Travel Parameter Modelling for Indian Cities- Regression Approach

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Abstract: **World is growing in terms of number of cities and the size of cities. Every city has its own travel demand with its own socio & travel characteristics like population, income, trip rate, trip length, walk (%), public transport (%). There is a great need for study of these parameters.**
This paper started with a presumption that various travel parameters have relation with socio and other travel parameters. About 30 Indian cities data were taken for the analysis. This data is taken from secondary source. This study reveals that there exist a moderate to good relation between various variables.
Regression analysis was carried out between various variables. It is observed that there exist a good relation between Trip Rates (All Modes)/Trip Rate (Motorised) with population, Area, Trip Length, Public Transport (%), City Buses (Govt+Pvt.). Regression equations were formed between these variables individually and collectively. Best out of various combinations were presented in this paper.

1. INTRODUCTION:

Population and vehicle registrations are increasing drastically in last decade. Sufficient transportation infrastructure is required for people movement from one place to other. Number of trips from an area is an indication of its development. And, these trips will decide the infrastructure deficiency of the city. The existing facilities cater to the trips generated from the city. These generated trips lead to the congestion and delay.

Country growth depends on infrastructure availability. Proper construction, planning and scheduling of these transportation facilities leads to the development of the region. This development of transportation facilities improves the socio-economics of the region. And, also keeps cultural & economic harmony in the region.

Inadequate transportation facilities lead to unhealthy development of the region. Social communications & economic prosperity occurs through good well planned transportation network. Transportation facilities indicate the development of the region. Governments are taking forward step to generate new cities in the world. So, it will be good to have model between various travel parameters.

Nomenclature

- *Trip rate (or) trip rate (all modes): Number of trips including walk per person of that study area.*
- *Trip rate (motorized): Number of trips excluding walk per person of that study area.*
- *Trip Length: the distance travelled for a trip in Kilometers.*
- *Congestion Index: CI=1-(observed speed on major corridors/Posted speed limit [i.e. 30kmph])*
- *City Bus Supply Index is city bus fleet per lakhs of population.*
- *Accident fatality index is road accident death per lakhs of population.*
- *Road safety index: - 1/ (road accident death per lakh population)*
- *Population density measurement of population per unit area.*
- *Per capita income is average income earned per person.*

Present study has following objectives:

1. To collect the travel data for various cities

2. To establish a trend between various travel parameters with one - one combination (Simple regression model).

3. To establish equations by simple regression analysis

4. To work out a multiple regression model between various variables.

This paper is presented in five sections. Section 1 deals with introduction of the topic, nomenclature, objectives of the work. In section2, review of literature is presented. Area under study and various cities included in the work is given in section 3(See Fig. 1). Section 4 includes analysis of data and formulation of various models. Conclusions are summarised in Section 5.

2. Literature Review

As a part of literature survey, various papers were studied critically to establish modelling techniques and to gather various socio-economic, trip information data for various Indian cities. In the following paragraph, the same were detailed out.

Liya et al.(2008) has worked on attractiveness of the destination of the trip for trip generation. Vrtic et al.(2006) framed some models for transportation planning at disaggregate level for Swiss. Goumopoulos et al.(2004) structured trip generation for crew scheduling. Lee et al.(2007) build some models on household type and behaviour, time-use pattern and chaining behaviour of trips. Zhou et al.(2009) found alternative formulation for combined models for four stage transportation planning. Using GPS travel datasets, increased the accuracy of trip rate by Jianhe et al. (2007)

3. Study Area:

Social & travel parameters of various cities in India were taken for this study. Geographical locations of various cities were presented in the following figure. The data for the present paper has been taken for the "Study of traffic and transportation policies and strategies in urban areas in India" by M/s Wilbersmith Associates Pvt. Ltd for MOUD (2008)

