ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

PCON-2019

National Conference and Seminar on Innovations in Engineering & Technology

Govt Polytechnic College, Palakkad

Vol. 8, Special Issue 1, January 2019

Feasibility Study of Provision for Exclusive Bus Lanes on Urban Roads : Effect on Intersections

Arathi A R[1], Vincy Verghese[2]

PG Scholar, Department of Civil Engineering, JECC, Thrissur, India[1]

Assistant Professor, Department of Civil Engineering, JECC, Thrissur, India[2]

Abstract: Optimal use of road transport system is necessary to address the problems like traffic congestion, road crashes, road user safety and air pollution. One such way to optimize is by encouraging use of public transport modes by assigning priority to them. One of the bus preferential treatments is the provision of exclusive lanes for buses on urban roads. This goal can be attained by encouraging public transport modes like buses by assigning priority. By providing exclusive road space for buses will facilitate faster movement of more people in less number of vehicles resulting in reduced congestion, road crashes and also air pollution. Main objective of the work is to study the feasibility of provision of exclusive bus lanes on urban roads and to study the general impact of exclusive bus lanes on traffic flow characteristics under heterogeneous traffic conditions. Methodology includes, vehicle composition survey, vehicle occupancy survey and survey of income of travelers. Collection of data on traffic flow is done to estimate the traffic volume and composition at the four intersections along the selected stretch of road. Data was collected using video camera. Vehicle occupancy survey was also carried out in Thrissur city, Kerala. Windshield method was used for the occupancy survey and income survey done at different locations in Thrissur city.

Keywords: Congestion mitigation, Exclusive bus lanes, Heterogeneous traffic, 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 travelers 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 travelers 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 is 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

Based on the need for study mentioned above, main objective of the work is to study the feasibility of provision of exclusive bus lanes on urban roads and to study the general impact of exclusive bus lanes on traffic flow characteristics under heterogeneous traffic conditions.

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 journey time of travellers using the different modes.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

PCON-2019

National Conference and Seminar on Innovations in Engineering & Technology

Govt Polytechnic College, Palakkad

Vol. 8, Special Issue 1, January 2019

III. LITERATURE REVIEW

Tanabooriboon and Toonim [1] determined the impact of with-flow bus lane on bus movements and on passenger car traffic. License plate technique and classified traffic flow counts were used to collect the field data which comprised bus and car travel times, and traffic flow and composition. It was found that the implementation of bus-lanes had a positive impact on the level of service of buses operation, and generally did not adversely affect the level of service of other vehicular traffic.

Shalaby [2] used TRANSYT-7F, a macroscopic simulator to examine the impact of reserved bus lane on the performance of through buses and adjacent traffic. From the simulation, speed, travel time, total and average delays and fuel consumption were estimated. The analysis of changes in performance showed that the performance of the average bus increased whereas the performance of the adjacent traffic deteriorated. Simulations were also done by providing different turn lanes at intersections and by permitting the taxies to use the reserved lanes. Provision of left-turn lanes made minor impact on the performance. The performance of other traffic deteriorated if the taxies are not permitted to use the reserved bus lane.

Arasan and Vedagiri [3] 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.

Yu and Kun [4] studied the efficiency of buses and other vehicles after the arrangement of bus lane. Intersection delay, capacity, saturation, and link-travel time were considered as the index for adaptability evaluation. They established an evaluation model for traffic efficiency adaptability of bus, social vehicles and all the other vehicles as well as to evaluate efficiency difference focusing on human-orientation before and after arrangement of bus lane on the whole road section. They identified that the arrangement of bus lanes will bring certain indirect benefits such as increased attraction to public buses, traffic jam reductions and reduction in pollution level and improved traffic environment.

Arasan and Vedagiri [5] 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 travelers per unit width of the road.

Cevero [6] 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. Global trends are next reviewed, highlighting cities and regions of the world with the most extensive and advanced systems. The report closes with discussions on BRT's likely future given global growth projections and other pressing policy agendas in the foreseeable future.

Siddarth and Ramadurai [7] presents a method and results on sensitivity analysis and automatic calibration of VISSIM model using data from an intersection in Chennai. This intersection has heavy flows during the peak time. VISSIM parameters affecting driving behaviour in Indian heterogeneous conditions were found using sensitivity analysis. ANOVA and elementary effects method were used in sensitivity analysis. The model was calibrated using Visual C++ COM interface of VISSIM. Genetic Algorithm was used to find the optimal combination of sensitive parameters during calibration.

