Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

Effect of Location and Bay Length on Performance of Bus Bays – Case Study on Trivandrum City

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Abstract **- Constraints to roadway capacity and congestion are at the forefront of issues which are faced by transportation professionals. These challenges along with budgetary restraints require thoughtful and innovative use of current facilities to maximize capacity. The thesis is about finding an optimum location of the bus bay which is at the downstream of a signalised intersection. Optimum location is selected by the position which minimises the queuing and disturbance to the adjacent lanes. Trivandrum city has synchronised signal systems. Since all the public transport buses follow the same route, same buses will be queued at all the intersections. Bus bay type of bus stop is constructed and separated from travel lanes and off normal section of a roadway that provides for the pickup and discharge of passengers. This design is meant to allow through traffic to flow freely without the obstruction of stopped buses. The existing bus bays do not have the facility to hold all the buses that are queued up. They interfere with the passing vehicles primarily while buses maneuverer to pull into and out of the bus bays. The queue length of the buses at the bus bay and the travel time of vehicles at the adjacent lanes are measured. Modelling is done using VISSIM software.**

I.INTRODUCTION

Bus bay types of bus stops are constructed mainly to separate the adjacent traffic flow from the buses which intends to stop at the bus stops, thereby reducing the congestion. Kerb side bus stops provide an obstruction to the flow of traffic. Bus bays allows easy access, unobstructed flow, minimal time spent at the bus stop and ensures smooth parking of buses

A. Need for study

Previous studies show that the share of Public Transport Thiruvananthapuram is nearly 40 percent and it consists of mainly bus transportation. The buses operating in Thiruvananthapuram City includes KSRTC City Ordinary /City fast buses, Private Buses operating in City Limits, Kerala Urban Road Transport Corporation (KURTC) Low Floor Non AC Buses, KURTC Low Floor AC Buses, KSRTC Mofussil Ordinary buses operating to various Towns in Thiruvananthapuram District, KSRTC Long Distance buses such as Fast Passenger/ Super-Fast/ Super Express buses etc. Almost 113 private stage carriers are in operation in the city limit and KSRTC is operating 1346 services daily using 520 buses. City buses are operating from East Fort Bus station and Mofussil buses are operating from Thampanoor Bus Station. The city buses except south bound buses ply through the common route .i.e. MG Road from East fort to Palayam, North bound buses including City as well as Mofussil share common route from Palayam to Kesavadasapuram. Considerable numbers of buses are operating from Medical College via Ulloor. It makes the concentration of buses very high in East fort- Ulloor section.

Most of the Junctions in the arterial roads of the city are signalized. The number of buses queuing up during the red phase of the signal will affect the performance of the bus bay when released together to the upstream bus stop during the green phase.

II. LITERATURE REVIEW

Bus bay type of bus stop is constructed and separated from travel lanes and off normal section of a roadway that provides for boarding and alighting of passengers safely. This design is meant to allow through traffic to flow freely without the obstruction of stopped buses. Bus bays are provided primarily on high volume or high speed roadways, such as sub-urban arterial roads. Also bus bays are frequently constructed in heavy congested downtown and shopping areas where large numbers of passengers may board and alight. The study stretch is Pazhavangadi intersection to Pulimoodu intersection in Trivandrum city. And the bus bay selected for study is Ayurveda college bus stop.

A. Previous Studies

Nurdin K. Mushule (2012) on his paper “Bus Bay Performance And Its Influence On The Capacity Of Road Network In Dar Es Salaam “ , 18% of the bus bay stops studied did not have capacity to cater for the available demand. 9% did not have adequate capacity during peak hours but the capacity was adequate during off-peak hours. The remaining 73% of bus bay stops possess adequate capacity all the time. Although most bus bay stops studied possess adequate capacity, severe congestion was observed at these locations. This is due to erratic behavior of bus drivers who do not utilize the provided space for them to drop off and pick up passengers.

Rodrigo Fernández and Nick Tyler on their paper “Study of Passenger-Bus-Traffic Interactions on Bus Stop Operations “, explains that it is important not to

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

underestimate the real situation found at bus stops, as designing for ideal conditions will be insufficient if the reality is different. It is seen that the actual arrivals at bus stops do not always follow a Poisson process, as is usually assumed. It was also stated when and why the differences in model outputs coming from Poisson and actual arrivals are statistically significant. In that case, a general purpose distribution cannot be used to model bus stop interactions. This leads to the necessity of microscopic simulation of bus, passenger and traffic interactions at bus stops to understand this seemingly simple problem.

By S. C. Wong et al (1998), in his paper “Delay At Signal-Controlled Intersection With Bus Stop Upstream”, a delay formula has been formulated, taking into account the passenger occupancies in buses and other vehicles in the calculation of signal timings for individual signal-controlled intersections with a bus stop upstream, would provide a more realistic signal plan in controlling the traffic on the street.

Gibson et al’s , (1989) Previous research suggests that bus stop capacity is an demand levels, and to investigate the operational performance of different bus stop configurations, twenty-two important determinant of overall bus system performance; Bus stops appeared to limit the capacity of several of the busways .

