Feasibility Study of Provision for Exclusive Bus Lanes on Urban Roads

Arathi A R, VincyVerghese

Abstract: ***Optimal use of road transport system is necessary to address the problems like traffic congestion, air pollution and safety. One such way to optimize is by encouraging use of public transport modes (buses) by assigning priority to them. One of the bus preferential treatments is the provision of exclusive lanes for buses on urban roads. The specific aim of this study is mainly to study the feasibility of provision of exclusive bus lanes based on two criteria, based on proportion of travellers using different types of road vehicles and based on the total travellers' time savings in terms of money value due to provision of exclusive bus lane on urban roads. The major work element of this study includes vehicle occupancy survey, vehicle volume and composition survey, income survey and estimation of journey time and journey time savings in terms of money value savings. The provision of exclusive bus lanes on urban roads increases the speed of buses, reduces journey time, saves travel cost and reduces road crashes.***

Index Terms: Exclusive Bus Lane, Money Value Savings, Vehicle Composition, Windshield Method.

I. INTRODUCTION

Transportation aims at safe and efficient movement of goods and passengers. Faster mobility of goods and passengers is the catalyst for economic growth of a country and this is facilitated by efficient transportation system. In case of road transportation systems, as facility increases, the volume of traffic also increases due to increasing demand for transport, particularly in developing countries like India. Because of the space, financial and material constraints urban road infrastructure cannot be developed beyond a limit and this leads to increase in congestion, pollution and reduction in road safety. Hence, there is a need for an appropriate strategy for optimal use of road transport system to reduce congestion and to increase efficiency of road networks. One way to reduce congestion is by encouraging the travellers to use public transport system (Buses) instead of private transport modes, because public transport system enables mass transit of passengers in fewer vehicles. To bring about a shift in the passenger preferences, the public transport system should be highly efficient and relatively less expansive to attract the travellers from private modes of transport. This goal can be attained by encouraging public transport modes like buses by assigning priority. One of the methods of assigning priority to public transit are by providing exclusive bus lanes.).

Exclusive bus lanes are the lanes restricted only for buses provided in order to speed up the buses, to reduce the interactions between buses and other modes of vehicles and thereby reducing the road crashes.

II. OBJECTIVES

By considering the aim of the study, the main objective formulated is to study the general impact of provision of exclusive bus lanes on traffic flow characteristics un-der heterogeneous traffic conditions. To achieve this main objective the subtasks formulated was the following.

1. To develop social criteria based on the proportion of travellers using different modes
2. To develop economic criteria based on the money value of time of travellers using the different modes.

III. LITERATURE REVIEW

Arasan and Vedagiri [1] estimated the probable shift of car users to bus due to the increase in level of service (LOS) after providing exclusive bus lanes on Indian city roads carrying heterogeneous traffic. The increase in LOS was determined using a recently developed simulation model. A mode-choice probability curve to depict the possible modal shift of car users to bus was developed. From the curve, the probability of shift of car users to bus was estimated 0.7 at traffic flow corresponding to level of service C, for an 11 m wide road and 0.28 for 14.5 m wide road. Arasan and Vedagiri [2] developed and used a heterogeneous traffic flow micro-simulation model to study the impact of provision of reserved bus lanes on urban roads in terms of reduction in speed of other categories of motor vehicles due to the consequent reduction in road space, over a wide range of traffic volume. It has been found that the maximum permissible volume to capacity ratio that will ensure a LOS C was 0.62 for the traffic stream other than buses if the bus lane is provided. Justification of providing exclusive bus lane has also been defined on the basis of number of travellers per unit width of the road. Cevero [3] developed working paper on Bus Rapid Transit (BRT): An efficient and competitive mode of public transport. This report reviews experiences with designing and implementing BRT systems worldwide. BRT is first defined across a spectrum of service qualities and costs. The report closes with discussions on BRT's likely future given global growth projections and other pressing policy agendas in the foreseeable future. Chen et al. [4] carried out a study to examine the effect of exclusive bus lanes (XBLs) and transit signal priority (TSP) on bus rapid

Revised Manuscript Received on June 23, 2018.

