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EFFECT OF LEFT TURNING VEHICLE ON QUEUE LENGTH & DELAY AT SIGNALIZED INTERSECTION: A CASE STUDY OF VRUNDAVAN CROSS ROAD VADODARA

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Abstract— The behaviour of traffic in the heterogeneous environment is complex and difficult to model. Cpmplexity increases many folds at intersection. In India due to heterogeneous traffic condition, traffic problems arise to the road users because different types of vehicle with different characteristics use the same roads. The more traffic signal time will result in bottleneck condition for the traffic hence the queue length and delay time of vehicle is more. Normally left turn vehicle has direct lane but sometime it is creating problems to vehicle from preceding road hence left turning vehicle creates conflict due left hand turning vehicle with merging of vehicle coming from preceding approach (straight movement). So many research works had been done on the left turning traffic like effect of left turn channelization on vehicle waiting time but the research work on vehicle queue length and delay time is less understood specially in mix traffic condition. The aim of this paper is to investigate the effect of left turning vehicles on queue length and delay at signalized intersection under mix traffic condition. The study area selected is Vrundavan intersection and the traffic survey was carried out during the morning time of 8:00 am to 12:00 noon and also for evening time 3:00 pm to 7:00 pm for working day as well as for non-working day. Data analysis is done with the help of VISSIM software. To solve the traffic problem of queue length and vehicle delay time Micro-Simulation Model is the best solution it can study models too complicated for analytical treatment. This paper focus on study of actual traffic condition of signalized intersection at Vrundavan intersection Vadodara and redesign a signal and simulated them using VISSIM Software.

Keywords— Left turn, Traffic congestion, VISSIM, Conflict, Signal, queue length.

I. INTRODUCTION

Rotary intersections are the particular form which are laid out for the movement of traffic in one desired direction around a central traffic island. Normally rotaries are preferable where high volume of turning traffic is carried out. The conflicts points arising from movements of traffic in all diff erent directions is addressed by time sharing principle. Generally, left turning movement has a direct path at some intersection which capacity is low. Left turning movement affect the traffic with opposing approach which creates conflict point, results in delays to vehicle, congestion at intersection. At intersection with permissive only signal control, pedestrians will move at the phase with through traffic movement and the permissive left turn movement.

Left-turning movement is permitted when straight movement is not affected at two phases signal control intersections. Left-turning movement is prohibited when the signal turns to yellow but, those vehicles those passed stop lines can continue to move. The left turn is an at-grade intersection is proposed to support high-traffic flow where there are large left turns and heavy through volumes. At a signalized intersection, typically, left-turning vehicle drivers are allowed to use the same signal phase that is assigned for the through vehicle.

Traffic in India is highly heterogeneous, comprising of different types of vehicles with widely varying static and dynamic characteristics. In order to study the behaviour and various interaction at intersection, simulation studies are carried out. A microscopic simulation tool VISSIM is used to model urban traffic. The program can simulate multi-modal traffic flows, including cars, goods vehicles, bus, heavy rail, two-wheeler, bicycle and pedestrians.

II. STUDY AREA

Vadodara is the largest city in the Gujarat, after Ahmedabad and surat. It is the administrative headquarters of Vadodara District. Known as “Baroda”. Area of Vadodara city is 149 sq. km and population of Vadodara city is 16.66 lakh (census India 2011). Vadodara is situated near the bank of the Vishwamitri river. Both the National Highway (NH 8) and railway line connect Delhi and Mumbai pass through Vadodara.

Study area is located 7 km far from the railway station. It is near to the National Highway which is connect all the major cities like Mumbai, Ahmedabad, Delhi etc. The study area is surrounding with too many education buildings which creates heavy traffic during the morning time and evening time and as it connects main area of city and highway so it is necessary to solve the traffic problems that particular area.