Fig. 1. Selected Cities for the Study

4. Analysis

4.1 Linear Relation of Trip Rate with Various Parameters

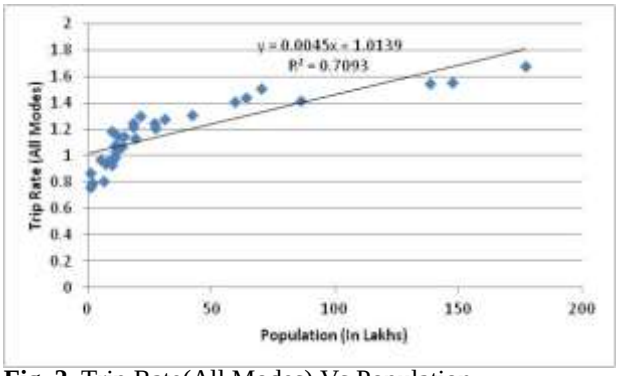

Fig. 2. Trip Rate(All Modes) Vs Population

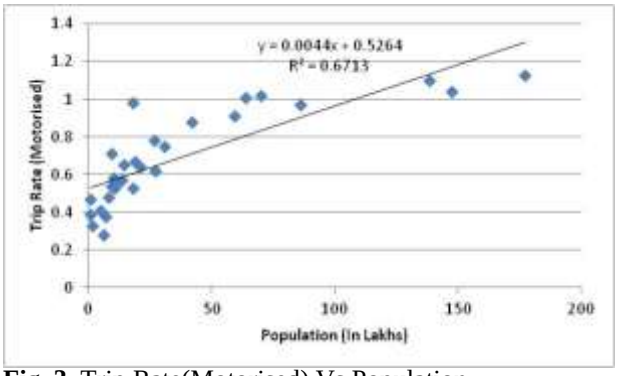

Fig. 3. Trip Rate(Motorised) Vs Population

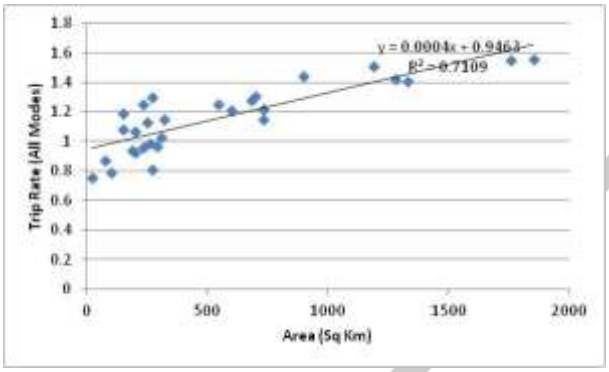

Fig. 4. Trip Rate(All Modes) Vs Area

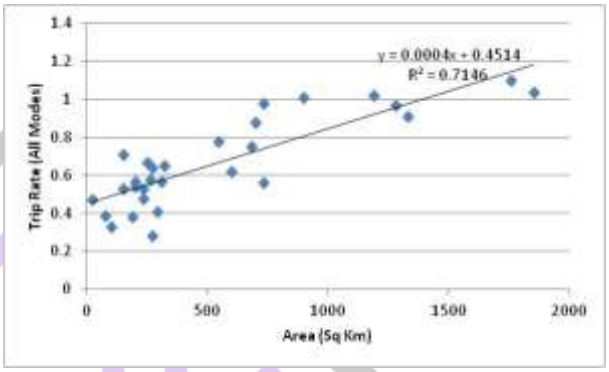

Fig. 5. Trip Rate(Motorised) Vs Area

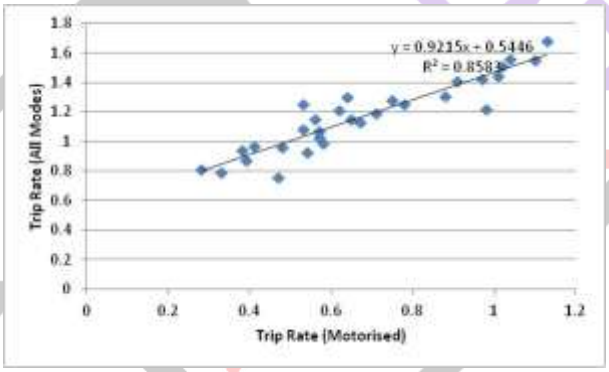

Fig. 6. Trip Rate(All Modes) Vs Trip Rate(Motorised)

