Delay Research at Three-Legged and Four-Legged Signalized Intersection on Urban Arterial

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Abstract*: Delay is an essential parameter that comes into the consideration during, optimization of traffic signal timings and the calculation of the level of service at signalized intersection. It is most communal problem now a days, which needs to be minimized. Signalized intersection of Chandigarh city and Chennai have taken into consideration. However, delay is also a measure that is difficult to estimate, But the delay components can be measured by hand and investigate the speed profiles or derived time-space diagrams, categorizing when vehicles start to decelerate or stop. In addition, a physical identification process may be stimulating and time consuming when handling a huge network or numerous runs. Therefore, we have used software 'traffic data extractor' for the data extraction which gives more precise readings than manually. As there are several methods currently available to estimate the delays incurred at intersection approaches. This paper discourses this issue by comparing the delays that are assessed by a number of existing delay models for a signalized intersection approach controlled in fixed-time, the more emphasis is laid over the vehicle trajectory or the lane changing behavior of a personnel which leads to delay, at times the delays are also incurred by right turning traffic at Intersection. The main objectives of this paper are to minimize delay, to define particular lane of right turning traffic and to increase the level of service, n numbers of readings have been taken from traffic data extractor. Therefore, after analysis we have concluded that there are many factors which leads to delay, for instance, acceleration delay, deacceleration delay, stopped time delay etc. But, delays due to lane changing behavior and delays due to right turning traffic at intersections, can be minimized and a brief study has been done on above two.

***Index Terms*: Signalized Intersection, Vehicle Trajectory, Delay Minimization, Vehicle Behavior and Total Delay.**

I. INTRODUCTION

The most communal measure of operational quality is delay, even though queue length is often used as a secondary measure. Whereas it is possible to measure delay in the field, it is a difficult process, and different observers may make decisions that could produce different results. Delay estimation of three-legged and four-legged intersection of Chandigarh and Chennai city have been measured. Delay is the key performance estimation for signalized intersections and used as a parameter for evaluating and designing traffic control systems because it is closely linked with driver embarrassment, hindrance, fuel consumption, and lost travel time. In fact, the HCM (Highway Capacity Manual) has implemented delay as the prime measure for estimating the LOS (level of service) at an intersection. In other aspect, traffic congestion is a condition on road networks that arises as use increases, and is considered by slower speeds, longer trip times, and increased vehicular queueing.

Vehicle delay is the most significant parameter used by transportation experts to estimate the performance of signalized intersections. This significance of vehicle delay is contemplated in the use of this parameter in both design and evaluation practices. For instance, delay minimization is commonly used as a key optimization measure when evaluating the operating parameters of traffic signals at isolated and coordinated signalized intersections..

II. TYPES OF DELAY

- Stopped Time Delay
- Approach Delay
- Travel time delay
- Time-in-queue delay
- Control delay

III. LITERATURE REVIEW

Michalopoulos et al. (1980) Scientific description of traffic stream flow under intermittent conditions was taken into contemplation by them. The improved traffic models were presented, have the advantage that they define the development of queues in both time and space rather than time alone. Moreover, they consider the fact that the queues do not remain in a dense state since density varies with time and distance during the dissipation period.

Akcelik et al. (1993) This paper has presented a general delay model that uses amodest variable demand model. Application of the general delay model using dissimilar delay parameterssuch as the average delays for vehicles incoming in the peak, non-peak and post peak oversaturation and total flow periodshas been explained.

Heidemann (1993) In the present paper, some new and precise formulas areestablished for the distribution of queue lengths and delays at signalized intersections. However, it is rather easy to reach the limits of exact analytical methods beyond which simulation remains the main tool.

