MULTI – REGRESSION ANALYSIS TO DEVELOP TRIP GENERATION AND ATTRACTION MODELS FOR HYDERABAD METROPOLITAN DEVELOPMENT AUTHORITY AREA

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ABSTRACT

Travel demand modeling is an important tool in Transportation Planning for forecasting travel characteristics into the future. In general, Travel Demand Forecast Model is defined as a systematic process of translating demand and supply into future projections of travel demand. First Generation of Transportation Models evolved in 1950s. Since then, different models are developed based on different criteria and requirements. Based on the level of analysis required, the transportation models are divided into Macroscopic, Mesoscopic and Microscopic models. Macroscopic models evaluate large groupings of people/vehicles, covering large geographical area focusing on single time period (day or peak hour). Mesoscopic evaluate smaller groups and time slices and are useful when conditions change during a time period. Microscopic and Micro-simulation models evaluate individual people or vehicles and are useful when individual or small groups of individual behaviour affect the system. In this paper an attempt have made to develop Trip Generation and Attraction Models for Hyderabad Metropolitan Development Authority Area to estimate the horizon year trips in order to meet the future travel demand and the same was achieved.

Key words: Transportation planning, travel demand, transportation supply, transportation survey, methodology of transport modelling, trip-based travel demand models, Etc

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1. INTRODUCTION
Transport is pivotal and shapes many aspects of human living in several ways. It plays crucial role in meeting the needs and mobility of goods and people as well. It also enables access to opportunities. It further plays critical role in shaping all facets of community’s social and economic fabric. It has profound impact on economy, development and quality of life of the communities. The liberalization of our economy has brought home the urgency of recognizing that an efficient transportation system is necessary for increasing productivity and enabling the country to complete effectively in the market. The transport system in India comprises a number of distinct services primarily grouped as railways, roads, ports, airports, and available modes classifies as roads transport, inland water transport, coastal shipping, and airlines. However, railways and roads are the dominant means of transport carrying more than 95% of total traffic generated in the country and would continue to dominate the transport landscape in the foreseeable future. Furthermore, other modes such as coastal shipping and inland water transport also play a greater role to portray the goods from one location to the desired location.

Planning is a fundamental characteristic of all human beings. The most important aspect of transportation planning is the fact that it is oriented towards the future. A planning activity occurs during one time period but is concerned with the action to be taken at various times in the future, so the purpose of transportation is to provide efficient access to various activities that satisfy human needs. The purpose of travel demand modelling phase of the urban transportation planning process is to perform a conditional prediction of travel demand in order to estimate the likely transportation consequences of several transportation alternatives that are being considered for implementation. This prediction is also conditional on a predicted target year land-use pattern. The major components of travel behaviour were identified as:
1. The decision to travel for a given purpose (trip generation)
2. The choice of destination (trip distribution)
3. The choice of travel mode (modal choice)
4. The choice of route or path (route assignment)

2. NEED FOR THE STUDY
Telangana was separated from Andhra Pradesh in 2014, which made Telangana the 29th state of India. Hyderabad is the capital of Telangana. As Hyderabad is metropolitan city the variation in the population takes place. As the traffic is increasing day by day in the cities, but the geometrical conditions and the network of existing road are not given due consideration to improve the traffic flow condition. Due to the increased traffic, speeds are falling down. The space provided for specified purpose is not utilized for that. In this context if the existing road conditions are improved like widening of the roads, restricting the road side business activities, providing on street parking facilities and footpath facilities for pedestrians etc.,

3. OBJECTIVES OF THE STUDY
- To develop the O-D Matrix for different Zones in the study area
- To obtain a trip generation model which helps in estimating the horizon year trips.
- To develop a trip distribution model to estimate the trip interchanges between the traffic analysis zones.
- To Calibrate and validate the developed trip generation and attraction models
- To Calibrate the Gravity Model
4. LITERATURE REVIEW

