TRAFFIC GROWTH RATE ESTIMATION USING TRANSPORT DEMAND ELASTICITY METHOD: A CASE STUDY FOR NATIONAL HIGHWAY-63

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Abstract

With the recent thrust on improving and developing highways for boosting National Economy, the importance of Traffic Demand Forecasting (TDF) has increased significantly as the forecasted traffic volume contributes substantially in engineering design, economic and financial liabilities of highway improvement projects. Therefore, estimation of traffic growth rates and the related issues concerned primarily to improve the rationality of traffic forecast is of prime importance. In the present Paper, the complete process of Traffic Growth Estimation by Transport Demand Elasticity Method even when available data is inaccurate or even missing, merits and demerits of various methods of obtaining traffic growth factors and critical issues associated in the process have been addressed and demonstrated through a case study. It has been revealed that with the constraints of availability of proper data and fluctuation of developing economy, the task of Traffic Growth Estimation could be quite subjective and approximate. Different approaches and necessary considerations for improving the rationality of traffic growth rate have also been addressed in the paper.

Keywords*: Traffic Volume, Seasonal Correction Factors, Project Influence, Demand Elasticity, Traffic Demand Forecasting, Traffic Growth Rates.*

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1. INTRODUCTION

The objective of this study is to estimate traffic growth using transport demand elasticity method and to compare how different these values are from the vehicle registration data.
In this present study, an attempt has been made to analyze the O-D data for passenger vehicles (cars & buses) and goods vehicle (trucks) collected by roadside interview method. The passenger characteristics such as average occupancy by mode, trip length, frequency and freight characteristics are analyzed and tabulated. The influence factors of various zones were found out. Socio-economic data viz -Per capita income and Net State Domestic Product, demographic data such as Population and registration of vehicle data of different states influencing the study stretch were collected from statistical data sources. The relationship between annual growths of vehicles in percentage over number of years is established.

To determine elasticity values, the regression analysis is carried out between socio economic variables growth index and vehicle growth index. The elasticity values for the future years are calculated based on the growth trend of vehicles.

2. STUDY AREA CHARACTERISTICS

The Project stretch is a part of NH-63 in the state of Karnataka which runs from east to west connecting Karnataka to Andhra Pradesh. The total length of NH-63 is about 432 km, out of which 370 km runs in Karnataka State and about 55.4 km runs in Andhra Pradesh.

This case study deals with Hubli – Hospet stretch of NH-63. The project stretch, starts at km 132+000 of NH-63 at junction with NH-4 Hubli-Dharwad bypass and ends at km 268+700 at junction of NH-63 and NH-13, Hitnal Junction.

3. DATA COLLECTION

For the purpose of forecasting traffic on the study stretch, several primary and secondary data were collected as mentioned below.

3.1 Primary Data

On the basis of reconnaissance survey and as per the recommendations of IRC, the project stretch was divided into two homogenous sections and suitable location for each section was strategically selected. The various traffic surveys carried out were:

- 7-day Continuous Traffic Volume Count
- 24 hour Origin and Destination Studies

Strict adherence to IRC codes and manuals were followed for the traffic surveys carried out.

Secondary Data:

- Fuel sales data along the study stretch
- Past data on traffic volume on the study stretch
- Previous year's vehicle registration data of Karnataka State
- Previous year's data on Per capita Income, Net State Domestic Product (NSDP), Population data of all the states influencing the project corridor and the National Average.