Reebu Zachariah Koshy (2005) on his paper “Influence of Bus Stops on Flow Characteristics of Mixed Traffic”, concludes that The flow level corresponding to a 25% reduction in general traffic speed would be an appropriate threshold value for the replacement of curbside stops with bus bays. The model may find its application in determining similar threshold values of traffic flow for the provision of bus bays of different widths and capacity, based on the road width, dwell times of buses, and traffic composition.

Borja Alonso et al (2008), in their paper “Public transport line assignment model to dual berth bus stops”, a methodology has been proposed to assign bus lines to divided stops, which minimises the costs to the user and takes into account the interaction with private traffic and congestion on the public transport system.

Xiao-mei Zhao et al(2014), in their paper “The capacity drop caused by the combined effect of the intersection and the bus stop in a CA model”, The combined effect of the signal-controlled intersection and the near-by bus stop is studied by using a two lane CA model. The simulations results indicate that the bus stop near the intersection serves as a bottleneck. They concluded that capacity increases as the distance between the bus stop and intersection increases.

Rodrigo Fernandez (2010) in his paper “ Modelling public transit stops by microsimulation”, presents a microscopic model for the study of operations at public transport stops, mainly bus stops and light rail transit stations, from the perspective of the traffic analysis. He states that a stop cannot operate near its absolute capacity, for upstream queues will develop even for low degrees of saturation. Unlike a junction where queues can be accommodated upstream the stop line, in a public transport stop there is few room for such queues. Probably no more than one vehicle during a short period would be acceptable.

V. ThamizhArasan and ReebuZacharia Koshy (2005) in their paper “ Methodology for modelling highly heterogenous traffic flow “ discusses how the flow model is prepared, what all are the steps in simulation process and also the procedures adopted for validation purpose. The application of the traffic flow characteristics on the urban road is also presented.

Fangwei Zhang (2011), in his paper “Influence of various types of bus stops on traffic operations of bicycles, vehicles and buses”, evaluates how different types of bus stops influence the operation of bicycles, vehicles and buses. The study showed that different bus stop designs have different impacts on the operations of traffic flow.

III. DATA AND METHODOLOGY

A. Data

For the study the intersection volume data at 4 intersections were taken, Pazhavangadi intersection, Overbridge intersection, Ayurveda college intersection and Pulimoodu intersection.Other data collected are frequency of buses arriving at the bus bay, the dwell time of bus bay,the geometric details of the bus bay and the adjoining road and the signal data at the intersections..

A. Methodology

The bus bay which was at the downstream of a signalised intersection which showed congestion during peak hour. Literature review was conducted and the data were collected. The traffic volume counts at the intersections were found out and peak hour flow was determined. The bus stop was measured for four hours. The geometric details of bus bay and the adjoining road were measured and the signal timings at the intersections were obtained. Modelling was done using VISSIM software. Validation of the model was done by comparing the actual speed of vehicles and the simulated speed of vehicles. The output of the software was queue length at the bus bay and the travel time of vehicles at the adjacent lanes.

IV. MODELLING AND ANALYSIS

A. Software

VISSIM is a microscopic, time step and behaviour-based simulation model developed to model urban traffic and public transport operations and flows of pedestrians. The program can analyse private and public transport operations under constraints such as lane configuration, traffic signals, PT stops etc.

B. Calibration

Calibration values were obtained from secondary source. The section for calibration was from Overbridge intersection to Ayurveda college intersection.

C . Model Validation

The behaviour of the vehicles were visually examined with the help of animation of the traffic flow and bus movements at bus stops as shown by the simulation output. Validation was done by comparing the obtained value of vehicle speed and simulated value of vehicle speed. The section for validation is from Ayurveda college intersection to Pulimoodu intersection.

Table 1: Result of validation

OBSERVED VALUE	SIMULATED VALUE	ERROR
15.23	14.47	-4.99

V. RESULTS AND DISCUSSIONS

The main two results in the study are queue length of buses at the bus bay and travel time of vehicles at the adjacent lane. The simulation was done for 3 different dwell times – 10s,20s, and 30s, 3 different length of bus stops – 18.9m, 25m and 30m. 7 different positions – 5m , 10m, 20m , 30m , 40m , 50m and 60m. The actual position of bus bay at Ayurveda college is 10m from the intersection, the length of us bay is 18,9 and average dwell time is found to be 20s. The aim of the thesis is to determine the optimum dwell time of the buses which minimises the queueing and congestion at the bus bay.

