Traffic Generation Model For Delhi Urban Area Using Artificial Neural Network

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Abstract - Transport facility and socio-economic structure for a city are interdependent resulting into improved transport infrastructure, which in turn influences socio-economic growth. As the society evolves it generates transport demand. The classical transportation planning methods are based on simple extrapolation of trends. Some mathematical models like linear regression models have also been used by researchers for estimating traffic generation for future period, however, these models do not account for nonlinearly in the model. In the present paper Artificial Neural Network Model has been used in modal Traffic Generation in Delhi Urban Area .ANN models account for nonlinear relationship between independent variables and the dependent variables. Future estimates of percentage of traffic generation by cars, buses and smaller vehicles in the inner, middle and outer areas of urban Delhi have been derived using the ANN. The model is implemented on MATLAB and the error in the training phase of ANN is quite low.

Index Terms - ANN - Artificial Neural Network

1. NTRODUCTION

1. 1 Different Phases of urban Transportation Planning

Trip generation is the first step in the conventional four-step urban transportation Planning process, widely used for forecasting travel demands. It predicts the number of trips originating in or destined for a particular traffic analysis zone. Urban area is divided into several traffic zones which are the clusters of households and socio-economic activities.

Trip distribution (or **destination choice** or **zonal interchange analysis**), is the second component (after trip generation, but before mode choice and route assignment) in the traditional four-step urban transportation planning process. This step matches trip makers' origins and destinations to develop a "trip table" a matrix that displays the number of trips going from each origin to each destination. Gravity model, entropy maximization models are widely used for trip distribution analysis [3].

Mode choice analysis is the third step in the conventional four-step urban transportation Planning process. Trip distribution's zonal interchange analysis yields a set of origin destination tables followed by; mode choice analysis allows the modeler to determine which mode of transport will be used.

Traffic assignment concerns the selection of routes (alternative called paths) between origins and destinations in transportation networks. It is the fourth step in the conventional urban transportation planning process. The zonal interchange analysis of trip distribution provides origin-destination trip tables. Mode choice analysis tells which travelers will use which mode. To determine infrastructure requirement, its cost and benefit, we need to know the number of travelers on each route and link of the network (a route is simply a chain of links between an origin and destination). We need to undertake traffic (or trip) assignment exercise.

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The Paper on "Planning for unpredictable future: Transport in Great Britain in 2030" by Kiron Chatterjee & Andrew Gordon [1], explores alternative future scenarios for Great Britain in the year 2030 and the Implications these have for travel demand and transport provision. In this paper author made a National transport model to forecasts the national road traffics. In this work no mathematical model has been developed where income could be a parameter for estimating trip generation. In Indian context wide income disparity which plays a dominant role in trip generation and modal choice behavior.

This paper attempts to model the traffic generation percentage in Delhi urban area by different modes such as car, buses and two wheelers in Delhi. Delhi urban area has been divided in the following Categories i.e. Delhi inner areas, Delhi middle areas and Delhi outer areas.

Delhi Inner Area consists of the following areas of Delhi region, it includes Dhola Kuan, Raja Garden, Azadpur, ISBT, B.S. Gurudwara, AIIMS.

Delhi Middle Area consists of the following areas of Delhi region, it includes Ashoka Road, Bara Khamba Road, Janpath, ourter circle (CP), Sansad Marg, K.G. Marg, Inner Circle CP, Punckuin Road, Tolstoy marg, Rajpath Road.

Delhi Outer Area consists of the following areas of Delhi region, it includes Singu Border (NH1), Badarpur Border (NH1), Rojokari Boarder (NH8), Shahadra(NH24), Kalindi Kunj, M.G. Road (Aaya Nagar), Old Gurgaon Road, Tikri Border (NH10), Gazipur (NH24 ByPass) Mohan Nagar Border, Loni Border, Noida Link Road.

Artificial Neural Network has been used as a model for the above analysis.

