Economic Analysis of Congestion –A Case Study

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Abstract: Economic cost of traffic congestion is one of the most discussed issues in an economy and time is our non-renewable resources, which cannot be regained if lost. Many people lose their job, life, money, and etc. due to delay which is associated with congestion. Also, traffic congestion creates more stress and difficulties for drivers, cyclist and pedestrians. This research paper aims to analyse the opportunity cost associated with the selected road stretch in the Palakkad city in order to quantify the intensity of congestion & the results obtained indicated that there is a considerable monetary loss due to delay during peak hours of the day.

Keywords: Congestion; Delay; Value of Time; Opportunity cost.

I. INTRODUCTION

Congestion is defined as a volume of traffic on road is more than its capacity (V/C ratio). Congestion costing is a term generally used to show total economy loss due to congestion. In India generally, congestion is caused due to encroachments, improper parking, accidents, heavy vehicles, poorly design intersection etc. which leads to fuel consumption, travel time delay, environment and health issues, and low-speed volume. Improper planning of road construction also leads to traffic congestion. Congestion prevents us from moving freely and it slows or otherwise disrupts the conduct of business within urban areas. However, it is important to note that unfettered movement is not the primary benefit we derive from living in urban areas. Cities provide access to a wide range of activities, people, services, goods, markets, opportunities, ideas and networks. These benefits can be delivered either through speed or through greater proximity. Congestion may affect travel speed but, in some circumstances, such as dense urban cores, congestion may both be expected and, to some degree, accepted. In these cases, cities have come to accept a degree of congestion and continue to get along relatively well as long as overall accessibility is high.[1]

Not only in metro cities but also many developing towns of India face similar types of congestion problems. Although, there are number of efforts made to accommodate and facilitate the increasing traffic in future for the developing town areas, congestion seems to be an unresolved issue. Keeping this in view, this research was conducted to investigate the extend of congestion and to quantify it in term of cost. For the analysis, one of the busiest roads stretches of Palakkad was selected i.e. Chandranagar which is enclosed by educational institutions, Industries, Recreational centers etc. as shown in figure.1. The research was designed to ascertain the traffic congestion and various traffic parameter were collected through field surveys. This paper contains the description about study area, type of data collected for this study and also shows the amount in terms of time which is lost by people due to congestion delay which is termed as opportunity cost as well as the fuel loss cost.

Fig. 1 Photograph of congestion at Palakkad

II.OBJECTIVES

The main objective of this paper is to find out the economic loss cost due to congestion and the specific objectives are as mentioned below,

- To analyze the performance of existing traffic condition.
- To estimate the opportunity costs of different modes of transport along the selected corridor during peak hours.

III. LITERATURE REVIEW

Research on economic costs related to traffic congestion was carried out by number of researchers using different techniques/ methodologies. These papers presents a widespread review of the literature on measuring the economic costs of road traffic congestion.

The amount loss is calculated in terms of fuel consumption or Vehicle Operating Cost (VOC), time loss (delay) or Value of Time(VOT), environmental loss or dead loss. Consumption of fuel is increasing with increase due to enhanced trip length. Cost of time wasted, is amount of extra time taken multiplied by the average income of person per day which is 93,108/- (Rs. /hr.).

- Total time loss by total traffic during congestion (hrs. /km.) = (time loss/free flow travel time)*V
- Time loss (min/km) = Peak period flow time-Free flow time
- VOT (Rs. /hr.) = annual average income per person/ (365*24)
- Amount of time loss (Rs. /hr.) = (VOT*V)

Cost of fuel wasted, is amount of extra fuel consumed during congestion multiply of its cost which is 58,241/- (Rs. /hr.). Cost of environment loss is CO2 emitted multiplied with CO2 cost which is 13,960/- (Rs. /hr.).