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Sharma et el. (2006) The input output and hybrid measurement techniques perform reasonably in terms of assessment accuracy and can be executed in the field for real-time measurement of delay and maximum queue length. **Zheng et al. (2013)** In this research paper, Signalized intersection performance plays a vital imperative role for safety and quality of travel on arterial networks. However, to collect intersection concert information, such as vehicle control delay and queue length, is a time-consuming chore. In this paperinclusive strategy has been developed and implemented in the In Perform system to quantitatively measure intersection performance in real-time with traffic count data collected with traditional traffic sensors. The strategy holds two algorithms for measuring important performance constraints for signalized intersections including average control delays and queue lengths.

IV. STUDY AREA

Signalized Intersection of Chandigarh and Chennai city have taken into account, where in Chandigarh city four-legged signalized intersection of sector 9-17 on Madhya Marg is shown in Fig 1.

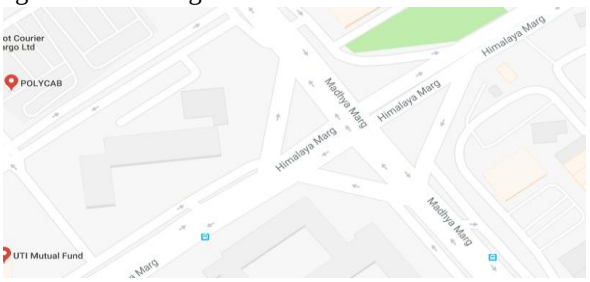

Fig. 1 Four-legged Signalized Intersection at sector 9-17 Chandigarh, India

Chennai, Indra Nagar's three-legged Signalized intersection towards Madhya Kailash is shown in Fig. 2

Fig. 2 Three-legged signalized Intersection on OMR Service Road, Chennai, India

A. *Delay at Signalized* Intersection

Delay at signalized intersections is calculated as the difference between the travel time that is truly, experienced by a vehicle while going across the signalized intersection. In Chandigarh city, the cycle length of Signalized intersection is more than 150 seconds, on Madhya Marg at sector 9-17, which is an alarm for the future requirements, at the same time, number of observations have been taken during peak and non-peak hour at signalized Intersection. In other aspect,Same is the case with thecity Chennai, where there is a quite same problem, and some parameters in terms of minimization of Delay have been concluded at the end of this Research paper.

As it is shown in the figure 3 that there are different types of delay which includes, deceleration delay, stopped delay and acceleration delay. Such types of delays are most common type, which incurred now a days which needs to be minimized. Hence brief study has been done and several results have been found. The main objective of this research paper is to minimize delay and to get the rid of causes which leads to delay at the intersection.

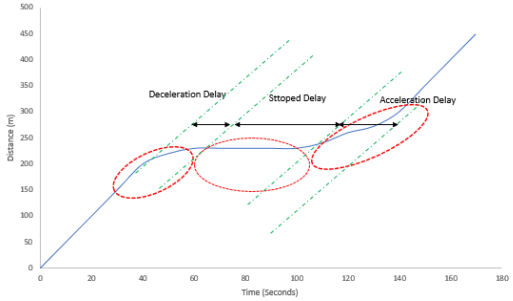

Fig. 3: Description of Total, Stopped, Deceleration and Acceleration delays

V. METHODOLOGY

A. *Data Collection*

Data collection is being done with the help of DSLR and Normal Cameras. Number of videos have been made and n number of readings have been taken into considerations, to evaluate the intersection performance as well as the total delays incurred there.

B. *Data Extraction*

Once the video analysis of both the cities is being done, they're after the videos is being put into the software that is Traffic data Extractor made by IIT Bombay, which gives very precise readings, in terms of distance in X-Direction, Y-Direction along the length of the road. It also gives time in seconds, vehicle type and frame number, which makes calculations easier. These are the some of readings from Traffic Data Extractor as shown below. As it can be seen in the figure 4 and 5 that a particular vehicle is being tracked for a long period of time and keep on tracking until or unless vehicle cross the intersection, and ultimately, we are having following readings as shown