2. ETHODOLOGY

2.1 Artificial Neural Network Model:

The architecture of the ANN consists of three layers namely input layer, hidden layer and output layer [3]. The input layer having input matrix denoted by **IW**11 having a source 1(2^{nd} index) and a destination 1(1^{st} index). The vector input 'P' is transmitted through a connection that multiplies its strength by the scalar weight W to form the product w*p. The neuron has a scalar bias 'b'. The bias 'b' is being added to the product w*p at summing junction by shifting the function 'f' to the left by an amount 'b'. The bias is much like a weight, except that it has a constant input of 1. The activation function net input 'n', is the sum of the weighted input w*p and the bias 'b'. This sum is the argument of the activation function f_l. Here f_l is activation function typically a sigmoid function, which takes the argument 'n' and produces the output 'a', weight 'w' and bias 'b' both are adjustable scalar parameters of the neuron. The central idea of neural networks is that such parameters can be adjusted so that the network exhibits the desired behavior. Thus we can train the network to do a particular job by adjusting weight or bias parameters or the network itself will adjust these parameters to achieve some desired end. The next section will be layer weight (LW).

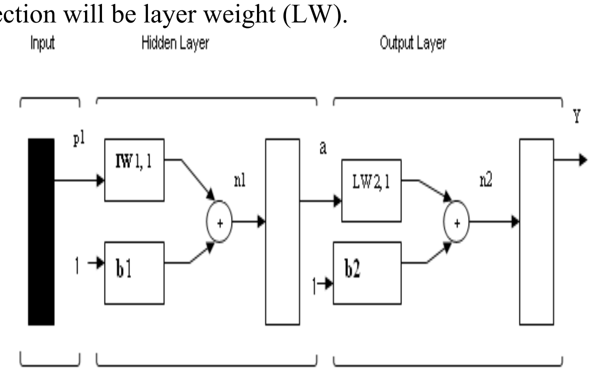


Figure 1a: Lay out of the multi-input multi-layer feed forward ANN.

In the present paper the ANN applied to traffic modeling is implemented in two phases viz training of the network based on part data and then estimating the output i.e. the traffic generated by socio-economic activities in Delhi urban area in percentage by cars, buses and two wheelers in the year 2021

Proposed Model

Percentage of Vehicle type C is Dependent on the Population (P) of Delhi and Per Capital Income (PCI) of Delhi.

C=f (P, PCI). Fig 1b shows the ANN Model for Proposed Model.

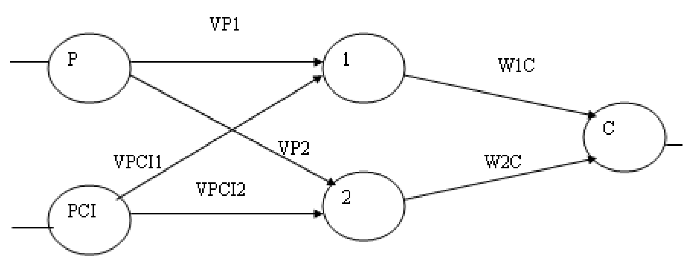


Figure 1b: ANN Model for Proposed Model

3. HYPOTHESIS OF THE MODEL

The proposed model Calibrated for different vehicle types like cars, buses and two wheelers for various zones in Delhi Urban areas

(i) Zone: Inner area

Vehicle type: cars

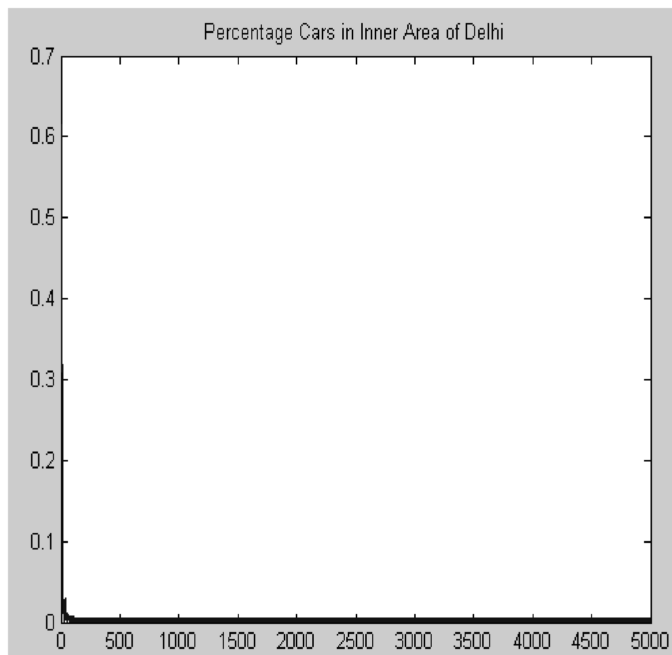
Data on the input variables are given in tables-1 and 2 and the error plot after training of ANN is given in errorgraph-1.

