shopping Trip (ST), and Work Trip (WT). Gender wise trips have two most dominated factors are Male (X1) and Female (X2) along their coefficients are C1, and C2 respectively and C0 is the constant of trip intercept which mentioned above table 2. R2 value changes with change of trip purpose which means variation in dependent variable greatly explained by the independent variable entered in to the regression model , R2 = 0.818 of business trips which shows that the independent variables entered in to the model explain about 81 % variation in the dependent variable, R2 = 0.928 for educational trips which reported that 92 % variation in educational trip, R2 = 0.995 for shopping trips which indicate that 99.5 % variation in shopping trip, and R2 = 0.778 for work trips which shows that 77.8 % fluctuation in work trip by most dominated common explanatory variables are male and female .

$$Y_{(TG)} = C_0 + C_1 * X_1 + C_2 * X_2 \quad \ldots (2)$$

Where, Y– the dependent variable (trips for business trip (BT), education trip (ET), shopping trip (ST) and work trip (WT) purpose); $X_1$ and $X_2$– independent variables (Male and Female), $C_1$, and $C_2$– coefficients of dependent variable w.r.t. Business Trip, Educational Trip, Shopping Trip, and Work Trip.$C_0$ is constant of gender wise trip intercept.

**Table 3 variation of the trips model and its coefficients**

| Trips | Model | Intercept Coefficient | Influencing Variable Coefficient | | |
|---|---|---|---|---|---|
| | | $D_0$ | $D_1$ | $D_2$ | $D_3$ |
| Profession ($Y_{TP}$) | $Y_{(WT)}$ | -1.439E+02 | 0.811 | 2.541 | 0.152 |
| | $Y_{(ET)}$ | -2.621E+01 | 0.951 | .925 | -0.223 |
| | $Y_{(BT)}$ | -3.110E+01 | 0.376 | -.096 | -0.193 |
| | $Y_{(ST)}$ | 1.345E+02 | 0.095 | -2.752 | 1.334 |
| Age Group ($Y_{TAG}$) | $Y_{(WT)}$ | -1.522E+02 | 0.945 | .737 | 3.209 |
| | $Y_{(ET)}$ | 4.116E+02 | -0.222 | -.097 | -3.208 |
| | $Y_{(BT)}$ | 2.521E+02 | -0.404 | -.278 | -2.971 |
| | $Y_{(ST)}$ | -4.728E+02 | 0.519 | 1.845 | 8.313 |
| Income Group ($Y_{TIG}$) | $Y_{(WT)}$ | 6.612E+01 | 1.86 | .331 | -0.102 |
| | $Y_{(ET)}$ | 5.531E+00 | 1.502 | -.269 | 2.713 |
| | $Y_{(BT)}$ | -7.150E+01 | 0.471 | -.306 | 1.819 |
| | $Y_{(ST)}$ | 4.807E+02 | -4.724 | 5.987 | -10.443 |
| Mode of Transport ($Y_{TMT}$) | $Y_{(WT)}$ | 2.703E+01 | 0.693 | 1.467 | -0.197 |
| | $Y_{(ET)}$ | 2.474E+02 | -0.297 | .836 | -0.03 |
| | $Y_{(BT)}$ | 9.781E+01 | -0.384 | .115 | 0.028 |
| | $Y_{(ST)}$ | -2.982E+02 | 0.755 | 1.148 | 1.023 |
| Vehicle Ownership ($Y_{TOV}$) | $Y_{(WT)}$ | -1.164E+02 | 0.001 | .167 | 3.139 |
| | $Y_{(ET)}$ | 6.341E+02 | -0.1 | -3.996 | -1.932 |
| | $Y_{(BT)}$ | 3.915E+02 | -0.076 | -2.659 | -2.199 |
| | $Y_{(ST)}$ | -1.650E+03 | 1.66 | 12.135 | 8.655 |
| Staring Time of Trip ($Y_{TST}$) | $Y_{(WT)}$ | -5.618E+01 | 1.429 | .051 | 0.062 |
| | $Y_{(ET)}$ | -2.938E+01 | 1.855 | -.039 | -0.267 |
| | $Y_{(BT)}$ | -5.760E+01 | 0.785 | -.039 | -0.194 |
| | $Y_{(ST)}$ | 1.791E+02 | -1.037 | .056 | 1.085 |
| $R^2$= 98625 | | | | | |

Equation (3) shows general trip generation model for profession wise trips. Most dominant predictors in profession wise trip generation model are student, labor, and housewife for different purpose like business, education, shopping, and work. Government employees, private employees and businessmen are the excluded variables from analysis by SPSS software package due to it has perfect goodness of fit and very less impact of independent variable on dependent variable and it reject at the 95 % level of significance.

