Roadside Friction, its Impact and Remedial Measures on Traffic Characteristics in Srinagar, Jammu & Kashmir (India)

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Abstract: Vehicles travelling on Srinagar city have precipitously increased resulting in an increase in traffic congestion and also leading decrease in the operation integrity of transportation. In spite of high financing in road and transportation developments, Srinagar city faces high and increasing problems of congestion, traffic accidents, air and noise pollution. Traffic congestion is particularly seen near bus stops, which occur due to the stoppage of the vehicle on the carriageway, causing shrinkage of road width by forming bottlenecks and ultimately leading the traffic jams. Traffic congestion in the city also got increased due to the high increase of private automobiles with the public transport for limited roadwayspace. Usage of private automobiles considerably declines the efficiency of public transportation buses and also causes increase in the traffic density on the roads. It is because of the fact that people using public transportation have to waste lot of time at bus stops and also in the buses to reach the destination, which also lead to change mind setup of the peopleand to get diverted for the usage of private automobiles. This whole scenario reduces efficiency and causes decline in the usage of public transport. The purpose of this project is to determine the roadway capacity loss at bus stops due to limited road width and later, after observing the situation by proper analysis of the collected data, remedial measures for the said cause is recommended for the smooth flow to the traffic. Data used for the analysis are collected for Srinagar city from two spots namely Pantha-chowk bus stop and Dalgate bus stops. The roadway is divided into two sections (A - Before bus stops, B - At bus stops). Based on bus arriving frequency during both the time, bus stop capacity has been defined. Results & analysis showed significant loss in roadway capacity for on-street bus stops. From the results, proper remedial measures were taken into consideration for the smooth flow to the vehicles moving on carriageway.

Keywords: Speed, Traffic volume, Traffic capacity, Dwell time, Clearance time, Bus stop, LOS

1. Introduction

Transportation infrastructure is one of the back bones of any country. For sustainable development, an economy has to ensure proper supply of transportation facilities. Vehicles on road have rapidly increased resulting in an increase in traffic congestion & decrease in operational integrity of transportation system. Despite investments in road infrastructure, and plans for land use and transport development, all cities face the ever increasing problems of congestion, traffic accidents, air, and noise pollution.

Traffic congestion significantly affects economic performance of the nation and living standards of the people. In majority of urban areas, travel demand exceeds highway capacity occasionally during peak periods. In addition, events such as crashes, vehicle breakdowns, work zones, adverse weather, suboptimal signal timing, etc. cause temporary losses in capacity, often deteriorating the situations on already congested road networks. These temporary capacity losses have significant impact on delay, reduced mobility, and reduced reliability of the roadway network. They may also cause the drivers to change their routes or reschedule their trips. The traffic characteristics of a road section can be influenced by various factors such as

surface type, shoulder and roadway width, terrain, driver skills, side friction or side activities, road maintenance, etc. However among all the factors, side frictions like bus stops, on-street parking, encroachments and frontage access significantly reduce the performance of an urban road.

Traffic congestion at bus stops in SRINAGAR particularly in Pantha-Chowk and Dalgate stops is on rise with increasing private automobiles on the roadways competing with public transports for the limited roadway spaces. Due to above considerations, efficiency of public transportation buses are declining considerably. Vehicle flow interaction, speed and density is determined at the bus stops of Pantha-Chowk and Dalgate.

2. Problem Identification

Traffic congestion at bus stops in JAMMU and KASHMIR particularly in Srinagar city is on rise with increasing private automobiles on the roadways competing with public transports for the limited roadway spaces. Due to above considerations, efficiency of public transportation buses are declining considerably.

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Figure 1: Traffic congestion at Srinagar (Pantha-Chowk) due to bus stop

Bus stops on roadways adversely affect the performance of roadways as well as capacity. When bus stops located on the carriageway, buses blocking the curb side traffic lane during their occupancy period or dwell period due to reduced width of the roadway or due to erratic behavior of driver. This bus stop also creates problems when attempting to re-enter the traffic, especially during the peak-hour period of high roadway traffic volumes.

Thus the project here is focused to determine the roadway capacity loss due to bus stops, due to limited roadway width. For that vehicle flow interaction, speed and density is determined at the bus stops of DAL-GATE and PANTHA-CHOWK and the remedial measures like proper bus bay usage is taken into consideration. The experimental studies are discussed later.

3. Aim and Objectives

In this project, the primary concern is bus stop locations on the highways and the consequences for traffic stream properties. The location of bus stops along a road carriageway lane is the main aim in this study. The number and type of bus stops provided on a road significantly influence the flow characteristics of traffic on the road. Along with the above concern, project also deals with the remedial reforms to the bus stops in the form of properbus bays. The main objectives of the proposed study are summarized as follows:

- To determine roadway capacity as perIRC-106-1990.
- To determine capacity loss at bus stops as per HCM 2000.
- To determine spot speed measurement at both sections i.e., before bus stop &at bus stop.
- To provide free flow movements at bus stops by providing proper designed bus bay.