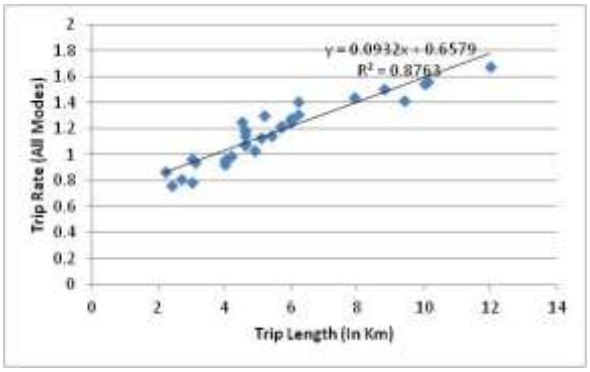

Fig. 7. Trip Rate(All Modes) Vs Trip Length

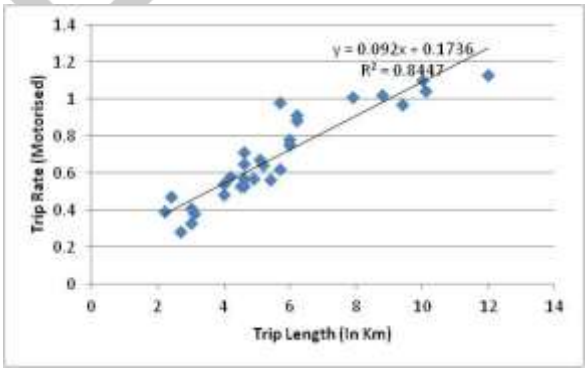

Fig. 8. Trip Rate(Motorised) Vs Trip Length

- Trip rate (All modes) varies from 0.76 to 1.67 for the population ranging from 1 to 177 lakhs. And, the distribution is as shown in the figure (See Fig. 2).

- Trip rate (Motorised) varies from 0.28 to 1.13 for the same population range of the selected cities. And, the spread of the data is as shown in the figure (See Fig. 3).

- Study shows that the trip rate (All modes) varies from 0.76 to 1.56 for the study area spread from 23 to 1851 Sq Km as given in the figure (See Fig. 4).
- Trip rate (Motorised) varies from 0.28 to 1.1 for the same spread of study area of the cities. And, it is presented in the figure (See Fig. 5).
- It is found that the trip rate (All modes) varies from 0.76 to 1.67 for the spread for trip rate (Motorised) from 0.28 to 1.13 as presented in the figure (See Fig. 6).
- Trip rate (All modes) changes from 0.76 to 1.67 for change of trip length from 2.2 to 12 Km as obtained in the figure (See Fig. 7).
- Trip rate (Motorised) varies from 0.28 to 1.13 for the spread of trip length from 2.2 to 12 Km as in figure (See Fig. 8).

4.2 Simple Regression Modelling:

Various combinations were studied, in order to build simple linear regression model. Out of these best combinations were presented in the Table 1.

4.3 Multiple Linear Regression Modelling:

At times, single variable alone may not define the behaviour of the target variable. To appreciate this behaviour multiple linear regression tools is used. For this, it is required to understand the strength of relation between various variables. So, Correlation matrix has been established between various variables and presented in the Table 2. By observing above relations, various combinations were worked out. The models of moderate to good relations for Trip Rate (All Modes) & Trip Rate (Motorised) were worked presented in the Table 3 & 4.

Table 1

Travel Parameter Models-Simple Regression

S.No	Model	R-Square
1	Trip Rate(All Modes)=0.0045*Population(In Lakh)+1.0139	0.71
2	Trip Rate(All Modes)=0.9314*Trip Rate (Motorised)-0.411	0.86
3	Trip Rate(All Modes)=0.000385*Area(SqKm)+0.9464	0.71
4	Trip Rate(All Modes)=0.0932*Trip Length(Kms)+0.6579	0.88
5	Trip Rate (All Modes) =0.0001*City Buses +1.0726	0.54
6	Trip Rate (Motorised)=0.0044*Population(In Lakh)+0.5264	0.67
7	Trip Rate (Motorised)=0.000396*Area(SqKm)+0.45139	0.71
8	Trip Rate (Motorised)=0.092*Trip Length(Kms)+0.1736	0.84
9	Trip Rate (Motorised)=1.2075*Public Transport(%)+0.4818	0.65
10	Trip Rate (Motorised) =0.0001*City Buses+0.5778	0.58
11	Trip Length(Kms)=0.05*Population(In Lakh)+3.751	0.88
12	Trip Length(Kms)=0.0025*Area(SqKm)+3.8621	0.75
13	Public Transport(%)=0.0026*Population(In Lakh)+0.0715	0.56

