

# Evaluation of Toll Traffic Revenue based on VOC and VOT Method on Bengaluru – Mysuru National Highway (NH-275)

Vineeth Kumar K.<sup>1</sup>; Nithin M. Patel<sup>2</sup>; Abhishek P.<sup>3</sup>; Vishwas J. S.<sup>4</sup>  
Department of Civil Engineering, PES University RR campus Bengaluru, India

**Abstract:-** Through this project report intend to bring about an economical analysis of BengaluruMysuru Expressway (NH-275) which is a stretch of 117km, constructed under Bharatmala Pariyojana (BMP) phase -1. For this economical analysis of Traffic Characteristics various study were performed. Using the studied data various estimations like liner regression method were performed for Traffic forecast (future Traffic), by traffic volume count data Average Daily Traffic (ADT) and Annual Average Daily Traffic (AADT) were considered. Estimation of Value of Time (VOT) by empirical method and evaluation of Vehicle Operating Cost (VOC) by Portuguese Road User Cost (RUC) model were used to Comparing of Toll price with VOT (Value of Time) and VOC (Vehicle Operating Cost). Revenue and Expenses from toll plaza were calculated and arrived that the company would gain profit. For the estimation of Traffic forecasting we had to study liner regression method. All the calculation made are approximate and not exact.

**Keywords:-** Value of Time (VOT), Vehicle Operating Cost (VOC), Average Daily Traffic (ADT), Annual Average Daily Traffic (AADT).

## I. INTRODUCTION

The Mysuru-Bengaluru Expressway (NH-275) is existing six-path roadway in the state of Karnataka, India, which will connect the cities of Mysuru and Bengaluru. The Expressway was constructed to reduce travel time between the two cities by one and half hour as it will bypass several congested stretches and reduce the distance between the two cities. The proposed interstate will be approximately 117 kilometres in length and will run parallel to existing National Highway 275. The project has been carried out by the under Bharatmala Pariyojana (BMP) phase-1 by National Highways Authority of India (NHAI) and is estimated to cost around Rs. 6400 crores. Vehicle Operating Cost (VOC) refers to the complete expense related with purchasing and working a vehicle throughout some stretch of time. This includes every one of the costs brought about while utilizing the vehicle, for example, fuel costs,

maintenance, repair, insurance and depreciation are one more significant part of VOC.

Generally speaking, the impact of VOC on Indian roads is complex and depends on several factors. While high VOC can adversely affect the economy and people, low VOC can prompt more vehicles out and about and possibly more mileage on the roads. In this manner, policymakers genuinely must adjust the expense of vehicle possession and activity with the requirement for protected and proficient transportation foundation. This can be accomplished through measures like putting resources into public transportation, advancing eco-friendly vehicles, and keeping up with streets and expressways in great shape. VOT is used in the economical evaluation of expressway project to estimate the benefits of reduced travel time. VOT is also used in tolling strategies for expressways, where tolls are charged to users to recover the costs of construction, operation and maintenance

## II. LITERATURE REVIEW

Vehicle Operating cost (VOC) crucial for cost benefit analysis of toll roads. Whereas traditional method for estimating VOCs often lack precision or are outdated. The research paper propose improvement in Vehicle Operating Cost (VOC) and Value of Time (VOT) calculation like lognormal distribution model for Value of Time (VOT) in India, Comparison of VOC between toll roads and existing roads in Indonesia etc . VOCs are significantly affected by road conditions (roughness, width), traffic flow and vehicle type. Precise VOC calculation can inform better road maintenance strategies and project decisions. The following research paper are limited to some studies focus on specific regions or vehicle types and limiting generalizability. The data availability and model complexity were challenges encountered in the following research paper. This research highlights the importance of accurate VOC calculation for informed decision making in road project planning and maintenance. Various models and approaches offer valuable insights for different contexts and needs. Further research in needed to refine existing model and address data limit.