$$Y_{(TP)} = D_0 + D_1 * X_{19} + D_2 * X_{23} + D_3 * X_{24} \quad \text{... (3)}$$

Where, T(TP) – dependent variable of profession wise trips (Business Trip (BT), Educational Trip (ET), Shopping Trip (ST), and work trip (WT) purpose); X19, X23, and X24 are the independent variable; D1,D2, and D3 are the coefficients of independent variables of X19, X23, and X24 respectively; D0 is the constant profession wise trips intercept

Equation (4) shows general trip generation model for different age group. Predictors in the equation are X4, X6, and X7 and other variables in the age group are X3 and X5 are the excluded variable from regression analysis due to it is highly correlate and it has perfect goodness of fit.

$$Y_{(TAG)} = D_0 + D_1 * X_4 + D_2 * X_6 + D_3 * X_7 \quad \text{... (4)}$$

Where, $Y_{(TAG)}$ = dependent variable of age group wise trips (Business Trip (BT), Educational Trip (ET), Shopping Trip (ST), and work trip (WT) purpose); $X_4$, $X_6$, and $X_7$ are the independent variable; $D_1$,$D_2$, and $D_3$ are the coefficients of independent variables of $X_4$, $X_6$, and $X_7$ respectively; $D_0$ is the constant of age group wise trips intercept.

Equation (5) indicates general trip generation model for different Income group. Equation indicates $X_9$, $X_{10}$, and $X_{11}$ are predictors in income group wise trip generation model. But $X_8$ income group has perfect correlation with dependent variable i.e. excluded variable from trip generation model of income group.

$$Y_{(TIG)} = D_0 + D_1 * X_9 + D_2 * X_{10} + D_3 * X_{11} \quad \text{… (5)}$$

Where, $Y_{(TIG)}$ = dependent variable of income group wise trips (Business Trip (BT), Educational Trip (ET), Shopping Trip (ST), and work trip (WT) purpose); $X_9$, $X_{10}$, and $X_{11}$ are the independent variable; $D_1$,$D_2$, and $D_3$ are the coefficients of independent variables $X_9$, $X_{10}$, and $X_{11}$ respectively; $D_0$ is the constant of income group wise trips intercept.

Equation (6) shows general trip generation model for different mode of transport. $X_{12}$ is the not entering in the trip generation model of mode of transport because of perfect fit and highly correlate with dependent variables. $X_{13}$, $X_{14}$, and $X_{15}$ are influenced variable i.e. predictors in the model.

$$Y_{(TMT)} = D_0 + D_1 * X_{13} + D_2 * X_{14} + D_3 * X_{15} \quad \text{… (6)}$$

Where, $Y_{(TMT)}$ = dependent variable of mode wise trips (Business Trip (BT), Educational Trip (ET), Shopping Trip (ST), and work trip (WT) purpose); $X_{13}$, $X_{14}$, and $X_{15}$ are the independent variable; $D_1$,$D_2$, and $D_3$ are the coefficients of independent variables $X_{13}$, $X_{14}$, and $X_{15}$ respectively; $D_0$ is the constant of mode wise trips intercept.

Equation (7) develops for general trip generation model for vehicle ownership from household trips. There is no goodness fit. All the variables in equation (7) are the predictors. It means vehicle ownership is the most dominant trips for trip generation.

$$Y_{(TVO)} = D_0 + D_1 * X_{16} + D_2 * X_{17} + D_3 * X_{18} \quad \text{… (7)}$$

Where, $Y_{(TVO)}$ = dependent variable of vehicle ownership trips (Business Trip (BT), Educational Trip (ET), Shopping Trip (ST), and work trip (WT) purpose); $X_{16}$, $X_{17}$, and $X_{18}$ are the independent variable; $D_1$,$D_2$, and $D_3$ are the

coefficients of independent variables $X_{16}$, $X_{17}$, and $X_{18}$ respectively; $D_0$ is the constant of vehicle ownership trips intercept.

Equation (8) general trip generation model which shows starting time of trips in a day. $X_{27}$, $X_{29}$, and $X_{30}$ are entering variables in regression analysis for trip generation model. $X_{25}$, $X_{26}$, and $X_{28}$ are the excluded variables in trip generation model from SPSS analysis Package.

$$Y_{(TST)} = D_0 + D_1 * X_{27} + D_2 * X_{29} + D_3 * X_{30} \quad \ldots (8)$$

Where, $Y_{(TT)}$ = dependent variable of starting time of trips (Business Trip (BT), Educational Trip (ET), Shopping Trip (ST), and work trip (WT) purpose); $X_{27}$, $X_{29}$, and $X_{30}$ are the independent variable; $D_1$,$D_2$, and $D_3$ are the coefficients of independent variables $X_{27}$, $X_{29}$, and $X_{30}$ respectively; $D_0$ is the constant of starting time wise trips intercept.