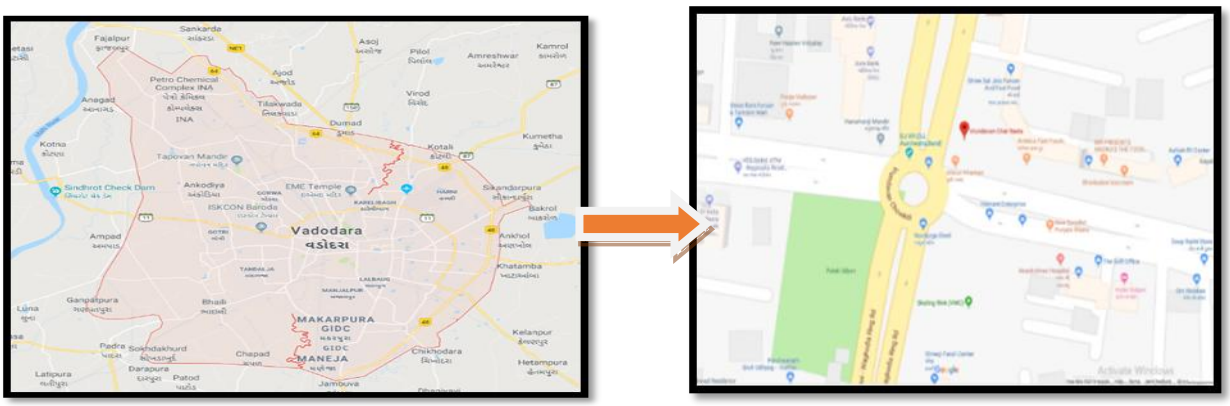

Figure 1 Study Area Location (Source: Google Map)

III. RESEARCH METHODOLOGY

Three scenarios are generated and compared.

1. Actual signal timing

   First the network is created in VISSIM software classified volume count is done and this data is put in VISSIM software. Actual signal is taken for analysis in software. Present signal time condition of Vrundavan intersection is fixed time signal in which the cycle length is pre-determined and fixed duration. This cycle length work for whole day for both peak and non-peak hour, which affect the road user travel time and people have to wait more time.

2. Design of signal timing using Webster method

   From the collected data of traffic count and observed actual signal timing, re-design of signal is carried out for the morning peak hour with the help of Webster method of signal design. As per the calculation of recent traffic data the signal time for morning peak hour is 118 seconds. After design signal timing network is prepared in software traffic data is put and design signal time is taken for the analysis.

3. Left turn lane

   First observe the traffic problems at existing intersection vehicle queue length and delay time of vehicle is more as the signal time is high, and it is also affect the left turn vehicle because other vehicle blocks the lane of left turning vehicle. At intersection due to lack of left turn lane, left turning vehicle have to wait more time hence the vehicle queue length and delay time for vehicle increases. So the addition of left turn is beneficial for the left turn vehicle. In this research paper it was describe that the addition of left turn lane on existing condition of intersection.

4. Traffic is increased by 10% with design signal and left turn lane

5. Traffic is increased by 30% with design signal and left turn lane

IV. SURVEY AND DATA COLLECTION

Vrundavan intersection is the busiest signalized intersection in Vadodara which handles a large number of vehicles and pedestrians. Hence it was chosen to study the effect of left turn. The entire geometry of the intersection was measured to replicate the intersection in simulation. Video cameras was used to record the traffic at intersection on all approach roads in the same time interval. Video camera was placed in such a manner that camera observed entire traffic of intersection with its turning movements. The traffic survey was carried out during the morning time of 8:00 am to 12:00 Noon and also in evening time 3:00 pm to 7:00 pm for working day as well as for non-working day. Total 16-hour traffic data was collected with each vehicle classification. And also measure the turning movement of vehicle of all approaches. Also collect the information about cycle time of existing signal with green time of all approach. In this study detailed analysis of morning traffic was explained.

Table 1 shows the Hourly volume of traffic at Vrundavan intersection with categorized vehicle type.

Table 1 Hourly Volume of Traffic

Time	Two-wheeler	Four-wheeler	Three-Wheeler	Heavy vehicle (truck and bus)	Cycle	Total (PCU/Hour)
8:00 am-9:00 am	2267	810	586	200	91	3954
9:00 am-10:00 am	2338	849	514	163	75	3939
10:00 am-11:00 am	2298	827	473	142	69	3809
11:00 am-12:00 noon	2204	989	512	138	59	3902

Figure 2 shows the hourly variation of traffic at vrundavan intersection.