Arathi A R, PG Scholar, Department of Civil Engineering, Jyothi Engineering College, Cheruthuruthy, Thrissur, Kerala 679531, India

VincyVerghese, Assistant Professor, Department of Civil Engineering, Jyothi Engineering College, Cheruthuruthy, Thrissur, Kerala 679531, India

transit (BRT) in China. A micro-simulation analysis was created based on extensive field data collection. The analysis showed that XBLs and TSP have a significant impact on the operational performance of BRT if both are implemented simultaneously.

Syed et al. [5] studied the Impact of Exclusive Bus Lanes on Traffic Performance in Urban Areas. In this paper, two different transit priority strategies at an intersection are analyzed and their performance impact is evaluated in terms of reduction in delay of the buses and cars, due to the priority given. The main findings of the study are that the bus priorities are more efficient at high volumes. Micro-simulation tool VISSIM is used to carry out the simulation process.

Abdelfatah and Abdulwahid [6] studied the Impact of Exclusive Bus Lanes on Traffic Performance in Urban Areas. This study investigates the impact of XBLs on urban road network performance under different traffic conditions using the micro-simulation software, VISSIM. It considers different parameters such as demand-to-capacity ratio D/C, traffic turning percentages and bus headway and direction.

IV. Study Area

Study area was selected considering the roadway geometry, traffic movement features and availability of suitable location for mounting the video camera. The area that satisfied the said requirements is Thrissur - Kechery road (17 km), state highway 69, Kerala. In that route Punkunnam – Puzhakkal road stretch is selected as study stretch. The selected stretch of road is four lane divided road and 1.8 km long. The available width of the carriageway is 14.5 m (7.0 m in both directions).

V. Data Collection

A. Vehicle Composition

The required traffic data for the study was collected by video recording of the traffic flow on the selected location. A total of 4999veh/hour, 4140veh/hour and 4926veh/hour were observed to pass through the section during the morning peak hour, off peak hour and evening peak hour respectively. The observed vehicle composition was shown in Fig. 1.

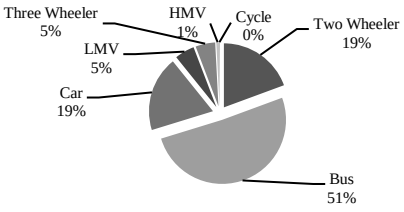

Fig. 1.Observed traffic composition.

B. Vehicle Occupancy

Occupancy of different modes of vehicles is determined using windshield method. Average occupancies of 58.84, 1.36, 2.28, 2.32, 2.76, 1.24 and 1.00 are obtained for bus, two wheeler, three wheeler, car, LMV, HMV and cycle respectively. Proportions of travellers using each mode of vehicles are shown in Fig. 2.

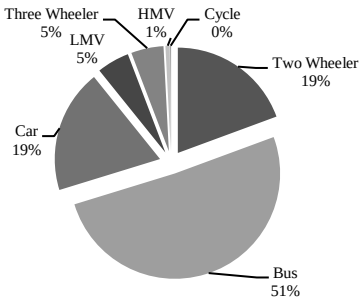

Fig.2.Observed traffic composition.

C. Speed

The time taken by different modes of vehicle to pass the known distance is retrieved from video and speeds of different modes of vehicles towards Thrissur and Kechery directions are determined. During peak hour the speeds of vehicles are less and their journey time are more compared to off peak hour.

D. Survey of Income of Travellers

Survey for monthly income of travellers is done at different locations in Thrissur city for different modes of vehicles. Proportion of travellers using different modes of vehicles under each income group is determined. Using (1), the hourly income of the users of different modes was calculated.

$$Hourly\ Income = \frac{Monthly\ Income \times 12\left(\frac{months}{in\ a\ year}\right)}{52\left(\frac{weeks}{in\ a\ year}\right)\times 5\left(\frac{working\ days}{in\ a\ week}\right)\times 8\left(\frac{working\ hours}{in\ a\ day}\right)} \quad (1)$$