### III. METHODOLOGY

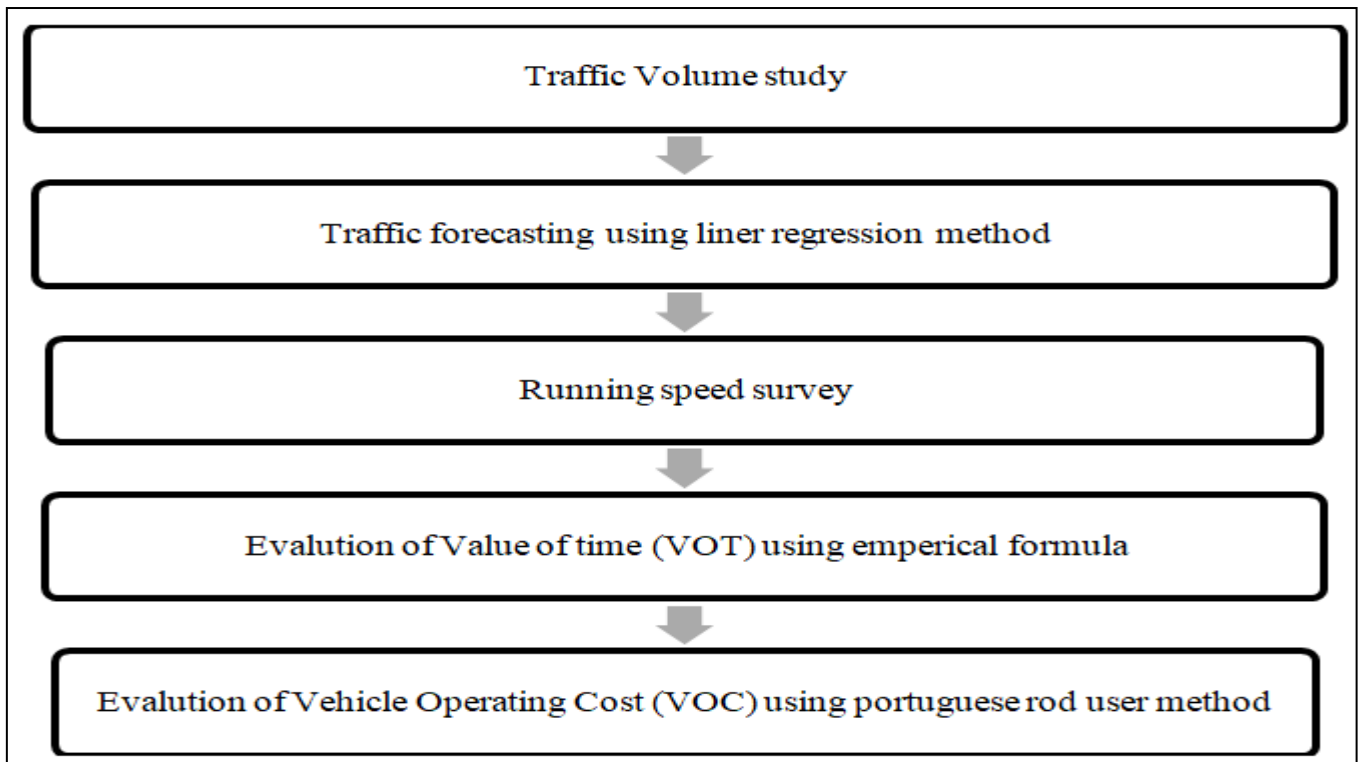


Fig 1: Flow Chart of Methodology

#### A. Traffic Volume Study

The purpose of traffic volume study on BengaluruMysuru expressway (NH-275) is to determine the traffic characteristics like peak hour traffic, Average Daily Traffic (ADT) composition. By carrying out the survey by manual method of counting and classifying the vehicle passing from toll plaza in both direction at one hour interval. The Average Daily Traffic (ADT) of 26,723 vehicle with the Passenger Car units (PCUs) of 32,539 was observed in Bengaluru-Mysuru Expressway (NH-275) for both direction and Annual Average Daily Traffic (AADT) of 27,599 vehicle with passenger car units (PCUs) of 33,007.