Year	Population of Delhi(P)	Per Capita Income of Delhi in Rupee.(PCI)
1991	9421000	12500
1994	10700000	17355
1997	12000000	25500
2000	13500000	29623
2002	14526000	31500

Table 1: Source [6&7]

Year	Percentage of Car in Inner Area (CI).
1991	27
1994	30
1997	33
2000	36
2002	38

Table-2: Source [6&7]



Error Graph 1

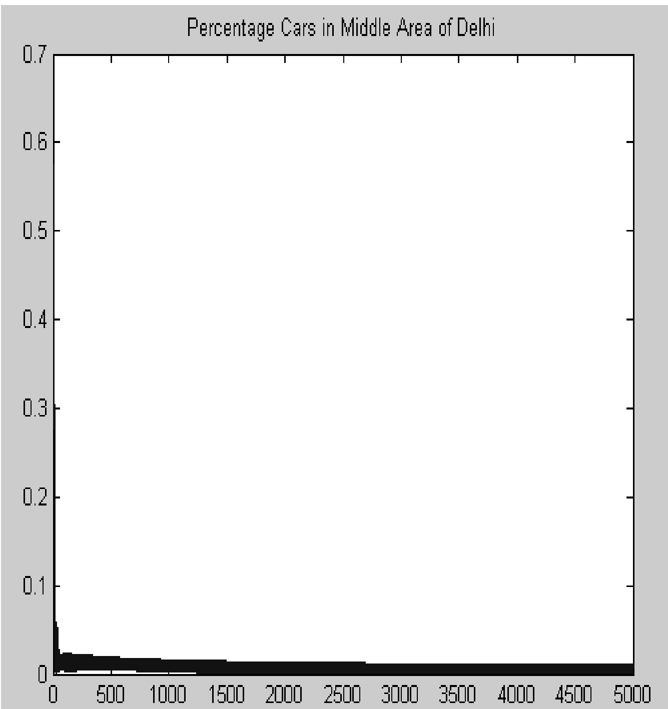
(ii) Zone: Middle area

Vehicle type: Cars

Data on the input variables are given in table1 and 3 and the error plot after training of ANN is given in errorgraphs2.

Year	Percentage of Car in Middle Area (CM).
1991	31
1994	34.5
1997	38.2
2000	41.5
2002	44

Table 3: Source [6&7]