Chen et al. [8] carried out a study to examine the effect of exclusive bus lanes (XBLs) and transit signal priority (TSP) on bus rapid 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. [9] 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 [10] 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.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

PCON-2019

National Conference and Seminar on Innovations in Engineering & Technology

Govt Polytechnic College, Palakkad

Vol. 8, Special Issue 1, January 2019

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. Location of the study area is as shown in Fig. 1. In that route Puzhakkal to Peramangalam road is selected as study stretch. The aerial view of this stretch is as given in Fig. 2. The selected stretch of road is four lane divided road and 3.5 km long. The available width of the carriageway is 14.5 m (7.0 m in both directions). Existing speed limit for that stretch of road is 50 Km/h.

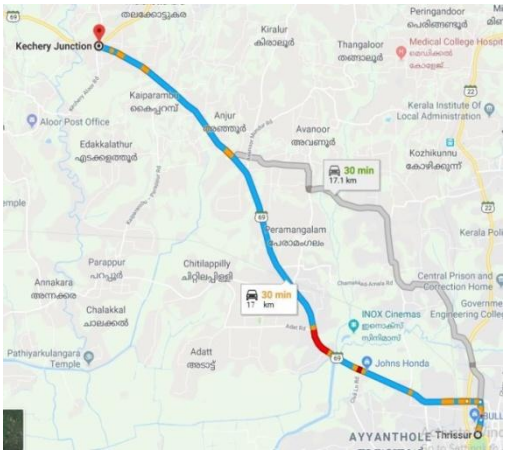

Fig. 1 Study area

Fig. 2 Arial view of the study stretch

V. DATA COLLECTION

The data needed for studying the feasibility of exclusive bus lane includes vehicle composition, vehicle occupancy and monthly income of travelers.

A. Vehicle Composition

The traffic composition on the roads of Thrissur city is highly heterogeneous comprising vehicles of wide varying static and dynamic characteristics. The traffic flow at four intersections(Puzhakkal, Muthuvara, Amala and Peramangalam), along the selected study section. was recorded during the peak period using a video camera mounted on the terrace of

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
PCON-2019
National Conference and Seminar on Innovations in Engineering & Technology
Govt Polytechnic College, Palakkad
Vol. 8, Special Issue 1, January 2019

an adjoining building, which enabled recording traffic flow. Then, these video recordings were transferred to the computer and data extracted from the video manually using macro in excel. The category-wise vehicle count was made conveniently by repeatedly playing the video recording in the computer. It is observed that the major part of road traffic is constituted by two wheelers and the minor part is by the heavy motor vehicle. Screen shot of the traffic flow at each intersection are shown in Fig. 3.

Fig. 3 Traffic flow at selected intersections

B. Vehicle Occupancy Survey

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 travelers using each mode of vehicles are shown in Fig. 4.

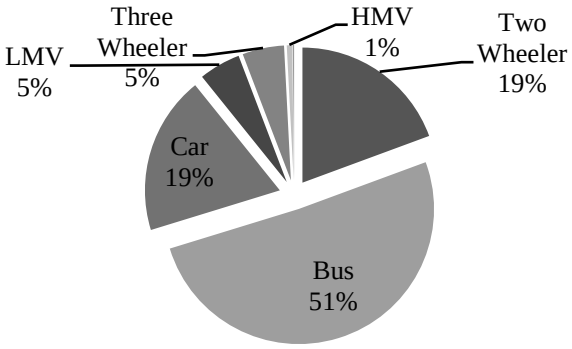

Fig. 4 Proportion of travelers

C. Survey of Income of Travelers

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

$$\text{Hourly-Income} = \frac{\text{Monthly Income} \times 12\left(\frac{\text{months}}{\text{in a year}}\right)}{52\left(\frac{\text{weeks}}{\text{in a year}}\right) \times 6\left(\frac{\text{working days}}{\text{in a week}}\right) \times 8\left(\frac{\text{working hours}}{\text{in a day}}\right)} \quad (1)$$

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
PCON-2019
National Conference and Seminar on Innovations in Engineering & Technology
Govt Polytechnic College, Palakkad
Vol. 8, Special Issue 1, January 2019

D. Road Space Allocation

Total width of the selected road stretch is 7m (in one direction), extra 3.5m is proposed 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. 5.