4. ESTIMATION OF AVERAGE DAILY TRAFFIC (ADT) AND ANNUAL AVERAGE DAILY TRAFFIC (AADT)

Table 1 showing Average Daily Traffic

Survey Location	Nalavadi -159.500			Hallikeri-221.400		
Vehicle Category	ADT Vehicles	ADT (PCU)	% Share of Traffic	ADT Vehicles	ADT (PCU)	% Share of Traffic
Two Wheeler	898	449	16.6%	329	164.5	10.6%
Auto Rickshaw	40	40	0.7%	36	36	1.2%
Car/Jeep/Van/Taxi	1960	1961	36.2%	1019	1019	32.7%
Mini Bus	24	36	0.4%	18	28.5	0.6%
Buses	658	1974	12.2%	259	780	8.3%
Mini LCV	366	366	6.8%	212	212	6.8%
LCV (4&6 Tire)	282	423	5.2%	212	318	6.8%
Truck (Two axle and Three Axle)	887	2661	16.4%	723	2169	23.2%
Multi Axle Trucks (4 axles and more)	145	652.5	2.7%	204	918	6.6%
HCM / EME	3	13.5	0.1%	5	22.5	0.2%
Tractor	40	60	0.7%	12	18	0.4%
Tractor + Trailer	54	243	1.0%	71	315	2.3%
Cycles	53	27	1.0%	10	5	0.3%
Cycle Rickshaw	1	2	0.0%	1	2	0.0%
Animal Drawn Carts	4	24	0.1%	3	18	0.1%
Total	5414	8932	100.0%	3112	6026	100.0%

4.1 Seasonal Variations of Traffic Volume:

Traffic levels along a study stretch vary during different periods of time i.e., in different months/seasons. Information on this aspect is necessary to estimate the AADT. This is best understood by studying monthly historical traffic volumes on the project corridor. This however is not available for the study stretch. In the absence of this direct information, it is customary to consider the monthly sales of petrol and diesel, at the fuel stations along the project corridor or on the road stretches in its environment. This information is presented in Table. The factors for passenger vehicles are based on petrol sales and that of goods vehicles (Trucks/LCV's) and buses on diesel sales.

Table 2 showing daily fuel sales and Seasonal Correction Factors (SCF) required estimating AADT

Month	Daily Diesel Consumption (liters)	Daily Petrol Consumption (liters)	Both	SCF (Diesel)	SCF (petrol)	SCF (Both)
April	4654	396	5051	0.9	1.07	0.91
May	4517	417	4933	0.93	1.01	0.94
June	4289	400	4689	0.98	1.06	0.98

July	3675	392	4067	1.14	1.08	1.14
August	3325	364	3689	1.26	1.16	1.25
September	3532	375	3907	1.19	1.13	1.18
October	3771	437	4208	1.11	0.97	1.1
November	4308	442	4750	0.97	0.96	0.97
December	4474	444	4918	0.94	0.95	0.94
January	4334	448	4782	0.97	0.94	0.97
February	4769	473	5242	0.88	0.89	0.88
March	4681	482	5162	0.9	0.88	0.89
Average	4194	422	4616			

Table-3 showing AADT obtained after applying Seasonal Correction Factors

Survey Location	Nalavadi -159.500		Hallikeri-221.400	
Vehicle Category	ADT (PCU)	AADT	ADT (PCU)	AADT
Two Wheeler	449	395	164.5	147
Auto Rickshaw	40	36	36	32
Car/Jeep/Van/Taxi	1961	1727	1019	897
Mini Bus	36	32	28.5	25
Buses	1974	1739	780	686
Mini LCV	366	322	212	186
LCV (4&6 Tire)	423	372	318	279
Truck (Two axle & Three Axle)	2661	2341	2169	1908
Multi Axle Trucks (4 axles and more)	652.5	574	918	807
HCM / EME	13.5	12	22.5	20
Tractor	60	54	18	16
Tractor + Trailer	243	214	315	277
Cycles	27	27	5	4
Cycle Rickshaw	2	2	2	2
Animal Drawn Carts	24	24	18	18
Total	8932	7869	6026	5305

5. TRAFFIC GROWTH RATES

To establish the future traffic growth rates, following approaches have been explored.

- Past trends in Traffic growth on the Project Road.
- Growth of registered motor vehicles.
- Transport demand elasticity approach.

5.1 Growth Rate based on Past Traffic Data:

Past traffic data as collected from PWD is available for two locations (near Annigere and Gadag) along the project corridor. These data are available from January to July months of last 10 years. The growth rates were worked out for various categories of vehicles and conclusions were drawn.