- Total fuel loss by total traffic during congestion (l/km) = (fuel loss*V).
- Fuel loss (ml/km) = Peak period fuel consumed- Free flow fuel consumed
- VOC (Rs. /hr.)= Fuel loss*price/Time loss
- Total CO2 emitted by total traffic during congestion (kg) = total fuel loss*CO2 emission rate

To calculate congestion costing two-time survey data is collected on Nagpur roads (sitabuldi region) one is peak period data and other is free flow period data and also pricing level of each type of motorized vehicle is considered. V/C ratio of peak period is 1.265 which define a level of service F. [1]

The estimates in monetary terms, the cost of traffic delay-increased travel time, increased fuel consumption and increased pollution, taking one of the corridors in Thiruvananthapuram, the capital of Kerala, India as a case study. Data analysis of willingness to pay survey was performed with the help of Microsoft Excel and models are developed to estimate value of travel time (VOT). Using the VOT, cost of travel time loss is estimated. Along with that, fuel cost and pollution cost were determined from other data like volume count, speed and delay survey, emission factors etc. which gave the total monetary value of total traffic delay along the study stretch. Cost benefit analysis of one of the improvement measures (Mass transit system) has been done. The cost - benefit analysis is carried out by using the Discounted Cash Flow (DCF) technique to obtain the Economic Internal Rate of Return (EIRR%) and Economic Net Present Value (ENPV) for the proposed investments linked with the project. [4]

With the rapid urbanization, it is evident that commercial and socio-economic activity tending to centralize only in few major cities in a country. This has led to increase in the number of the commuters daily traveling to the cities. Also, the economy grows and real income of household vehicle population also increasing. Those things are creating a major issue of congestion, especially within urban cities. Road traffic congestion interrupts and reduces productivity level and it is a symbol of economic depression. This research presents the complete methodological process from data collection to analysis of main two cost factors of road traffic congestion. Those cost factors are workforce productivity time loss excess fuel energy consumption/ operating cost. The most important aspect of this study is that it provides a measure of the real monetary cost of congestion to local or regional economies.

The summary of the findings is that growth of vehicles per 1000 people has risen from 171 to 305 between 2008 and 2016 in Sri Lanka. The alarmingly the bus to private vehicle ratio is 1:11.37 meaning that 91.92% of private vehicles in operation and shared the road space with public transport in the selected urban corridor. Nevertheless, in term of bus passenger capacity to private vehicle ratio is 1.6:1 that means additional 61.16% of passengers are catered by public bus transportation. This indicates that personalized transports significantly contribute to the traffic congestion making significant losses to the economy.[6]

IV. METHODOLOGY AND DATA COLLECTION

The preliminary analysis started with the selection of study stretch followed by data collection .Primary data collection such as speed and delay survey to estimate travel time delay along the selected corridor using License plate method,, traffic volume survey using video-graphic survey. Data analysis of survey was performed with the help of Microsoft Excel. Along with that, fuel cost was determined from other data like volume count, speed and delay survey etc. which gave the total monetary value of total traffic delay along the study stretch. Data collection includes Speed and delay survey and classified volume count survey were done during 8:30 am - 10 am and 4:30 pm - 6 pm.

Study stretch selected for this study is Chandranagar -Bypass road from Focuz computers - Palakkad Rifle Association. Study area is the only route to reach Palakkad town and Coimbatore. Peak and off-peak condition of the road is shown in figure 2 and figure 3 respectively. Also, study area is concentration of activities for shopping, business. Study area has mixture of government; residential, commercial building that is generating tremendous amount of traffic, and also the shoulder width of the study area