Habibullah and Pyle (1998) defined force-deformation criteria for hinges used in pushover analysis. Three points labeled IO, LS and CP are used to define the acceptance criteria for the hinge. (IO, LS and CP stand for immediate occupancy, life safety and collapse prevention respectively). Kadid and Boumrkik (2008) proposed use of pushover analysis as a viable method to assess damage vulnerability of a building designed according to Algerian code. Pushover analysis was a series of incremental static analysis carried out to develop a capacity curve for the building. Monavari et al. (2008) used nonlinear static analysis and five locals and overall yields and failure criteria to estimate seismic demands of buildings. The failure is directed towards losing structure’s performance during the earthquake or subsequent effects. Cinitha et al. (2011) have illustrated the nonlinear static analysis responses of OMRF and SMRF building frames under designed ground motions. The capacity against demand is observed significantly higher for SMRF building frames compared to OMRF. Khan and Modani (2012) in their investigation a performance based evaluation and retrofit of an existing hostel building in Babasaheb Naik College of Engineering, Pusad. Built in 1987, the subject hostel building is a four-story, rectangular structure. Satpute and Kulkarni (2013) studied on “Comparative study of reinforced concrete shear wall analysis in multi storied building with openings by nonlinear methods”. Chandra Sekaran and Gupta (2013) focuses on pushover analysis of multi-storey RC framed buildings subjecting them to monotonically increasing lateral forces with an invariant height wise distribution until the preset performance level (target displacement) is reached.

5. RESULTS AND ANALYSIS

5.1. General

The data collected for the travel demand modelling is used for the analysis. The data chosen for the present analysis is given in table below. In achieving the objectives of the study such as modelling, validation, forecasting the following procedure is followed.

5.2. Trip Generation

The trip generation process involves the following steps:

- The total productions and attractions for various zones were compiled based on the OD data.

Data collected regarding population, employment potential, vehicle ownership, number of students, and the number of earning-members was tabulated. Performing regression analysis for generation of equations for production and attraction. Different combinations of independent variables were analyzed and the most suitable multiple linear regression equations for trip-productions and trip-attractions were identified. The $R^2$ value, F-test value and the t-test value were obtained and regressions with a significance level of 85% were considered. Independent Variables available for regression and their correlation with zonal productions and zonal attractions are verified.

Modal summary of the best fitting regression equations for zonal attractions and zonal productions are provided in Table
Multi – Regression Analysis to Develop Trip Generation and Attraction Models for Hyderabad Metropolitan Development Authority Area

Table 1 Variables available and Model Summary for Vehicles

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Note:

Pop_2017=Population in the zone;
Emppot_2017=Employment potential in the zone; and
Vehicles =Number of vehicles in the zone.

The final regression adopted for prediction of trip productions and attractions of the zones areas follows:

Trip-productions =14947+0.004P+0.003E+0.008V-1.01SS+0.06F+0.23OF
Trip-attractions = 6617+0.003P+0.01E-0.02V+0.61SS+0.03F+1.08OF

Where,
P =Population of the zone, E =Number of employees in the zone, V =Total number of registered vehicles in the zone, SS= Small scale industries, F=factories/enterprises, OF=offices/companies

5.3. Calibration of the Model

Once the model parameters have been estimated the process of calibration and validation begins. Model calibration adjusts parameter values until the predicted travel matches the observed travel within the region for the base year. The model calibration is one of the important components which have to be performed after building any model to check for its rationality, correctness and practicability. The model calibration includes the component of evaluating the reliability of the mathematical model developed by checking the various criteria. The correlation matrix formulated depicts the existence of fairly good relationship between the dependent and independent variables. The final selected model is acting as the best estimator of the independent variables. This is evident from high value of coefficient of determination (R²=0.91) and coefficient of correlation (R=0.93). The value of adjusted R² is 0.91 which substantiates the argument that the model can be regarded as the best among the candidate models considered. The F-value calculated for the dependent and independent variables is found to be statistically significant.
5.4. Validation of the Model

Model validation tests the ability of the model to predict the future behaviour. Validation requires comparing the model predictions within formation other than that used in estimating the model. Validation is typically an iterative process linked to calibration. If the analyst finds that the model output and the independent data are unacceptable agreement, the model can be considered validated. In the present study, validation of the model developed carried out with available travel data. The goodness of fit drawn between the observed values and calculated values for vehicles is shown in the Figures. The bisector drawn is represented as nearly 85% regression line, indicating a fairly good regression model.