VI. Data Analysis

A. Journey Time Savings In Terms of Money Value

According to survey, 45% of passengers are ready to shift to bus after the implementation of exclusive bus lane. The reduced traffic volumes after 45% shift of occupants to bus towards Thrissur and towards Kechery are determined. During peak hour and off peak hour, the speeds are determined for different modes of vehicles corresponding to actual traffic volume (without bus lane).Then, the speeds of different modes of vehicles except bus for reduced traffic volume (with exclusive bus lane) is determined using interpolation technique. After the implementation of exclusive bus lane, the bus can flow freely with an increased speed around 70 km/h [6], without any interruption from other vehicles. Then from this speeds, journey time of all modes of vehicles with and without bus lanes were calculated for travelling a distance of 17km road. While analyzing the journey time, it can be observe that the journey time for all modes are reduced with the implementation of exclusive bus lane. Then, the journey time savings for different modes of vehicles are determined. For bus, a savings of around 11 minute is obtained after the implementation of exclusive bus lane.The journey time savings are then converted into money value savings by multiplying the journey time savings of each mode with their corresponding hourly incomes and calculated money savings was shown in Table I. A total of ₹ 2777 money savings per hour are obtained with the provision of exclusive bus lane.

TABLE I: MONEY VALUE SAVINGS

Vehicle Type	Savings in Journey Time (min)		Average Hourly Income (Rs.)	Money value savings (Rs.)	
	Towards Thrissur	Towards Kechery		Towards Thrissur	Towards Kechery
Two Wheeler	0.37	0.41	159.13	58.88	65.24
Three Wheeler	0.68	0.33	139.13	94.61	44.52
Car	0.21	1.29	195.61	41.08	252.34
LMV	0.03	2.26	187.50	7.50	425.63
Bus	10.49	10.58	73.55	771.54	778.16
HMV	0.15	1.18	177.40	26.61	211.11
Total money value savings				Rs.2777	

B. *Minimum Frequency and Composition of the Buses*

There were 51 buses per hour and 62 buses per hour flowing towards Thrissur and Kechery respectively. The minimum frequencies of buses obtained were 1.2 min towards Thrissur and 1.0 min towards Kechery.

Minimum composition of the buses is obtained by dividing the total number of buses in that direction by the average occupancy of bus. The minimum composition is obtained as 0.90% towards Thrissur and 1.10% towards Kechery.

C. *Road Space Allocation*

Total width of the selected road stretch is 7m (in one direction), extra 3.5m is pro-posed to be provided exclusively for buses on both directions adjacent to the curb. So that passenger can easily enter to and exit from the buses. A schematic layout of the road stretch with 3.5 meter exclusive bus lane is shown in the Fig. 3.

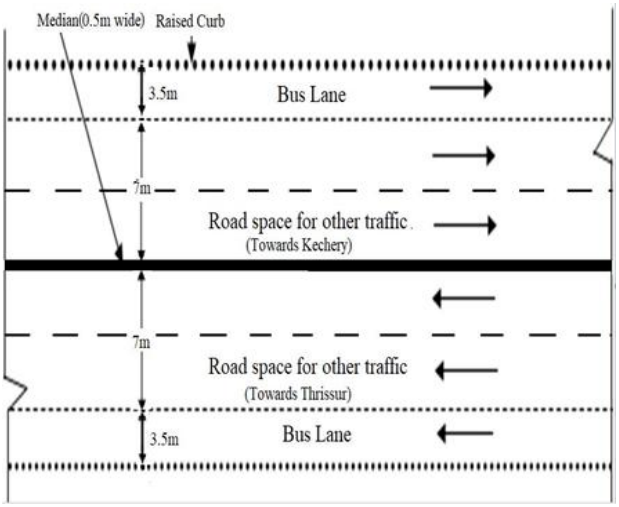

Fig.3.Schematic layout of the road stretch with exclusive bus lane.

D. *Findings*

The feasibility study of provision for exclusive bus lane is done based on proportion of travellers using buses and other vehicles and the journey time savings in terms of money value. The following are the findings of this study:

1. The bus travellers, constituting 51% of the total of the travellers, will use only 33 % of the road space, whereas, the users of all the other modes (excluding buses) constituting 49 % of the total of the travellers, will use 67 % of the road space. This shows that the provision of exclusive bus lane is justifiable based on the proportion of travellers using different modes of vehicles.
2. The money value of total travellers' time savings in one hour, due to the provision of exclusive bus lane on 14.5 m wide and 17 km long urban road stretch was estimated as ₹ 2777 per hour. This shows that the provision of exclusive bus lane is justifiable based money value of journey time savings.
3. Minimum frequency of bus is determined as 1.2 min towards Thrissur and 1.0 min towards Kechery and the minimum composition of buses were 0.9% and 1.1% towards Thrissur and Kechery respectively.