Fig 1 : Graph of Queue length versus Dwell time for the position of bus bay 10m from the intersection

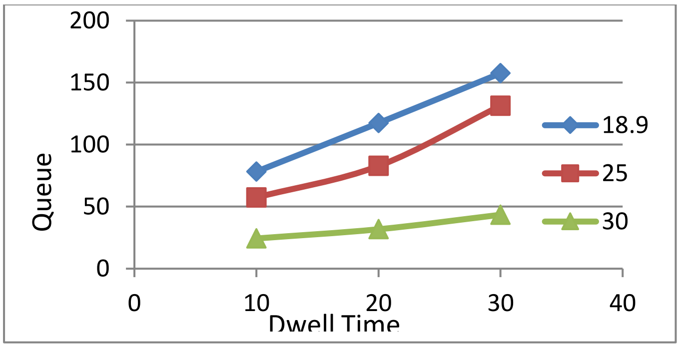


Fig 2 : Graph of Queue length versus Dwell time for the bay length 18.9m

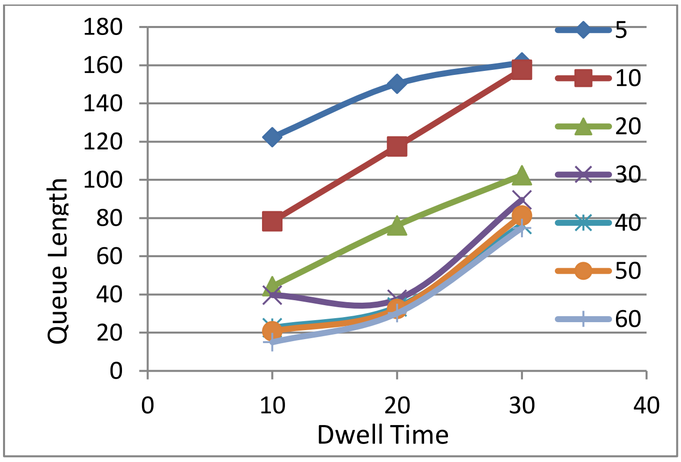


Fig 3 :Graph of Travel time versus Dwell time for the position of bus bay 10m from the intersection

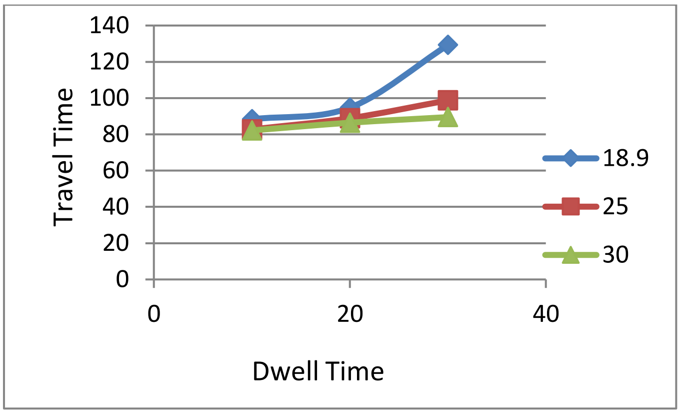
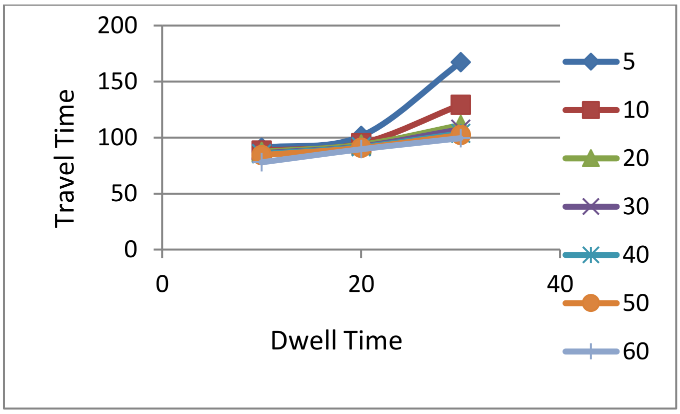


Fig 4 : Graph of Travel time versus Dwell time for the bay length 18.9m



V. CONCLUSION

In the study, it is seen that as the dwell time is increased the queue length as well as the travel time in that section increases. This is because, as the bus waits in the bay area for a longer time, more and more buses gets queued up behind it, which increases the queue length. Buses queuing to enter into the bay interfere with the traffic in the adjacent lane causing congestion, thereby increasing the travel time. So from the simulation study, we can understand that 10s is the most favourable dwell time option which gives the least queue length as well as the travel time. But a dwell time of 10s is not sufficient for the boarding and alighting demand of the passengers. So we propose that a dwell time of 20s is suitable for the present condition.

Also we can see that an increase in the length of the bus bay decreased the queue length and decreased the travel time. That is because, when the length of the bus bay is increased more buses can be accommodated into the bus bay, thus reducing the queuing up of buses which in turn reduces the congestion, thereby reducing the travel time. So we can safely say that a length of 30m is suitable in the present scenario.

And finally we could see that as the position of the bus stop is moved farther and farther away from the intersection, there is a significant reduction in queue length and travel time. That is because the presence of an intersection has a great effect on the performance of bus bays. The buses

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 01, January-2018

queuing up in the bus bay gets into the intersection and blocks the whole movement when the bus bay is situated too near the intersection. If the distance from the intersection is increased, the chances of buses blocking the intersection reduces and also the due to the availability of more space the queue gets resolved faster. From the graphs we can see that the variations for positions 40m, 50m and 60m are almost same. So the most economical position would be 40m from the intersection.

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