Error Graph 2

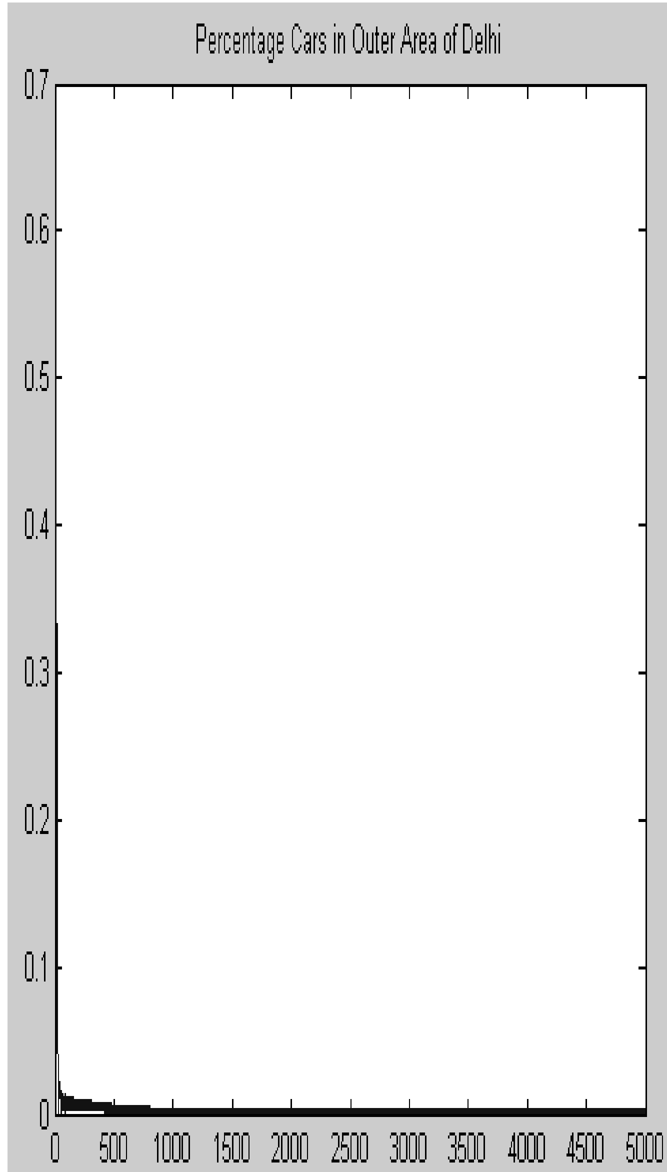
(iii) Zone: Outer area

Vehicle type: Cars

Data on the input variables are given in table-1 and 4 and the error plot after training of ANN is given in error graphs-3.

Year	Percentage of Car in Outer Area (CO).
1991	23
1994	25.5
1997	27.9
2000	30.3
2002	32

Table 4: Source [6&7]



Error Graph 3

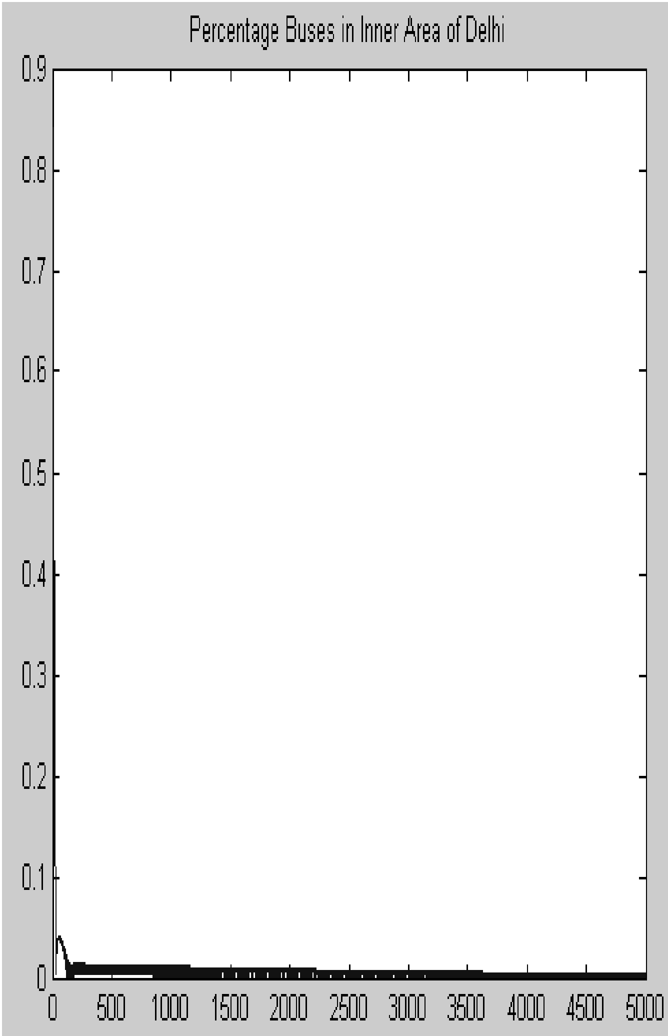
(iv) Zone: inner area

Vehicle type: Buses

Data on the input variables are given in table 1 and 5 and the error plot after training of ANN is given in error graphs -4

Year	Percentage of Buses in Inner Area (BI).
1991	6
1994	5.7
1997	5.5
2000	5.3
2002	5

Table 5: Source [6&7]