4. Problem Specification

Problem caused at bus stops

- Huge traffic congestion due to bus stoppage.
- Traffic jam creates long queues of vehicles.
- Increase travel time and fuel consumption.
- Air pollution and noise pollution.



Figure 2: Traffic congestion and traffic jam at Dal-Gate bus stop

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Accident caused at site

- Most crashes happen at bus stops.
- Accident cause due to some technical problem of vehicle

5. Need and Significance of Proposed Research Work

The road traffic on JAMMU AND KASHMIR particularly SRINIGAR CITY and its areas like DAL-GATE, PANTHA-CHOWK is highly heterogeneous comprising vehicles of wide ranging static and dynamic characteristics. Under the heterogeneous traffic flow conditions, the buses, being relatively larger vehicles, find it difficult to maneuver through the mixed traffic and are subjected to frequent acceleration and deceleration leading to lower speed and discomfort to both the driver and passengers. The level of service of bus transit systems in <u>Srinagar</u> cities is gradually declining due to inadequate capacity and managerial and financial problems, making bus, a less attractive mode of transport. In the absence of an adequate and efficient bus transit system, the potential bus users shift to personal vehicles.

On 20-october-2017, one of the government official, as the traffic advisor to the Jammu and Kashmir made an official statement that "71 intersections to be redesigned for smooth traffic regulations" and along with it he also said that there would be proper provision for bus stops in Srinagar vicinity as "In high traffic flow, if vehicle stops even for 5 seconds, traffic behind will come to stand still".

The above scenario also leads us to go for related work of bus stop impact and to assemble/collect data for small network of road i.e. from Dal-Gate and Pantha Chowk. As ,this small work will benefit the residents of the land and feel us proud as the citizen of it.

The official statement of the officer is present in the image below taken from the leading news paper of the state, Greater Kashmir.



Figure 3: Greater Kashmir (statement of officer)

6. Experimental Work and Investigation

Collection and analysis of data play a pivotal role in the development of successful results. The traffic data should be collected by observing traffic flow near the bus stop. The collected data is then used for the analysis of capacity, level of service as per IRC. At each bus stop, parameters needed for analysis & calculation are as:

- Dwell time,
- Clearance time,
- Dwell time variability and
- Failure rate.

Methodology

Methodology used for the analysis and data collection is divided into various stages. The various stages are presented below.

- Road inventory survey
- Traffic survey and data collection
- Spot speed Survey
- Analysis

Road inventory survey

Before carrying out any improvement measure like bus bay facility, there is a need to obtain road width, surrounding

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features, obstructions if any in the alignment and other important information which helps in planning and design.

Traffic survey and data collection

- Classified Traffic Volume Count has been done manually to carry out analysis part.
- The Roadway section was divided into two sections, (Before Bus Stops &At Bus Stops), traffic count was done simultaneously at both section.
- In addition, bus arrival frequency was also studied at the same bus stops and same time. This was done by counting the buses that arrived within 15 min period.
- Subsequently, the maximum flow rate was then determined by considering the highest number of buses which arrived in any 15 min duration converted into equivalent hourly rate.

Spot speed Survey

- Spot speed study carried at both sections and compared.
- Speed at the bus stops reduces due to presence of bus stop on the street lane. When the buses stops on the onstreet bus stops in order to board or alight the passengers, following vehicles are forced to slow down their speed due to decreased lane width.
- By this speed reduces as well as number of vehicles passing also reduces and hence capacity reduces significantly

Analysis of data

- Calculation of PCU values of different classes of vehicle and defining LOS.
- Defining LOS base on Speed data.
- Determining Bus Stop Capacity.

These parameters would be used to calculate the capacity of each bus bay stop.

7. Selection of Study Area

The study area selected for the analysis is SRINAGARcity. Srinagar is a developing city with wide spread of commercial, industrial, government, private and other activities and having a good road network around the city with well-conditioned roads. In order to study the effect of these city buses on traffic, two bus stops are selected for the analysis and these two stops are as PANTHA-CHOWK BUS STOP and DAL-GATE BUS STOP.The above two bus stops come under the important national highway, which have the huge traffic flow through out whole year as it connects two ends of the country and has been named on the basis of it. This national highway is popularly known as **Srinagar-Kanyakumari Hwy.** (NH 44).Along with it these two spots also act for the service route to the various tourist destinations as DAL-GATE and PANTHA-CHOWK spots give connection to the Mughal gardens like Nishat garden, Shalimar garden etc. and other religious site like Hazratbal shrine.