## 3. Multi-Collinearity Statistics Test

Multi-Collinearity statistics explain in terms of tolerance and Variable Inflation Factor (VIF). VIF is the simple diagnostics for detecting the overall collinearity problems that do not involve the intercept. From the regression analysis, obtained the VIF value of each explanatory variable less than 10 and tolerance value greater than 0.1. It can be concluded that there is non-collinearity between them. When VIF is greater than 10 and tolerance value is less than 0.1 then there is no practical difference in collinearity as shown in table 4.

**Table 4 shows multi-Collinearity statistics (Tolerance and VIF)**

| Model Trips | Explanatory Variables | Collinearity Statistics | |
|---|---|---|---|
| | | Tolerance | VIF |
| Total General Trips | $X_9$ | .896 | 1.116 |
| | $X_{10}$ | .921 | 1.085 |
| | $X_{30}$ | .956 | 1.046 |
| Trips by Gender | $X_1$ | .575 | 1.738 |
| | $X_2$ | .575 | 1.738 |
| Trips by Profession | $X_{19}$ | 0.558 | 1.791 |
| | $X_{23}$ | 0.997 | 1.003 |
| | $X_{24}$ | 0.559 | 1.787 |
| Trips by Age Group | $X_4$ | .084 | 11.937 |
| | $X_6$ | .749 | 1.336 |
| | $X_7$ | .086 | 11.647 |
| Trips by Income Group | $X_9$ | .771 | 1.297 |
| | $X_{10}$ | .528 | 1.892 |
| | $X_{11}$ | .556 | 1.798 |
| Trips by Mode of Transport | $X_{13}$ | 0.202 | 4.94 |
| | $X_{14}$ | 0.329 | 3.039 |
| | $X_{15}$ | 0.179 | 5.581 |
| Trips by Vehicle Ownership | $X_{16}$ | .975 | 1.026 |
| | $X_{17}$ | .517 | 1.933 |
| | $X_{18}$ | .527 | 1.897 |
| Trips by Starting Time of Trip | $X_{27}$ | .790 | 1.266 |
| | $X_{29}$ | .801 | 1.248 |
| | $X_{30}$ | .849 | 1.178 |

## 4. Comparison of Data

Model verification is the test to confirm model ability to predict the future behavior of explanatory variables or and trips. To verify the general trip generation model and various types of trips that generated due to purpose of trips. In the comparison, predicted trips estimated from the trip generation regression model compare with observed trips from different zones for different purpose shown in table below. The comparison was done by comparing the value from observed value and predicted value for the same by using methodology presented in this paper. Data of (8) equation model trips we are taken for comparison. Table no (5) and Fig. (9) Shows the comparison of observed value and predicted trip for work trip, education trip, business trip, and shopping trip. Table no (5) and Fig. (9) shows the comparison between observed trip and predicted trip for (8) models from equation (1), (2), (3), (4), (5), (6), (7), and (8). The percentage difference is found to be well within ± 5 %.

**Table 5 show the comparison of observed trip and predicted trip**

| Model Trips | Zone | Work Trip | | Educational Trip | |
|---|---|---|---|---|---|
| | | Obs. trips | Pred. Value | Obs. trips | Pred. Value |
| General Trip | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |
| Trips by Gender | Zone 1 | 229 | 228.63 | 249 | 249.31 |
| | Zone 2 | 261 | 250.24 | 290 | 298.89 |
| | Zone 3 | 248 | 256.53 | 305 | 297.96 |
| | Zone 4 | 224 | 226.61 | 297 | 294.84 |
| Trips by Age Group | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |
| Trips by Income Group | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |
| Trips by Mode of Transport | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |
| Trips by Vehicle Ownership | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |
| Trips by Starting Time of Trip | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |
| Trips by Profession | Zone 1 | 229 | 229 | 249 | 249 |
| | Zone 2 | 261 | 261 | 290 | 290 |
| | Zone 3 | 248 | 248 | 305 | 305 |
| | Zone 4 | 224 | 224 | 297 | 297 |

| Model Trips | Zones | Business Trip | | Shopping Trip | |
|---|---|---|---|---|---|
| | | Obs. trips | Pred. Value | Obs. trips | Pred. Value |
| General Trip | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |
| Trips by Gender | Zone 1 | 39 | 39.3 | 259 | 258.77 |
| | Zone 2 | 57 | 65.63 | 134 | 127.25 |
| | Zone 3 | 70 | 63.17 | 141 | 146.35 |
| | Zone 4 | 72 | 69.91 | 82 | 83.64 |
| Trips by Age Group | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |
| Trips by Income Group | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |
| Trips by Mode of Transport | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |
| Trips by Vehicle Ownership | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |
| Trips by Starting Time of Trip | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |
| Trips by Profession | Zone 1 | 39 | 39 | 259 | 259 |
| | Zone 2 | 57 | 57 | 134 | 134 |
| | Zone 3 | 70 | 70 | 141 | 141 |
| | Zone 4 | 72 | 72 | 82 | 82 |