![Graph showing goodness of fit plot](image)

**Figure 1** Goodness of fit plot between calculated and observed demand for vehicles

### Table 2 O-D Matrix

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5.5. Trip Distribution: Gravity Model

Trip distribution, next stage of modelling, is carried out as mentioned in the following steps.

Step 1: Given trip production $P_i$ and trip attraction $A_j$ from trip generation model. Take the initial value of friction factors, $F_{ij}$.

Step 2: Assume that the $K_{ij}$ are all unity ($K_{ij}=1$).

Step 3: With the initial value of $F_{ij}$, and $K_{ij}=1$, calculate the $T_{ij}$.

$$T_{ij} = P_i \frac{A_jF_{ij}K_{ij}}{\sum_j A_jF_{ij}K_{ij}}$$

Where, $T_{ij}$=number of trips produced in zone $i$, and attracted to zone $j$, $P_i$=total trip produced from zone $i$, $A_j$= total trip attracted to zone $j$, $F_{ij}$= friction factor for trip interchange $ij$. $=1/t^2$, $K_{ij}$=socioeconomic adjustment factor for interchange $ij$ if necessary, $c_{ij}$=travel time (or impedance) for interchange $ij$, $i=$origin zone number, $i=1, 2, 3, \ldots, n$, $j=$destination zone number, $j=1, 2, 3, \ldots, n$, and $n=$number of zones in the study area. The trip distribution matrix is obtained. However, the total trip attraction for each zone does not satisfy to the observed zone-by-zone attractions, then it is called unbalanced. To solve the balancing problem the next iteration is required.

Step 4: Estimated $F_{ij}$ is obtained and trip distribution matrix is balanced. To make the result is closer with the original data, then find the $K_{ij}$ matrix of zonal adjustment factors.

Initial value for $F_{ij}$ is assumed as, $F_{ij} = f(c_{ij})=1/t^2$ If the calculated trips are deviating highly from observed trips, the friction factors are adjusted by the iterative procedures.

5.6. Gravity Model Calibration

Calibration of gravity model includes revising friction factor matrix to reduce the error between the observed and calculated values. Friction factors matrix is revised using the

$$F_{ij}^{(i+1)} = (F_i^{(i)}T_{obs})/T_i$$

Figure 2 Graph showing average travel time vs percentage trips for calculated and actual values

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Where,
\[ F_{(i+1)} = \text{friction factor for the iteration (i+1)}, \quad F_i = \text{friction factor for the iteration } i, \]
\[ T_{obs} = \text{observed trips}, \quad T_i = \text{calculated flow for iteration } i \]

After five iterations, the calibrated friction factor matrix and trip interchange matrices are calculated.

**Figure 3** Graph showing average travel time and calculated values

**Figure 4** Graph showing average travel time and actual values

### 6. CONCLUSIONS

Telangana, a newly born state, is in the process of building a capital city for the state, infrastructure of the state has to be improved to meet the demand for future. Transportation is one of the key factors which influence the economy of the state and plays a crucial role in meeting the needs and mobility of goods and people as well. So there is a need to study and meet the gaps in road network of Hyderabad city. Trip generation model developed for the data shows that the trips attracted to a zone and produced from a zone depend on population, employment and registered number of vehicles in the zone done by multiple regression analysis results the regression of 85%. Gravity model is developed for estimating the trip inter-changes, with an RMSE value less than 10 and error between the calculated and observed percentage trips for an average travel time was found to be less than 10% for passenger vehicles and less than 15% for goods vehicles.
Multi – Regression Analysis to Develop Trip Generation and Attraction Models for Hyderabad Metropolitan Development Authority Area

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