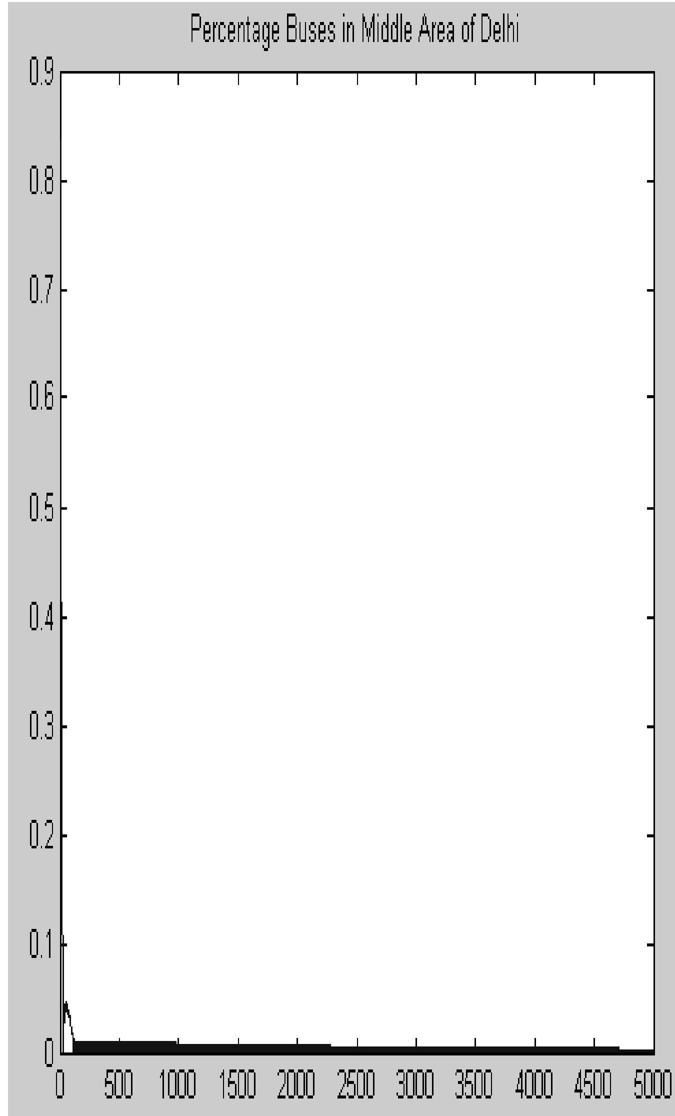


Error Graph 4

(v) Zone: Middle area
Vehicle type: Buses
Data on the input variables are given in table 1 and 6 and the error plot after training of ANN is given in error graph-5.

Year	Percentage of Buses in Middle Area (BM).
1991	6
1994	6
1997	6
2000	6
2002	6

Table 6: Source [6&7]

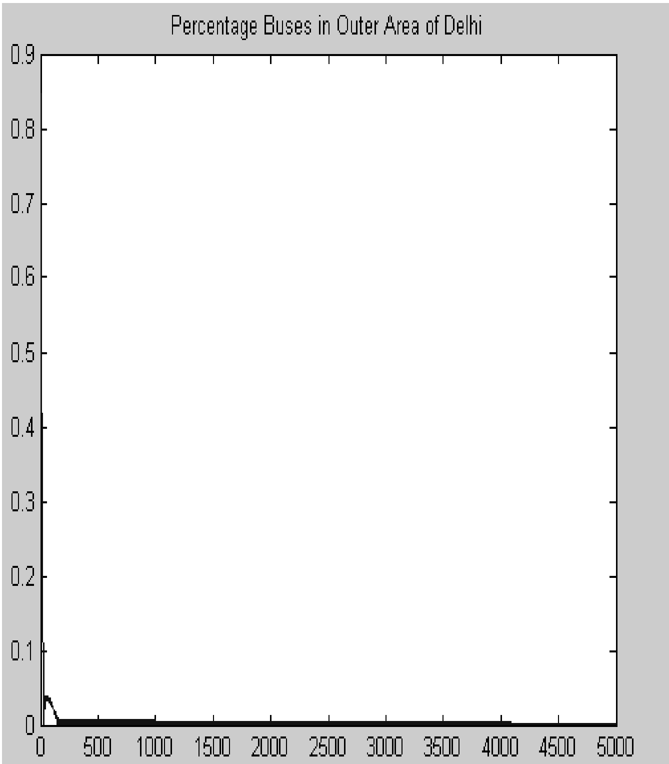


Error Graph 5

(vi) Zone: Outer area
Vehicle type: Buses
Data on the input variables are given in table 1 and 7 and the error plot after training of ANN is given in error graph -6.