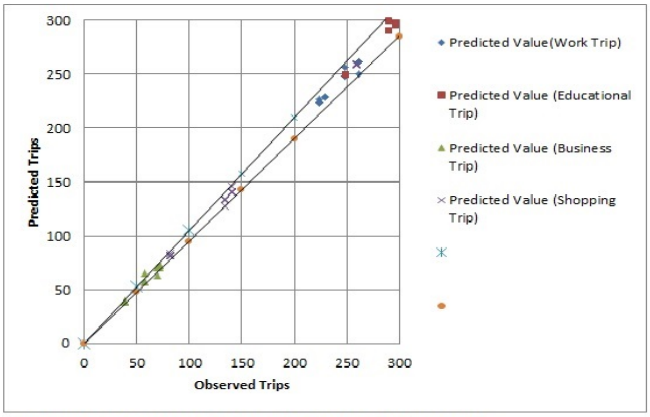



**Fig. 9 Shows Variation of Observed Trips and Predicted Trips**

## 5. Summary and Conclusion

The government employees and private employees are generally using private mode of transport in peak hours. The trip depends on explanatory variables like age, gender, profession, income, mode of transport, vehicle ownership, and starting time of trip. The student, labor, and housewives are used intermediate public mode of transport. The male are identified generally using private mode for business, work, and education purpose. The female are using mostly for shopping purpose. Higher income groups are using private mode of transport and it has enhanced the vehicle ownership rate. Travel demand forecasting model can be used to estimate different trips and trips behavior demanding for future. Trip generation model are helps to predicting the trips in future using equation (1), (2), (3), (4), (5), (6), (7), and (8). Base on the analysis of trip generation and parameter used in this research work following conclusion are made

The trips depend up on the explanatory variable like mode of transport, vehicle ownership, gender and destination of trip.

- The student trips are more significant to education purpose.
- Government employees and private employees generally used private mode of transport in peak hours. Whereas, the student, labor, and housewives generating the trips using intermediate and public mode of transport.
- Higher income group used private mode of transport and it has higher the vehicle ownership rate.
- The comparison are made well within a ± 5%

### Nomenclatures

Explanatory variables used in the model:
X1= Trips by Male
X2= Trips by Female
X3= Trips by age group under 16 age
X4= Trips by age group 16-24 age
X5= Trips by age group 25-40 age
X6= Trips by age group 41-60 age
X7= Trips by age group above 60 age
X8= Trips by Income below 10000 (LIG)
X9= Trips by Income 10001-20000 (LMIG)
X10= Trips by Income 20001-40000 (HMIG)
X11= Trips by Income above 40000 (HIG)
X12= Trips by mode of transport i.e. Two Wheeler
X13= Trips by mode of transport i.e. Three Wheeler
X14= Trips by mode of transport i.e. Four Wheeler
X15= Trips by mode of transport i.e. Bus
X16= Trips by Vehicle Ownership i.e. Two Wheeler

X17= Trips by Vehicle Ownership i.e. Three Wheeler
X18= Trips by Vehicle Ownership i.e. Four Wheeler
X19= Trips by profession i.e. Student
X20= Trips by profession i.e. Government Employee
X21= Trips by profession i.e. Private Employee
X22= Trips by profession i.e. Businessman
X23= Trips by profession i.e. Labor
X24= Trips by profession i.e. Housewife
X25= Trips by time i.e. before 8 AM
X26= Trips by time i.e. 8-9 AM
X27= Trips by time i.e. 9-10 AM
X28= Trips by time i.e. 10-12 AM
X29= Trips by time i.e. 12-5 PM
X30= Trips by time i.e. after 5 PM

Dependent variable used in the model;

Y(BT) = Trips for Business purpose
Y(ET) = Trips for Education purpose
Y (ST) = Trips for Shopping purpose
Y(WT) = Trips for Work purpose
Y(GTT) = Trips by general total trips
Y(TG) = Trips by gender wise
Y(TP) = Trips by Profession
Y(TAG) = Trips by age group
Y(TIG) = Trips by income group
Y(TMT) = Trips by mode of transport
Y(TVO) = Trips by vehicle ownership
Y(TST) = Trips by starting time of trip

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