Non-Uniformity in past traffic data of PWD may be attributed to errors during collection and processing of data and policy measures of the Government and other influences etc. To illustrate this point during recent years some of the mining activities around the project corridor have been banned by the Government which has caused a substantial decrease in the amount of trucks and Lorries. As the past traffic data on the Project Road is not showing any definite trend, one should not be guided by past traffic data for deriving growth rates.

5.2 Growth Rate based on Vehicle Registration:

An alternative approach is to explore the registered motor vehicles growth in the influence area and assume a growth rate equal to the average growth of vehicle registration. Such an assumption may not be correct, unless the area of influence is well defined and the general development pattern of influence area remains same. The growth rates for various modes are estimated and presented in Table-4, Growth of Registered Motor Vehicles in Karnataka. It can be observed from the above Table, during the last 7 years, average growth of two wheelers, cars and that of trucks is around 11%-12%. This high growth rate of more than 10% may not sustain in future. Therefore other rational approaches were explored in order to derive realistic growth rates.

Table 4 – Summary of Cumulative Average Annual Growth Rate of Vehicles (%) in Karnataka state

Year	Goods Vehicles	Buses	Cars/Jeep/Taxi	Two Wheelers	Three Wheelers
2004-2005	221913	89294	841846	3957762	284078
2005-2006	276013	95627	958300	4512910	307862
2006-2007	312272	99202	1030629	3755719	359920
2007-2008	344764	110558	1209431	4230864	403910
2008-2009	366597	115016	1326395	4796587	364781
2009-2010	377495	159377	1398221	6404905	349729
2010-2011	415491	167087	1561131	7033045	440368
CAAGR in %	11.22%	11.62%	10.91%	11.10%	8.27%

Source: Ministry of Road Transport & Highways Government of India (MoRT&H)

5.3 Traffic Growth Estimation by Transport Demand elasticity Method:

The exercise of traffic growth rate estimation has been carried out by us using the elasticity approach. The elasticity method relates traffic growth to changes in the related economic parameters. According to IRC-108-1996, elasticity based econometric model for highway projects could be derived in the following form:

$$\text{Log e (P)} = A0 + A1 \text{ Log e (EI)}$$

Where:

- P = Traffic volume (of any vehicle type)
- EI = Economic Indicator (GDP/NSDP/Population/PCI)
- A0 = Regression constant;
- A1 = Regression co-efficient (Elasticity Index)

The main steps followed are:

- Defining the Project Influence Area from OD analysis of travel pattern.
- Estimating the past elasticity of traffic growth from time series of registered vehicles of influencing states.
- Assessment of future elasticity values for major vehicle groups, namely, cars, buses and trucks.

5.4 Project Influence Area

The results obtained from the Origin Destination surveys were used to identify the project influence area. The ratio of the total traffic originated/destined to a particular zone to the total traffic gives the influence factor for the particular zone. The influence factors were developed from the OD matrices and influence of each State is given in Table5 . A comparative study of the influence factors indicated that Karnataka State, where the project stretch runs has the majority influence of ninety two percent (92%). State of Goa, Andhra Pradesh and Maharashtra that has its border abutting Karnataka State has an influence factor of two percent (2%) our percent (4%) and two percent (2%) respectively. Tamil Nadu/Kerala and Rest of India has minimal or no share at all. These factors have all been accounted in derivation of the combined growth factor and utilized for the project sections.

Table -5 Influence of Vehicles observed on the Project Road`

States	Cars	Buses	Truck	Average
Karnataka	97.0%	93.9%	86.4%	92.4%
Goa	1.3%	0.5%	3.7%	1.8%
Andhra Pradesh	1.1%	3.7%	6.6%	3.8%
Maharashtra	0.6%	1.9%	2.7%	1.7%
Rest of India	0.0%	0.0%	0.7%	0.2%
Total	100.0%	100.0%	100.0%	100.0%

5.5 Elasticity Values

Elasticity value is the factor by which the socio-economic growth rate is multiplied to get the growth rate of traffic. Traffic is directly linked to the economic growth such as per-capita income, population and NSDP/GDP. Considering the time series data on category wise registered vehicles and the

economic variables, by regression analysis elasticity values is estimated as shown in Table-6