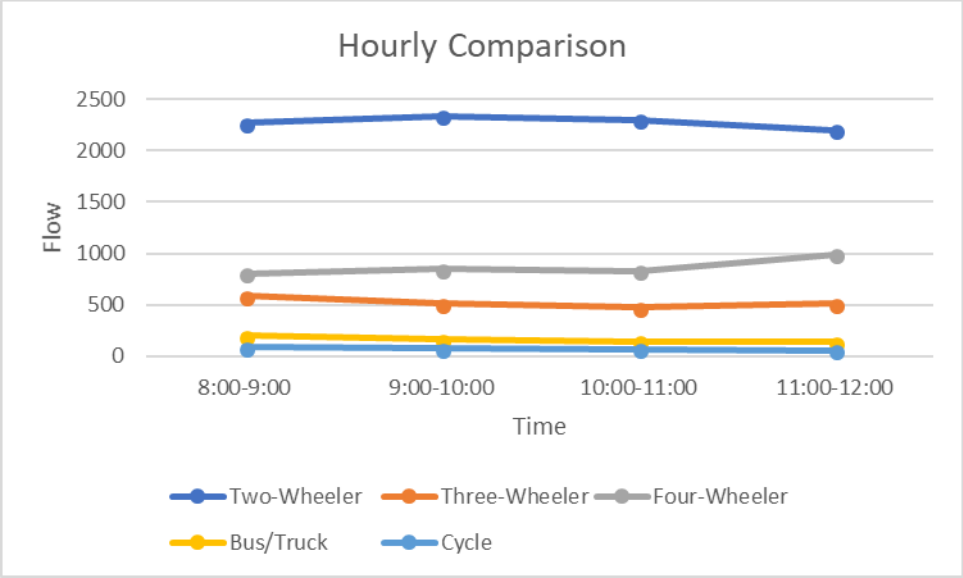

Figure 2 Hourly Volume Comparison of Intersection

V. DATA ANALYSIS

SIMULATION IN VISSIM SOFTWARE

The procedure of making model is consists of (i) identification of important geometric features (ii) collection of traffic data (iii) VISSIM coding (iv) calibration based on the observation (v) calibration is the process in which individual component of simulation model are refine and adjusted so that the simulation model accurately represents field measured traffic condition or observed traffic condition.

The geometry of existing Vrundavan intersection was created using links and connectors which are builds the VISSIM network. The number of lanes per road and width of each lane and other features of road were specified as per existing road condition. After the completion of creating network, the vehicle input data for various links was given.

Table 2 shows the signal group of present traffic condition of the intersection while Table 3 shows the design signal group.

Table 2 Existing Signal Cycle Time

Group	Red signal time	Green signal time	Total Cycle time
Uma to Waghodia	109	25	138
Airport to Soma Talav	98	36	138
Waghodia to Uma	98	36	138
Soma Talav to Airport	109	25	138

Table 3 Design Signal Cycle Time

Group	**Red signal time**	**Green signal time**	**Total Cycle time**
Uma to Waghodia	93	22	118
Airport to Soma Talav	94	21	118
Waghodia to Uma	79	36	118
Soma Talav to Airport	88	27	118

VI. RESULT AND DISCUSSION

PERFORMANCE EVALUATION OF INTERSECTION EXISTING V/S MODIFIED (WITH TURNING LANE ON LEFT)

Evaluation of performance of intersection is carried out for measurements of effectiveness such as average queue length, average delay per vehicle etc. Figure 3 shows the comparison of average queue length of existing signal condition, design signal time of morning peak hour and addition of left turn lane at signalized intersection.