road is comparatively small. The area around study area has high land value. The amount of vehicular traffic is more, due to this traffic congestion and delay in travel occurs. Having less width of shoulder the study area also has the parking issues. Due to less curb width and pedestrian path, parking of vehicle is not sufficient enough so that due to illegal parking of vehicle reducing the travel width path and making congestion.
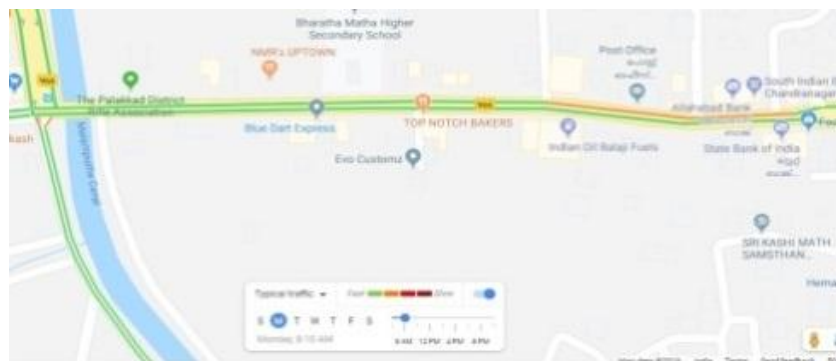

Fig.2 Peak period condition

Fig.3 Off peak condition

V. DATA ANALSYIS

From the reviewed literatures a suitable method was chosen for calculating the opportunity cost.[1][7]

The steps involved in calculation of opportunity cost is as follows:
- Estimate the daily volume of vehicles per lane corresponding to the congested peak hours.
- Calculate daily vehicle kilometers traveled (DVKT) for roadway section as the average daily traffic (ADT) of a section of roadway multiplied by the length of that section of roadway.
- Calculate peak period volume.
- Determine average freeway speed during the peak period based on data collected from travel time & speed survey in corridor.
- Estimate travel delay: The difference between the amount of time it takes to travel the peak-period vehicle-Kilometers at the average speed and at free-flow speeds is termed delay.
- Calculate daily recurring vehicle-hour delay.

Opportunity cost (Rs) = Avg delay x Vehicle count x Vehicle Occupancy x Value of Time

VI. RESULTS AND CONCLUSIONS

Traffic volume count was observed more by two-wheelers. The traffic volume for different modes during morning and evening peak hour are as shown in figure 4 and figure 5.
Delay was mainly caused for heavy motor vehicles, and buses. Less delay was observed for two-wheelers. The average delay time for different modes during morning and evening peak hour are as shown in figure 6 and figure 7.
Since the delay was caused for buses, opportunity cost was more for buses. Two wheelers were more in number and they also constituted maximum opportunity cost. The Opportunity Costs for different modes during morning and evening peak hour are as shown in figure 8 and figure 9.
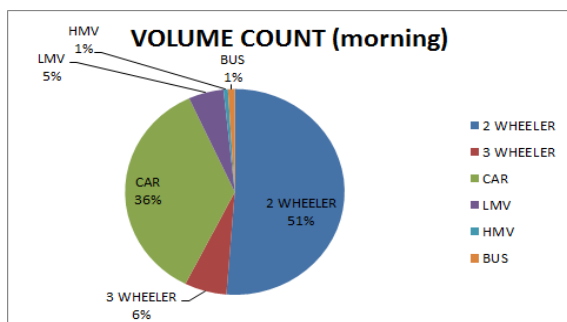
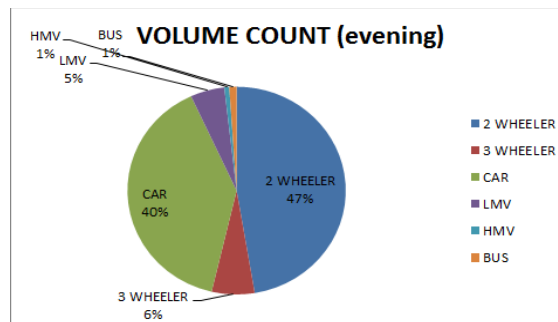Fig.4 Traffic volume count (Morning)
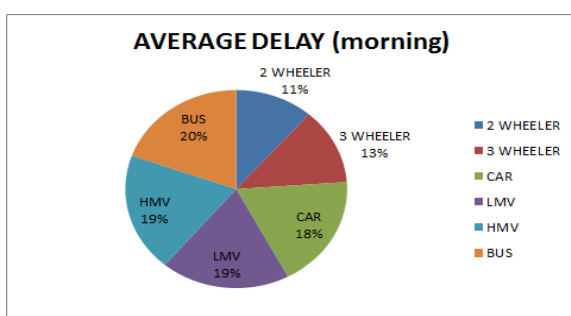