E. *Findings*

The following are the features of the proposed exclusive bus lane:

- Free flow of buses without any delay
- Proper and systematic scheduling of buses
- Speed = 70 km/h
- Journey time = 14.57 min
- Journey time saved by around 11 min
- Minimum frequency of bus services required = 55s
- Money value savings = ₹ 775 per hour
- Increased proportion of travellers using bus=7%
- Bus headway = 0.85 km
- Width of exclusive bus lane = 3.5m (near curb)
- Length of exclusive bus lane= 17km

VII. CONCLUSIONS

By introducing this systematically scheduled and rapid bus service in exclusive bus lanes, more travellers will get attracted towards it and there by the use of public transportation gets enhanced and the private transportation gets reduced. By increasing the frequency of bus services, the demand for bus transit increased. As frequency increases waiting time for the travellers reduced. More travellers get attracted to bus transit. This will reduce the accidents, pollution and congestion problems. Therefore, it increases the efficiency of the road transportation system and thereby increasing the social and economic background of the country itself.

The obtained results are based on the limited data collected. More extensive data collection and the analytical reasoning are required. Reliable results will be obtained only after the implementation. For getting more reliable results implementation has to be done in simulation software. Land acquisition problems due to extra widen-ing have to be analysed to make this study more acceptable one.

ACKNOWLEDGMENT

I express my sincere thanks to my colleagues ThasneemNadirsha, Midhun T. and Leejiya Jose for their help during data collection.

REFERENCES

1. V.T. Arasan and P. Vedagiri, "Simulating heterogeneous traffic flow on roads with and without bus lanes," Journal of Infrastructure Systems, vol.15, no. 4, pp. 305-312, Dec. 2009.

2. V.T. Arasan and P. Vedagiri, "Micro simulation study of the effect of exclusive bus lanes on heterogeneous traffic flow," Journal of Urban Planning and Development, vol. 136, no.1, pp.50-58, Jun. 2010.
3. R. Cervero, "Bus Rapid Transit (BRT): An efficient and competitive mode of public transport," Institute of Urban and Regional Development, Aug. 2013.
4. Y. Chen, G. Chen and K. Wu, "Evaluation of performance of bus lanes on urban expressway using paramics micro-simulation model," Procedia Engineering, vol. 137, pp. 523 – 530, 2016.
5. U. Syed, S. D. Ghodmare and B. V. Khode, "Performance impact of various bus priority strategies using vissim 7.0," International Research Journal of Engineering and Technology, vol. 3, no. 4, pp. 2479 – 2483, Apr. 2016.
6. A. Abdelfatah and Abdulwahid A. R., "Impact of exclusive bus lanes on traffic performance in urban areas," Proceedings of the 2nd World Congress on Civil, Structural and Environmental Engineering, vol. 125, pp. 1 – 10, Apr. 2, 2017.

AURTHORS PROFILE

Arathi A R is born and brought up at Thrissur district of Kerala state, India. She was born on 3 rd May 1996.After schooling, she took Bachelor of Technology in Civil Engineering, from Government Engineering College, Thrissur, Kerala, India, in the year of 2017. She is pursuing Master of Technology in Transportation Engineering inJyothi Engineering College, Cheruthuruthy, Thrissur, Kerala, India, which will be completed in 2019. Her field of interest is transportation and traffic engineering. She worked as an Intern in NATPAC, Thiruvananthapuram, for two months in 2018.

VincyVerghese was born in Thrissur, India in 1987. She received Bachelor's degree in Civil Engineering and Master's degree in Traffic and Transportation Engineering, from College of Engineering Trivandrum under Kerala University, Thiruvananthapuram, India in 2008 and 2010 respectively. She was a research scholar in Indian Institute of Technology, Madras, India from 2012 to 2017.

She worked as Assistant Professor in Marian Engineering College, Thiruvananthapuram for one year in 2011 and is currently working as Assistant Professor in Jyothi Engineering College, Thrissur, India, since 2017. Her area of interest include control theory, adaptive traffic signal control, urban traffic networks, congestion mitigation, intelligent transportation systems and modifiers in bituminous pavement design.