- Pantha-Chowk Bus Stop
- Dalgate Bus Stop



Figure 4: Dal-Gate bus stop



Figure 5: Pantha-Chowk bus stop

8. Data Collection Calculations and Results

Dal-Gate Bus Stop Basic Capacity: 3200 Lane Width: 7.3 m Table 1: Level of service based on traffic count

Table 1. Level of service based on traffic count									
Description	Day	Before Bus Stop		At Bus S	Stop	LOS	Capacity		
		V (PCU/hr)	V/C	V (PCU/hr)	V/C		Loss (%)		
National highway road	01	1222	0.38	1404	0.44	В	12.96		
with frontage access	02	1032	0.32	1332	0.42	В	22.52		
with side roads,	03	1050	0.33	1162	0.36	В	9.63		
connecting Dal-Gate	04	934	0.29	1124	0.35	В	16.90		
with Pampore.	05	729	0.23	974	0.30	А	25.15		
	06	1154	0.36	1368	0.43	В	15.64		
	07	878	0.28	1126	0.35	В	22.02		

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Pantha-Chowk Bus Stop Basic Capacity: 2900 Lane Width: 7.3 m Table 2: Level of service based on traffic count

Description	Day	Before Bus Stop		At Bus St	op	LOS	Capacity	
		V (PCU/hr)	V/C	V (PCU/hr)	V/C		Loss (%)	
	01	1148	0.40	1302	0.45	В	11.82	
National highway	02	962	0.33	1024	0.35	В	6.05	
road with frontage	03	960	0.33	1112	0.38	В	13.66	
access with side	04	958	0.33	1096	0.38	В	12.59	
roads, connecting	05	616	0.21	760	0.26	А	18.94	
Pantha-Chowk with	06	970	0.33	1110	0.38	В	12.61	
Dal-Gate	07	684	0.24	814	0.28	А	15.97	

Traffic Volume Calculations for Bus Stop DAL GATE

Before Bus Stop at Bus Stop



Figure 6: No. Of vehicles BBS



Figure 7: No. of vehicles ABS

Traffic Volume Calculations for Bus Stop PANTHA-CHOWK

Before Bus Stop at Bus Stop



Figure 8: No. Of vehicles BBS



Figure 9: No. Of vehicles ABS

Spot Speed

LOS Based on Speed Data

Table 3: Level of Service Based on Speed Data										
Location	Section	2	3	Car/ Jeep	L.C.V	Truck	Bus	Tractor	Avg. Speed	LOS
		Wheeler	Wheeler							
DAL GATE	Before	45	32	47	38	29	25	-	36	С
	At	35	26	35	30	20	15	-	26.8	D
PANTHACHOWK	Before	41	28	42	40	30.5	26	20	32.5	С
	At	32	19	30	29.5	22	18	14	23.5	Е

Table 3: Level of Service Based on Speed Data

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Figure 10: Variation of speed at Dal-Gate BBS and ABS

Variation of speed at PANTHA-CHOWKBefore Bus Stop and At Bus Stop



Figure 11: Variation of speed at PanthaChowk BBS and ABS

Density

Table 4: Tabulated Density and LOS as per HCM 2000

Bus Stops	Section	Time Interval	Day	Flow	Flow	Speed	Density	Density	LOS
-			-	Veh/15min	Veh/hr	(kmph)	K	Km/h/l	
Dalgate	Before	15 mim.	01	271	1084	36	30.11	15	С
	At	15 mim.	01	307	1228	26.8	45.82	23	Е
Pantha-Chowk	Before	15 mim.	01	262	1048	32.5	32.24	16	D
	At	15 mim.	01	294	1176	23.5	50.04	25	Е



Figure 12: Variation of density BBS and ABS

Bus Stop Capacity

Table 5: Bus Stop Capacity							
Deversations	Location						
Farameters	Dal-Gate	Pantha-Chowk					
Dwell Time(s)	65	59					
Coefficient of Variation of dwell time	60%	60%					
Failure Rate	15%	15%					
Z_{2}	1.040	1.040					

g/c ratio	1	1
On Line / Off Line	On line	On line
Clearance Time S	28	49
Loading Area/ Bus Berth	2	3
No. Of Comulative effective berth	1.75	2.25
Bus Stop Capacity (bus/hr)	27	25
Max./Actual bus stop capacity (bus/hr)	48	57

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9. Remedial Measures

evaluation of bus stops should be used for stoppage of vehicles (buses). There are three types of bus stops i.e.