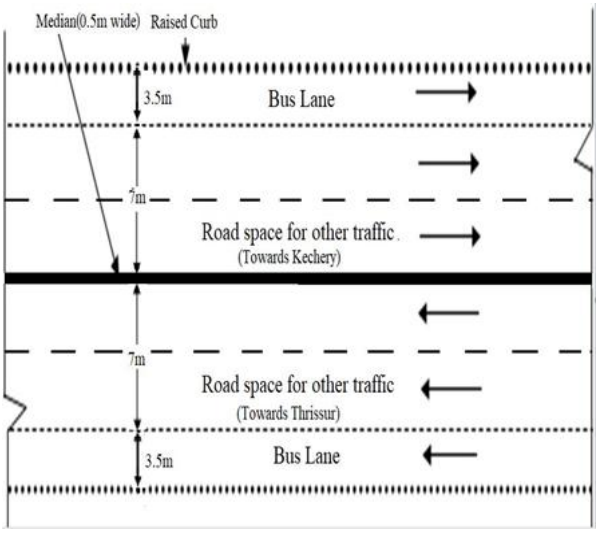

Fig. 5 Schematic layout of the road stretch with exclusive bus lane

VI. RESULTS

The bus travelers, constituting 51% of the total of the travelers, 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 travelers, will use 67 % of the road space. This shows that the provision of exclusive bus lane is justifiable based on the proportion of travelers using different modes of vehicles.

The money value of total travelers' 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.

There were 54 buses per hour and 32 buses per hour flowing towards Thrissur and Kechery respectively. The minimum frequencies of buses obtained were 1.2 min to-wards Thrissur and 1.9 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 0.92% towards Thrissur and 0.54% towards Kechery.

During one hour period, the total straight traffic flow at Puzhakkal, Muthuvara, Amala and Peramangalam intersections are1326, 1477, 1621 and 1184 vehicles per hour towards Kechery direction and 2122, 2689, 2548, 1994 towards Thrissur directions respectively . Their respective turning volumes are 227, 277, 95 and 70 vehicles per hour (towards Kechery direction) and 778, 154, 112 and 87 vehicles per hour (towards Thrissur direction). This indicates that the straight traffic movement is more compared to turning movements and hence the delay will be less while providing exclusive bus lanes. Also the frequency of buses along selected study stretch is also high.

VII. CONCLUSION

Under Indian conditions, the urban roads are relatively narrow and hence, provision of exclusive bus lanes on these roads may adversely affect the users of other vehicles to a significant extent, resulting in reduced speed. Hence, strong justification, on rational basis, is needed for provision of exclusive lanes for buses. Introduction of provision of exclusive bus lanes with systematically scheduled and rapid bus service, more travelers 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 travelers reduced. More travelers get attracted to bus transit. This will reduce the road crashes, road user safety, 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.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

PCON-2019

National Conference and Seminar on Innovations in Engineering & Technology

Govt Polytechnic College, Palakkad

Vol. 8, Special Issue 1, January 2019

VIII. FUTURE SCOPE

The obtained findings are based on the limited data collected. More extensive data collection is needed and further analytical reasoning needs to be found out. Reliable results will be obtained only after the implementation of exclusive bus lanes. For getting more reliable results, implementation of the strategy has to be done in simulation software like VISSIM.

REFERENCES

[1]. Y. Tanabooriboon and S. I. Toonim, "Impact study of bus lanes in bankok, Journal of Transportation Engineering, Vol. 109, no. 2, pp. 247 – 256, 1983.
[2]. S. A. Shalaby, "Simulating performance impact of bus lanes and supporting measures", Journal of Transportation Engineering, Vol. 125, no. 5, pp. 390 – 397, 1999.
[3]. 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.
[4]. B. Yu and X. Kun, " Discussion about evaluation method of traffic efficiency adaptability of bus lane", Second International Conference on Intelligent Computation Technology and Automation, IEEE, pp. 566-570, 2009.
[5]. 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.
[6]. R. Cervero, "Bus Rapid Transit (BRT): An efficient and competitive mode of public transport," Institute of Urban and Regional Development, Aug. 2013.
[7]. S. M. P. Siddharth & G. Ramadurai, "Calibration of VISSIM for indian heterogeneous traffic conditions, Procedia-Social and Behavioral Sciences, Vol. 104, pp. 380-389, 2013.
[8]. 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.
[9]. 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.
[10]. 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.

BIOGRAPHY

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 in Jyothi 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.

Vincy Verghese 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.