Fig.5 Traffic volume count (Evening)

Fig.6 Average Delay Time (Morning)

Fig.7 Average Delay Time (Evening)
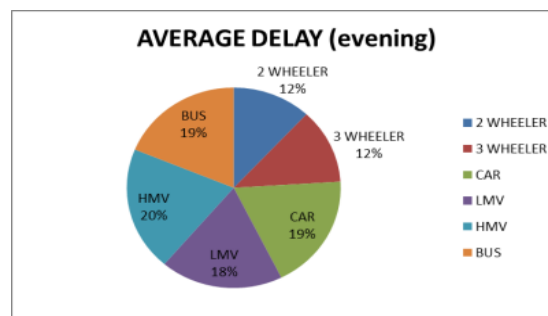
	MODE	OPPORTUNITY COST (Rs)	DELAY (Rs/hr)
MORNING	2 WHEELER	883.81	5404.470693
	3 WHEELER	102.55	
	CAR	2010.37	
	LMV	127.42	
	HMV	22.44	
	BUS	2257.89	
EVENING	2 WHEELER	1418.39	9862.450116
	3 WHEELER	197.35	
	CAR	4651.54	
	LMV	123.22	
	HMV	37.91	
	BUS	3434.04	

Fig.8 Opportunity Cost (Morning and Evening)

After the analysis the conclusions is that the maximum amount loss during congestion is due to cars and buses. Opportunity cost was mainly incurred for buses and two wheelers. The reason is that all buses like college buses, public transports, local buses travels through this path. Also, mainly people use two wheelers for their work and non-work trips. Sudden release of traffic flow from intersection nearby also contributes for congestion.

REFERENCES

[1]. S. Patni, V. Landge, and S. Gupta, "Motor vehicle traffic congestion costing in Nagpur city," *International Journal of Civil Engineering and Technology*, vol. 8, no. 4, 2017.
[2]. C. R. Sekhar, P. Raj, P. Parida, and S. Gangopadhyay, "Estimation of delay and fuel loss during idling of vehicles at signalised intersection in Ahmedabad," *Procedia-Social and Behavioral Sciences*, vol. 104, pp. 1178–1187, 2013.
[3]. M. J. Solanki, F. Umrigar, L. Zallu, and A. A. Amin, "Travel time & congestion analysis under heterogeneous traffic condition of cbd area case study of Surat-rajmarg (Chowk bazar to Delhi gate)," *International Journal of Current Engineering and Technology*, vol. 6, no. 4, pp. 1224–1234, 2016.
[4]. G. Bivina, V. Landge, and V. S. Kumar, "Socio economic valuation of traffic delays," *Transportation Research Procedia*, vol. 17, pp. 513–520, 2016.
[5]. A. Chakrabartty and S. Gupta, "Estimation of congestion cost in the city of Kolkata—a case study," *Current Urban Studies*, vol. 3, no. 02, p. 95, 2015.
[6]. S. Jayasooriya and Y. Bandara, "Measuring the economic costs of traffic congestion," in *2017 Moratuwa Engineering Research Conference (MERCon)*. IEEE, pp. 141–146, 2017.
[7]. M. S. Ali, M. Adnan, S. M. Noman, and S. F. A. Baqueri, "Estimation of traffic congestion cost-a case study of a major arterial in Karachi*," Procedia Engineering,* vol.77, pp 37-44, 2014.