#### B. Traffic Forecasting

Previous year economic growth for the state of Karnataka by considering GDP was analysed. The traffic growth rates were estimated based on the available data The traffic growth rate estimation can carried out using linear regression model. According to “IRC 108-2014: Guidelines for Traffic Forecast on Highways”. Could be derived in following form:

$$\ln P = A_0 + A_1 \ln (EI)$$

Where:

- P = Traffic volume (of any vehicle type)
- EI = Economic Indicator (GDP)
- A<sub>0</sub> = Regression constant;
- A<sub>1</sub> = Regression co-efficient (Elasticity Index)

#### C. Evaluation of Value of Time (VOT)

The travel speed data for each category of vehicles were collected from Origin and Destination survey. In the next step the Travel Time Saved (TTS) were calculated. For each of the 84 origin destination pairs, suppose the estimated time taken before construction of expressway T<sub>2</sub> and the estimated time taken after construction of expressway T<sub>1</sub>.

$$\text{Travel Timed Saved (TTS)} = T_2 - T_1 = \Delta T$$

It is important to note that while TTS varies over different points of time throughout the day, the toll rate  $\tau_i$  is specific to the user category and does not vary by time. Thus dynamic pricing is not prevalent in the Indian toll roads. Consequently, the implicit Value of Time (VOT) for each user category  $i$  is estimated by using the following equation.

$$VOT = \frac{\tau_i}{\Delta T}$$

Where

- $\tau_i$ : Toll rate for specified vehicle (Rupees)
- $\Delta T$ : Travel time saved (hours)

#### D. Evaluation of Vehicle Operating Cost (VOC)

The VOC components considered in this model were: fuel (because of the high impact in total RUC), maintenance and repairs (which has a medium impact, influences other components as fuel consumption, vehicle depreciation and VOT, and reflects the benefits of roads improvements), vehicle depreciation (with medium impact, reflects capital

invested in vehicle acquisition versus car optimal life) and tires. The model still considers the users willing to pay for improved roads by the addition of tolling costs to VOC and VOT.

$$VOC = C_{fi} + C_{ti} + C_{mi} + C_{di} + \text{Engine oil cost}$$

Where:

- $C_{fi}$  : - fuel consumption cost
- $C_{ti}$  : - tire consumption costs
- $C_{mi}$  : - maintenance cost
- $C_{di}$  : - vehicle depreciation cost

#### IV. RESULT AND DISCUSSION

From the analysis of traffic volume study, estimated Average Daily Traffic (ADT) and Annual Average Daily Traffic (AADT) traffic composition was obtained. It shows the estimated percentage of traffic over a week from 2nd September 2023 to 8th September 2023 are represented in the following pie chart. Vehicle composition of Cars, jeep are 86.09%, Buses are 4.31% , Trucks are 9.60%

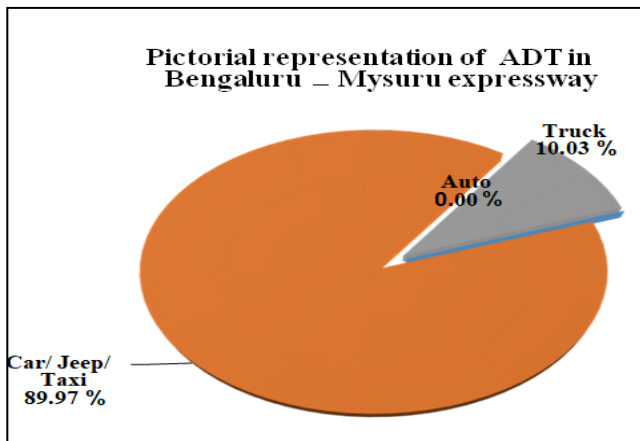


Fig 2: Pictorial Representation of Annual Daily Traffic (ADT)

The following graph represent Peek hour traffic based on hourly variation it obtained from the above mentioned data for Peek hour traffic. It is observed that during the time

period of 10am – 11am there is maximum movement of vehicle.