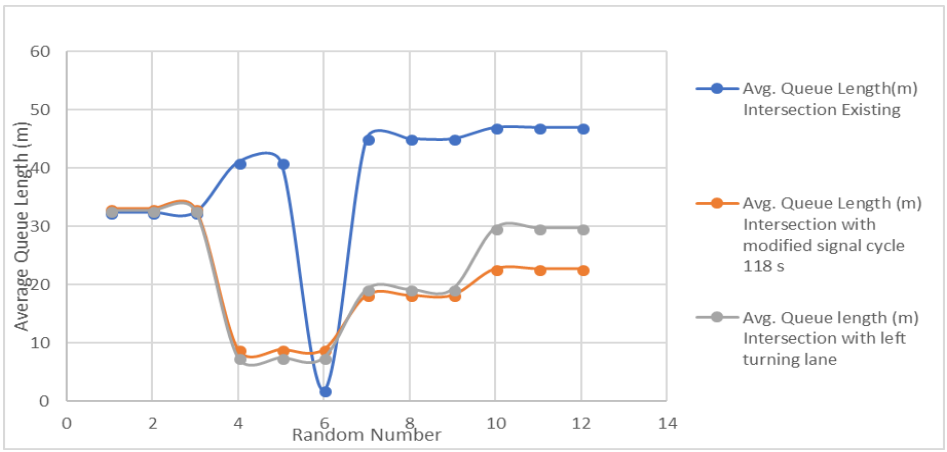

Figure 3 Comparison- Average Queue Length

Figure 4 shows the comparison of delay time per vehicle of existing signal condition, design signal time and addition of left turn lane at signalized intersection.

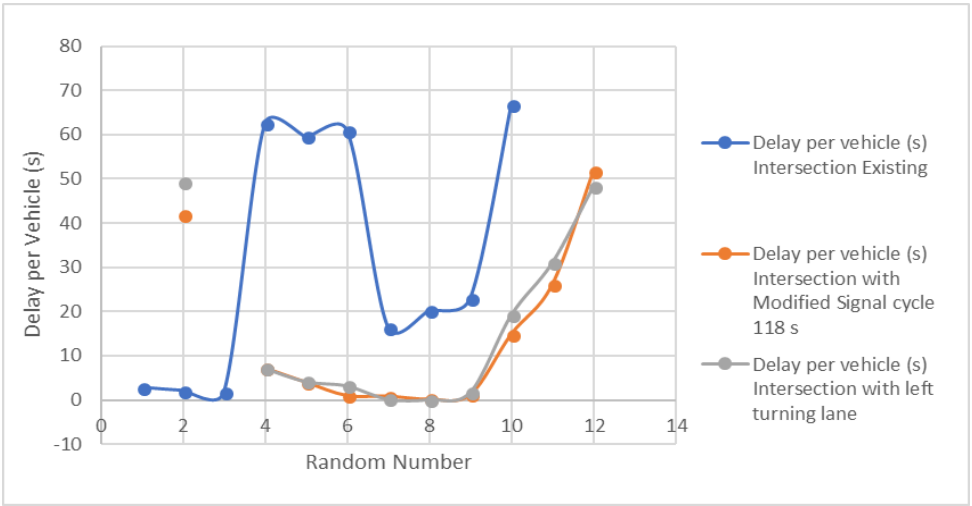

Figure 4 Comparison Delay Time per Vehicle

Figure 5 shows the comparison of delay time per vehicle for addition of left turning lane and also show the difference between if traffic increase by 10% and 30%.