Year	Percentage of Buses in Outer Area (BO).
1991	5
1994	5
1997	5
2000	5
2002	5

Table 7: Source [6&7]

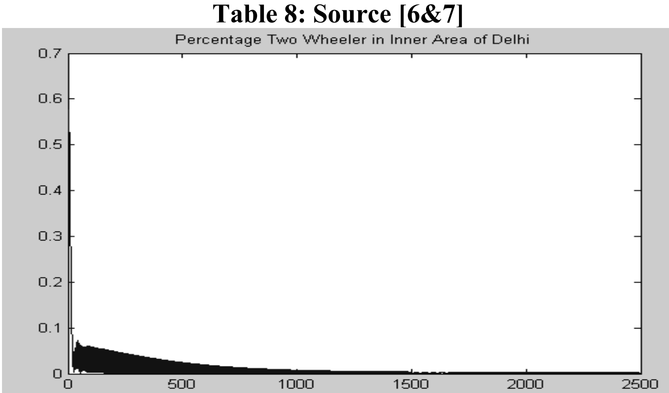


Error Graph 6

(vii) Zone: inner area
Vehicle type: Two wheelers
Data on the input variables are given in table 1 and 8 and the error plot after training of ANN is given in error graph 7.

Year	Percentage of Two Wheelers in Inner Area (TI).
1991	33
1994	32.7
1997	32.5
2000	32.2
2002	32

Table 8: Source [6&7]

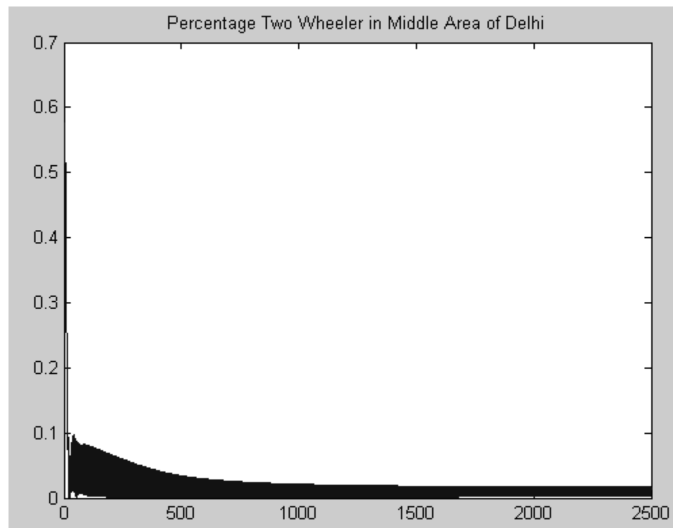


Error Graph 7

(viii) Zone: Middle area
Vehicle type: Two Wheelers
Data on the input variables are given in table 1 and 9 and the error plot after training of ANN is given in error graph 8.

Year	Percentage of Two Wheelers in Middle Area(TM).
1991	37
1994	35.4
1997	33.7
2000	32.2
2002	31

Table 9: Source [6&7]

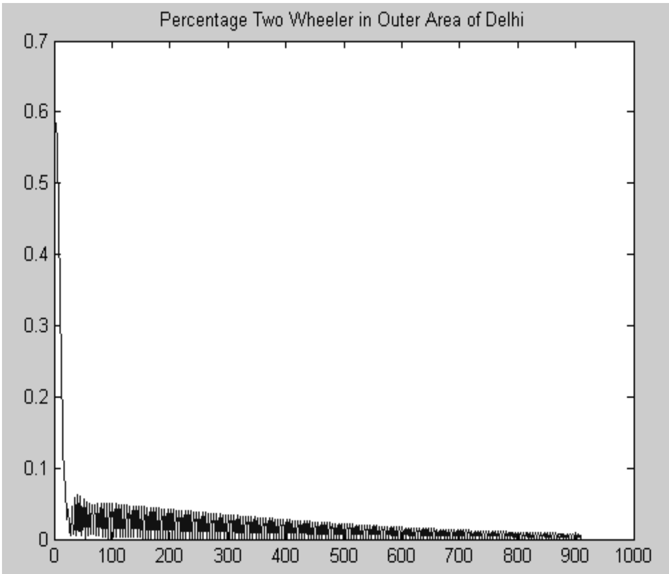


Error Graph 8

(ix) Zone: Outer area
Vehicle type: Two Wheelers
Data on the input variables are given in table 1 and 10 and the error plot after training of ANN is given in error graph 9.