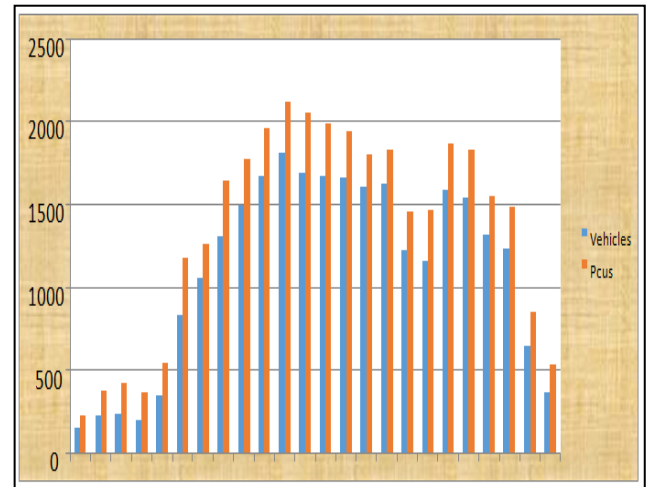


Fig 3: Peek Hour Traffic vs Time

From traffic forecasting using linear regression method, estimated Annual Average Daily traffic (AADT) of car for the present year 2023 is 23697 with the estimated GDP of 77000 crores and estimated traffic for the year 2035 is 54580 with GDP of 92600 crores. With the approximate traffic growth rate of 6.7% over the year similarly for the buses and trucks the approximate traffic growth rate is 6.7% over the year of 2023 to 2035.

The estimated Value of time (VOT) for Bengaluru – Mysuru expressway (NH-275), for car is obtained per hour of travel time saved was estimated at 186 rupees/hour , for bus it is 673 rupees/hour, for mini bus it is 297 rupees/hour, for Light commercial vehicle (LCV) it is 301 rupees/hour and for truck it is 789 rupees/hour.

The Vehicle Operating cost (VOC) for Bengaluru – Mysuru expressway (NH-275), depends on fuel consumption cost, tires usage cost, engine oil cost, maintenance cost and depreciation cost was estimated, VOC of all vehicle are presented as follows:

Table 1: Comparision of Computed Toll Charges

SI NO	VEHICLE	FUEL CONSUMPTION COST (Cfi)	TYRE COST (Cti)	ENGINE OIL COST	MAINTAINANCE COST (Cmi)	VEHICLE DEPRECIATION (Cdi)	VOC
1	CAR	13.26	0.348	1.34	0.00032	0.0003	14.94
2	MINI BUS	11.22	0.58	1.8	0.0026	0.00013	12.06
3	BUS	18.36	1.6	0.17	0.0013	0.00011	17.44
4	LCV	12.24	0.43	1.43	0.00064	0.00019	10.99
5	TRUCK	14.28	2.55	2.98	0.0044	0.00019	14.87

Using the result from Value of Time (VOT) and Vehicle Operating Cost (VOC) the estimated toll charge is calculated and are presented as follows