Table 2

R-Square Matrix for Various Variables

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	1.00	0.86	0.71	0.59	0.32	0.88	0.41	0.46	0.54	0.37	0.11	0.35	0.42	0.20
B		1.00	0.67	0.55	0.24	0.84	0.47	0.65	0.58	0.31	0.17	0.42	0.34	0.12
C			1.00	0.84	0.16	0.88	0.14	0.56	0.79	0.47	0.04	0.32	0.38	0.30
D				1.00	0.02	0.75	0.08	0.46	0.50	0.35	0.06	0.21	0.35	0.51
E					1.00	0.23	0.43	0.04	0.18	0.12	0.01	0.03	0.18	0.00
F						1.00	0.30	0.61	0.73	0.46	0.08	0.45	0.38	0.27
G							1.00	0.19	0.10	0.12	0.10	0.11	0.11	0.01
H								1.00	0.56	0.15	0.16	0.55	0.09	0.10
I									1.00	0.38	0.03	0.57	0.32	0.11
J										1.00	0.00	0.07	0.14	0.22
K											1.00	0.27	0.02	0.00
L												1.00	0.10	0.01
M													1.00	0.13
N														1.00

A - Trip Rate(All Modes), B-Trip Rate(Motorised), C-Population(In Lakhs), D-Area(Sq.KM), E-Population Density(C/D), F-Trip Length(In KMs), G-Walk(%), H-Public Transport(%), I-City Buses(Govt.+Pvt.), J-Congestion Index, K-Public Transport Accessibility Index, L-City Bus Supply Index, M-Road Safety Index, N- Income

Table 3

Multiple Regression Models for Trip Rate (All Modes)

S.No	Model	R-Square	Root Mean Square Error
1	Trip Rate (All Modes)=0.1181*Trip Length(Kms)-0.142*Public Transport(%)-(3E-05)*City Buses+0.5718	0.89	0.078
2	Trip Rate(All Modes)=0.1039*Trip Length(Kms)-0.207*Public Transport(%)+0.6327	0.88	0.082
3	Trip Rate(All Modes)=0.1132*Trip Length(Kms)-(3E-05)*City Buses+0.5793	0.89	0.079
4	Trip Rate(All Modes)=0.4245*Public Transport(%)+(8E-05)*City Buses+1.0312	0.58	0.1557
5	Trip Rate(All Modes)=0.0045*Population(In Lakh)+0.2002*Public Transport(%)-(2E-05)*City Buses+0.9958	0.72	0.127
6	Trip Rate(All Modes)=0.004*Population(In Lakh)+0.166*Public Transport(%)+1.0021	0.71	0.1283
7	Trip Rate(All Modes)=0.0048*Population(In Lakh)-(9E-06)*City Buses+1.0119	0.71	0.13

Table 4

Multiple Regression Models for Trip Rate (Motorised)

S.No	Model	R-Square	Root Mean Square Error
1	Trip Rate(Motorised)=0.0866*Trip Length(Kms)+0.3856*Public Transport(%)-(2E-05)*City Buses+0.1626	0.87	0.087
2	Trip Rate (Motorised)=0.0747*Trip Length(Kms)+0.3309*Public Transport(%)+0.2139	0.86	0.089
3	Trip Rate(Motorised)=0.1*Trip Length(Kms)-(1E-05)*City Buses+0.142	0.85	0.094
4	Trip Rate (Motorised)=0.801*Public Transport(%)+(5E-05)*City Buses+0.4998	0.70	0.131
5	Trip Rate(Motorised)=0.0028*Population(In Lakh)+0.6627*Public Transport(%)-(5E-	0.76	0.119

S.No	Model	R-Square	Root Mean Square Error
	06)*City Buses+0.4779		
6	Trip Rate(Motorised)=0.0026*Population(In Lakh)+0.6528*Public Transport(%)+0.4779	0.75	0.119
7	Trip Rate(Motorised)=0.0037*Population(In Lakh)+(2E-05)*City Buses+0.5312	0.68	0.137

5. CONCLUSIONS:

1. Trip rate (All modes) and Trip rate (motorised) increase with the increase in population and increment rate is same for both trip rates.

2. Trip rate (All modes) and Trip rate (motorised) increase with the increase in city area and increment rate is same for both trip rates.

3. Trip rate (All modes) and Trip rate (motorised) has good relation with each other.

4. Trip rate (All modes) and Trip rate (motorised) has incremental relation with trip length of the city.

5. Trip Length is also being predicted by the population of the city.

6. Trip rate (All modes) is well explained by combination of Population and Public Transport (%).

7. Trip rate (Motorised) is in good relation with the trip length and public transport (%).

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