- On –carriageway bus stop
- Off –carriageway bus stop
- Separate bus lanes

On-Carriageway Bus Stop



Figure 13: On-carriageway bus stop

On carriageway bus stops are simple, as in this case provisions like bus stop cage, bus boarders are used on carriageway. In this type of stop, no separate bay is provided for the buses, as in this stop, buses could stop on the carriageway. But with this advantage, it leads to various inconveniences to the flowing traffic in the form of

From the data analysis and its results, it has been found that

with the side friction on the carriage way in the form of bus stops has great impact on the capacity of road. The data

analyzed in this thesis in the form of traffic volume, traffic

speed, density or LOS (level of service) of traffic shows a considerable changes. So, for the smooth flow, proper

bottlenecks, reduced speed etc. These bottlenecks are very dangerous as they cause problems to the traffic in the form of congestion, accident, time delays etc. Other main drawback with this kind of stop is conflict points.

Off-Carriageway Bus Stop



Figure 14: Off-carriageway bus stop

This is another type of bus stop, it needs additional land, other than carriageway for bus stops. But with this facility provided additional to the carriageway, various detriments of the former bus stop gets reduced. This type of bus stop is called as bus bay type of bus stop.

Separate Bus Lanes

This type of facility is best to service. It reduces conflict points founded during the exit of buses from bus bays. By this type of separate lane, a proper channelized traffic is seen on the roads, it reduces the chances of accidents, conflict points or the bottle necks. But there are some of the points which hinders its usage, some of it are as under:

- Extra land in the form of separate lanes is used.
- It is used only for national or express ways, this type of facility cannot be used for arterial routs.
- Huge economy is used for providing this kind of facility.

10. Selection of Alternative

From the various alternatives, the bus stop that we want to establish for our research will be off carriageway bus stop. As it has high meritorious result than on carriageway stop in the form of less conflict points, accidents, proper parking space for buses where passengers can easily alight or board buses without any risk, non-creation of bottlenecks etc.

In the figure below bottleneck creation are highlighted and from the figure, it can be seen that bottlenecks gets created in on carriageway bus stop, the creation of bottleneck leads to various traffic related problems. The various problems caused by this are:

- Reduction in speed behind stopped vehicle.
- Increase in density behind stopped vehicle
- Abrupt volume increase on carriageway which ultimately leads to traffic jams and time delays.
- Loss of LOS(level of service)



Figure 15: Bottleneck Caused by On-Carriageway Bus Stops

 $(S_1: upstream end)$ (S₂: transition section) (S₃: downstream end)

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Figure 16: No Bottleneck Creation by Off-Carriageway Bus Stops

 $\begin{array}{c} (S_{1:} \text{ upstream end}) & (S_{2:} \text{ transition section}) & (S_{3:} \text{ downstream end}) \end{array}$

Separate lanes are not taken into consideration because of it high economic value. So, from the above two provisions and their results, off carriageway bus stop is taken as the selected stop from alternatives.

11. Conclusion

It should be noted that the study was confined to determine the impact on the capacity of traffic by bus stops only. Some other parameters like problems due to mismanagement by traffic department, uneducated road users, law violationetc. are beyond the scope of research.

The data was collected from 2 different stop:

- Dal-Gate Bus Stop
- Pantha-Chowk Bus Stop

Data was collected for 10 hours survey from 8am to 6 pm and 7 day count was done for the data accumulation that is from Monday to Sunday represented as Day 01 to Day 07 respectively. Peak hour data of all the 7 days is presented in the research and mostly peak hour data comes from morning hours of Monday and the evening hours of Saturday .In case of other days it was changing.

From the data, various results were obtained for example:

- Traffic volume increases from before bus stop to at bus stop for all fore bus stops and there is capacity loss for all the bus stops, before bus stop and at bus stop.
- Average speed of different vehicles get decreased from before bus stop to at bus stop, with this speed reduction, level of service gets ranked down.
- For the case of density, it increases from before bus stop to at bus stop.

After the data gets analyzed for all the four bus stops, the remedial measures from the results are taken into consideration. The three remedial measures which are taken for the study are as:

- On carriageway bus stop
- Off carriageway bus stop
- Separate bus lanes

As for implementing and usage of the proper remedial measure from the three categories, off carriageway bus stop is taken as a best of the remedial measure because of its high hand over the on carriage way bus stop and it has greater edge over separate bus lanes because separate bus lane provision needs huge economy and large area for its implementation. It will also cause disturbance as:

- Various government buildings, commercial buildings, houses etc. have to be demolished for extra land width.
- Compensation is given to residential households, shopkeepers whose structures are raised down.
- It also takes lot of time from its construction to its usage.

That is why from the three, off carriageway bus stop is recommended as the best bus stop for the research.

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