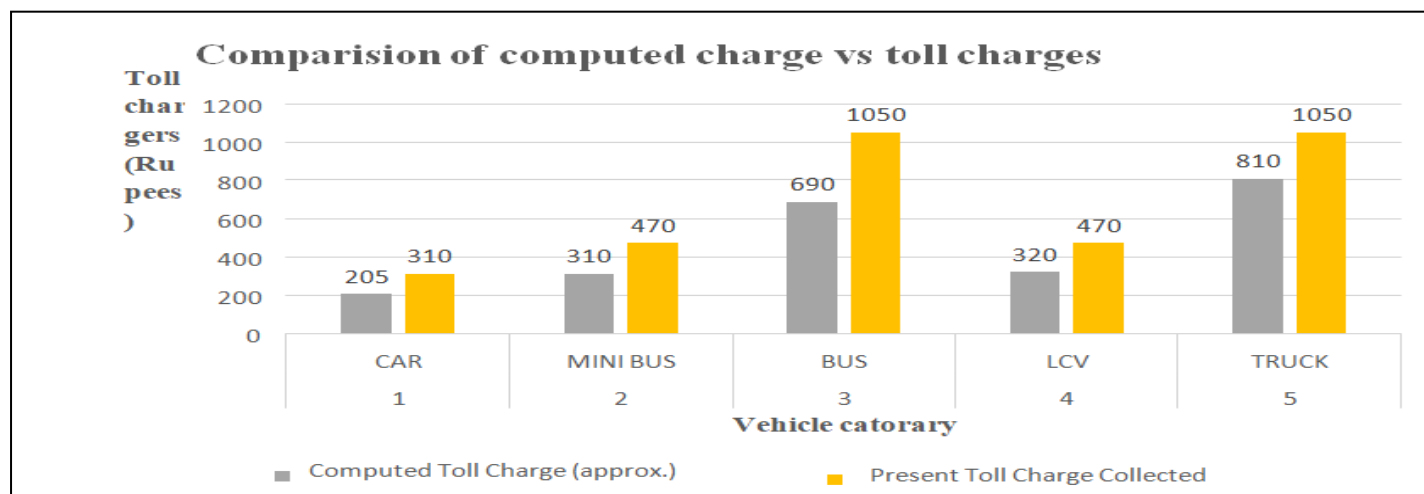


Fig 4: Comparison of Computed Charge vs Toll Charges

## V. CONCLUSION

- This project contributes to the literature in following ways. First, The liner regression method used for traffic forecasting help to determine the regression coefficient as shown in the figure 3. With the help of regression coefficient the following traffic growth was determined.
- Second, the methodology used to determine Value of Time (VOT) and Vehicle Operating Cost (VOC) contribute in determining toll charge for NH-275 Bengaluru – Mysuru expressway
- Third, by comparing the approximately calculated toll charge obtained from Value of Time (VOT) and Vehicle operating cost (VOC) with the present toll charge collected, it is observed that the collected toll charge is higher than the calculated toll charge.
- Fourth , this project conclude that the toll charge collected is greater than the calculated toll charge from Value of Time (VOT) and Vehicle Operating Cost (VOC), hence the company would gain more profit in following year.

## REFERENCES

- [1]. C.G. Swaminathan and Ir. Kadiyali. Vehicle Operating Costs Under Indian Road and Traffic Coriditions , *Transportation Research Record* 898 (2003)
- [2]. Gary Barnes and Peter Langworthy.:The Per-mile Costs of Operating Automobiles and Trucks, *Minnesota Department of Transportation Office of Research Services* 395 John Ireland Boulevard St. Paul, MN 55155. (2003)
- [3]. Bertha Maria Batista dos Santos, Luís Guilherme de Picado Santos and Victor Manuel Pissarra Cavaleiro. Vehicle Operating, Accident and User Time Costs in Pavement Management Systems: Approach for Portuguese Conditions, *Journal of Civil Engineering and Architecture*, ISSN 1934-7359, USA(2011)
- [4]. Hui Gao and Xueqing Zhang .A Markov-Based Road Maintenance Optimization Model Considering User Costs, *Computer-Aided Civil and Infrastructure Engineering* 28 451– 464 (2013).
- [5]. Anil Minhansa, Ali Moghaddasi. Transport Cost Analysis of City Bus and Private Car Usage in Johor Bahru, Malaysia , *Anil Minhans & Ali Moghaddasi / JurnalTeknologi (Sciences & Engineering)* 65:325–31. (2013)
- [6]. Lakshya Siddhi and Adarsh Pandey. Toll Traffic Revenue and Expenses at NH-22 Zirakhpur-Pinjore Parwanoo Highway, *journal paper from JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGH.*(2014)
- [7]. Giuseppe Loprencipe, Antonio Pantuso and Paola Di Mascio. Sustainable Pavement Management System in Urban Areas Considering the Vehicle Operating Costs, *article Sustainability.*(2017)
- [8]. Saika Ranawaka and H.R Pasindu, Estimating the Vehicle Operating Cost used for economic feasibility analysis of highway construction projects, *Moratuwa Engineering Research Conference (MERCon).* (2017)
- [9]. E Kadarsa , Hanafiah ,B B Adhitya , M Pataras , A Azari.Comparison Analysis Operastional Cost of Vehicle (VOC) Between Kayu Agung-Palembang-Betung Toll Road Plan with Existing Road , *The 2nd International Conference on Smart City Innovation* .(2019)
- [10]. R E Wibisono, M S D Cahyono and A Muhtadi. Analysis on calculation of Vehicle Operating Cost (VOC) at Gejayan intersection and after fly over ring road operation in Yogyakarta, *IOP conference series Earth and Enviromental science* 340(2019)0012036. (2019)
- [11]. Rajorshi Sen Gupta and Mohammed Anjal. Estimation of Value of Time of Toll Road Users in India, *International Journal for Traffic and Transport Engineering*, 2020, 10(4): 508 – 518.(2020)