Table-6 Elasticity Values derived based on Regression Analysis for Karnataka State

Mode	Variable	Elasticity	R square	CAAGR (Vehicle Registration)
Two Wheelers	Per Capita Income	2.86	0.80	11.10%
Cars	Per Capita Income	1.48	0.97	10.91%
Buses	Per Capita Income	1.45	0.75	11.62%
Goods	NSDP	1.23	0.97	11.22%
Auto Rickshaw	Per Capita Income	0.84	0.7	8.27%

Table-7 showing adopted Elasticity values for future years

Mode	Estimated Elasticity(2004-2011)	Recommended Elasticity	2013-2018	2018-2023	2023 and Beyond
Goods	1.20	1.20	1.08	0.97	0.87
Buses	1.45	1.20	1.08	0.97	0.87
Passenger Cars	1.50	1.5	1.43	1.28	1.15
Two Wheelers	2.86	1.6	1.52	1.37	1.23
Three Wheelers	0.84	0.84	0.80	0.72	0.65

5.6 Traffic Growth Rates:

Based on the moderated elasticity values and the projected economic/demographic indicators and with the given model as follows, the future average annual compound traffic growth rates by vehicle type are estimated.

Passenger Vehicles:

Traffic Growth Rate = [(1+rp) (1+ rpci x Em) – 1]

Where,
rp= Population Growth, rpci= Per capita Income Growth, Em= Elasticity

Goods Vehicles:

Growth Rate for Goods Vehicles = Elasticity Value * NSDP Growth Rate

The growth rate estimated form elasticity values are shown in the table below:

Table-8 Showing Growth Rates adopted for different classes of Vehicles

Projected Traffic Growth Rates adopted for the Study		Pessimistic Approach			Normal Approach			Optimistic Approach		
Sl. No	Vehicle Type	Projected Annual Traffic Growth Rate (%)			Projected Annual Traffic Growth Rate (%)			Projected Annual Traffic Growth Rate (%)		
		2013-2018	2018-2023	2023-2023	2013-2018	2018-2023	2023-2023	2013-2018	2018-2023	2023-2023
1	LCV	8.0%	7.6%	6.5%	9.2%	8.7%	7.5%	10.5%	9.8%	8.5%
2	2-Axle Truck	4.9%	4.6%	3.9%	5.6%	5.3%	4.5%	6.4%	6.0%	5.2%
3	3-Axle Truck	8.0%	7.6%	6.5%	9.2%	8.7%	7.5%	10.5%	9.8%	8.5%
4	Multi-Axle Truck	7.0%	6.6%	5.6%	8.0%	7.6%	6.5%	9.1%	8.6%	7.4%
5	Bus	6.8%	6.6%	5.7%	7.9%	7.6%	6.6%	9.0%	8.5%	7.4%

6	Car	8.5%	8.3%	7.1%	10.0%	9.6%	8.3%	11.4%	10.9%	9.4%
7	Two Wheeler	8.9%	8.7%	7.5%	10.5%	10.1%	8.7%	12.1%	11.5%	10.0%
8	Auto Rickshaw	5.2%	5.1%	4.4%	6.0%	5.8%	5.0%	6.8%	6.5%	5.6%

DISCUSSIONS AND CONCLUSIONS:

The comparison of growth rates on vehicular registration data and by elasticity value are as shown in the table below:

Table-9 Comparison of Growth Rates by Various Methods

Table-9 Comparison of Growth Rates by Various Methods

Method	Mode				
	Two Wheeler	Car	Bus	Truck	Auto Rickshaw
Past Traffic on Project Corridor	No trend	No trend	No trend	No trend	No trend
Vehicle Registration Growth of Karnataka State	11.10%	10.91%	11.62%	11.22%	8.27%
Elasticity Method(2004-2011)	10.50%	10%	7.90%	8%	6%

The growth rates obtained from transport demand elasticity method is being widely used method all over India. These growth rates are adopted to predict future traffic volumes and Laning Requirements.

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