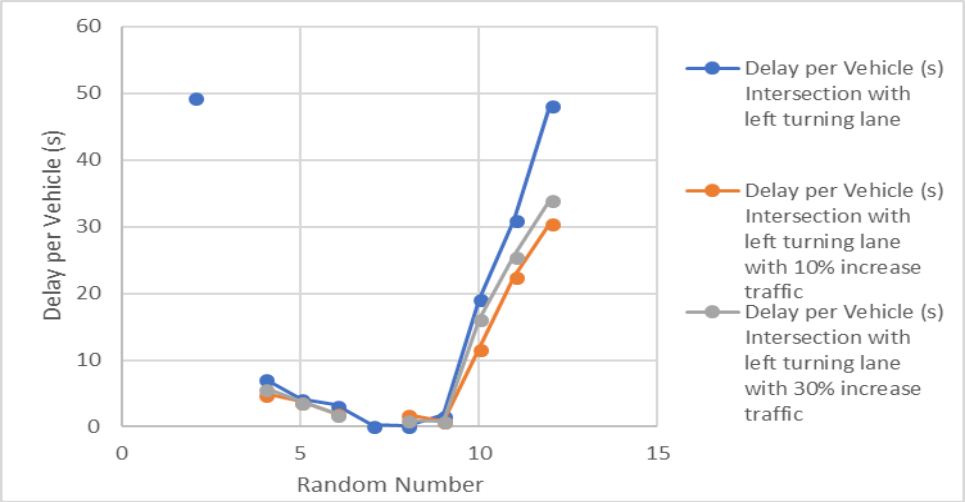

Figure 5 Comparison Delay Time per Vehicle with Traffic Increment

Figure 6 shows the comparison of delay time per vehicle for addition of left turning lane and also show the difference between if traffic increase by 10% and 30%.

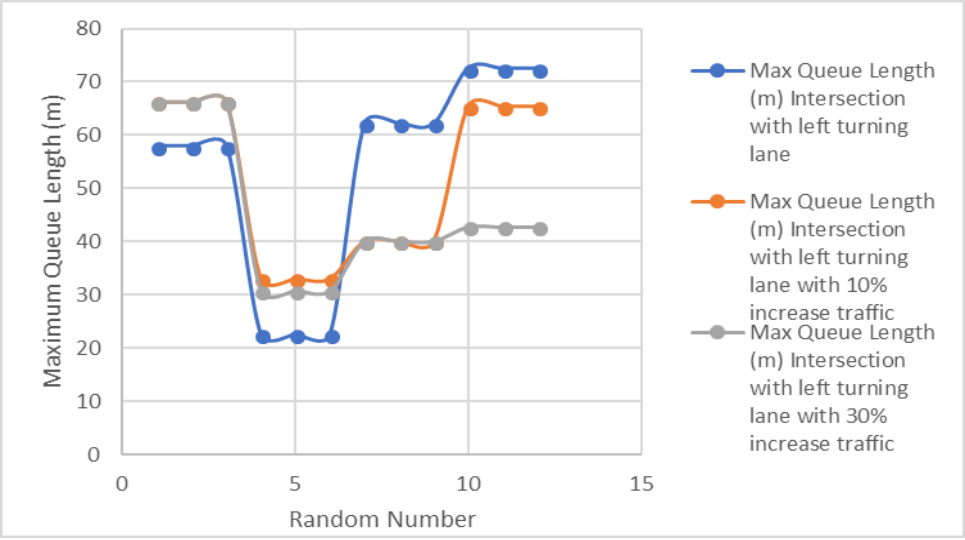

Figure 6 Comparison Maximum Queue Length with Traffic Increment

It is observed that the effect of (i) addition of left turn lane (ii) reduction in signal cycle time is the considerable reduction in average queue length, maximum queue length and average delay time per vehicle.

Hence, the addition of left turn lane on present condition of intersection resulting in reduction of traffic congestion. To increase the efficiency or capacity of intersection, modification of signal cycle time should be necessary.

VII. CONCLUSIONS

From the analysis in VISSIM software it is concluded that the for morning peak hour traffic with existing signal time is increasing the vehicle delay time, and more halt time of the vehicle, while the modified signal time for peak hour is resulting in reducing the waiting time, delay time of the vehicle.

- For existing signal condition, average queue length, maximum queue length and vehicle delay time are respectively 33.52 m, 71.57 m, 66.76 sec.

- For modified signal condition, average queue length, maximum queue length and vehicle delay time are respectively 20.80 m, 63.24 m, 14.35 sec.
- If left turn lane is added to the existing condition of road, then the result of average queue length and delay time per vehicle are reduce to 22.31 m and 16.98 sec respectively.
- If the left turn traffic increase by 10% after addition of left turn lane then average queue length and delay time to the vehicle are reduced to 20.83 m and 12.80 sec respectively.
- If the left turn traffic increase by 30% after addition of left turn lane then average queue length and delay time to the vehicle are reduced to 21.35 m and 14.06 sec respectively.
- And it is also concluded that the increasing turning movement does not affect the queue length but it affect the vehicle delay time.

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