Year	Percentage of Two Wheelers in Outer Area(TO).
1991	31
1994	31.3
1997	31.6
2000	31.8
2002	32

Table 10: Source [6&7]



Error Graph 9

Note: Data for 1991 and 2002 were directly available. Data for the other years have been interpolated accordingly.

4. RESULTS

As per the master plan of Delhi for 2021

Based on the trend analysis of past population we are assuming approximation 20% growth in population (P) and percapita income (PCI) for next 20 years, the estimates of modewise traffic in different zone are given in the pie chart.

Inner Area

Figure 1 shows the number of cars will be 50 % and number of buses will be 0.2348 % and number of two wheelers will be 18.7436 %.

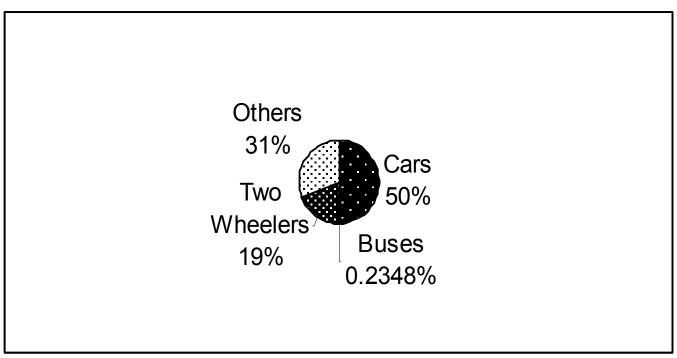


Figure 1: Mode wise traffic in inner area of Delhi in 2021

Middle Area

Figure 2 shows the number of cars will be 50 % and number of buses will be 0.1844 % and number of two wheelers will be 27.2394 %.

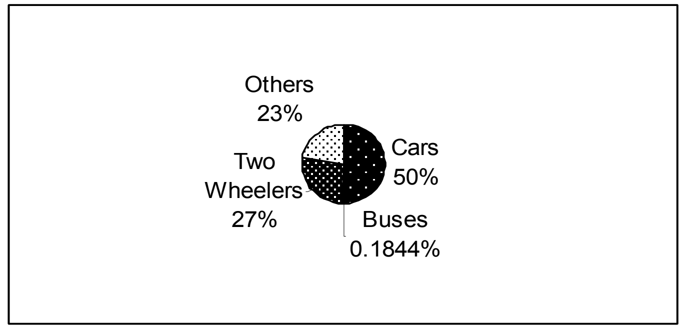


Figure 2: Mode wise traffic in middle area of Delhi in 2021

Outer Area

Figure 2 shows the number of cars will be 50 % and number of buses will be 0.1166 % and number of two wheelers will be 36.5493 %. And of the percentage is share by other mode of Communications.

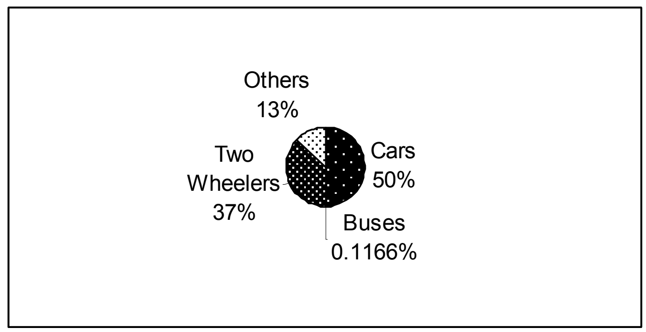


Figure 2: Mode wise traffic in outer area of Delhi in 2021

5. CONCLUSION

The present paper has successfully demonstrated the application of Artificial Neural Network for modeling traffic generation in Delhi Urban Area. The data on socio-economic variables have been collected from Economic Survey of Delhi, Delhi Planning Dept. and C.R.R.I Study 2002.Error generated in training phase is quite low; it is approximately 0.33% on Inner Car Percentage the calculation of error is based on the method of Steepest Descent [8]. The application demonstrates that the relationship between socio-economic variable and transport variable is non-linear which is taken care by ANN.

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Continued on page no. 250