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Vehicle No	Frame No	Time (s)	Vehicle Type	X (m)	Y (m)	Length	Width
1	1	0.001		734.0922	74.05322	15.3392	10.96751
1	1	0.001		856.6594	74.05322	137.9064	10.96751
1	1	0.001		737.6999	63.55322	18.94692	0.467512
1	1	0.001		860.2671	63.55322	141.5141	0.467512
1	0	0	Bus	830.8497	70.76547	112.0966	7.679761
1	10	0.01	Bus	827.1564	70.68712	108.4034	7.60141
1	20	0.02	Bus	824.2969	70.65796	105.5439	7.572256
1	30	0.03	Bus	820.8699	70.54602	102.1169	7.460315
1	40	0.04	Bus	818.2717	70.29314	99.51866	7.20743
1	50	0.05	Bus	816.3568	70.1645	97.60381	7.078793
1	60	0.06	Bus	812.0296	69.94816	93.27662	6.862458
1	70	0.07	Bus	807.8561	69.95591	89.10309	6.870201
1	80	0.08	Bus	808.3866	70.13825	89.63357	7.052548
1	90	0.09	Bus	806.0347	70.29559	87.2817	7.209885
1	100	0.1	Bus	802.7132	70.23088	83.96021	7.145171
1	110	0.11	Bus	801.5661	70.46048	82.81311	7.374773

Fig. 4 Readings from traffic data extractor

1	500	0.5	Bus	719.9002	72.34334	1.147187	9.25763
1	510	0.51	Bus	719.9002	72.34334	1.147187	9.25763
1	520	0.52	Bus	719.5865	72.70505	0.833493	9.619341
1	530	0.53	Bus	719.2012	72.81525	0.448213	9.729543
2	10	0.01	Car	823.8779	65.14968	105.1249	2.063977
2	20	0.02	Car	819.1336	65.21004	100.3805	2.124337
2	30	0.03	Car	815.9109	65.20314	97.15791	2.117438
2	40	0.04	Car	815.9109	65.20314	97.15791	2.117438
2	50	0.05	Car	810.9741	65.27251	92.22112	2.186805
2	60	0.06	Car	810.9741	65.27251	92.22112	2.186805
2	70	0.07	Car	809.1611	65.4187	90.40807	2.332992
2	80	0.08	Car	805.7209	65.45574	86.96789	2.370032

Fig. 5

C. Data Analysis

Data analysis is done with the help of Excel which includes different types of delays, vehicle trajectory, Lane changing behavior and Intersection effect. The graphical representation is shown below.

D. Vehicle Trajectory

Vehicle Trajectory is perhaps the most important parameter which needs to be measured, therefore more emphasis has been laid over the vehicle trajectory, and traffic data extractor software have been used for the data extraction. Data extraction of both the cities that is Chandigarh and Chennai is being done. Trajectory of each vehicle has been followed for 100 m distance and time in seconds is also being calculated by software itself.

As it is shown in the Fig. 6 n number of readings have been taken, but one major entity which is playing its part is, right turning traffic leads to delay for number of vehicles, and vehicle trajectory of each vehicle is being shown there. When the traffic reaches to Signalized Intersection, delay is incurred there due to certain reasons, which needs to eliminated and the total delay can also be minimized.

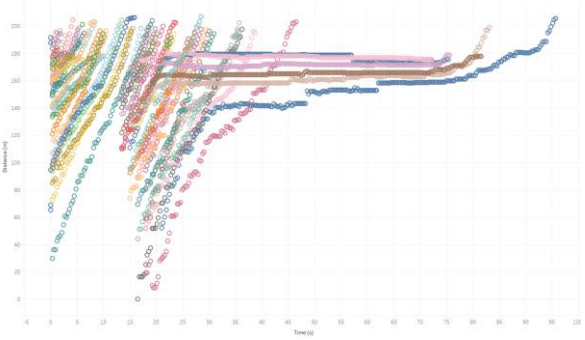

Fig 6: Vehicle Trajectory of four-legged Signalized Intersection on Madhya Marg at Sector 9-17 Chandigarh, India

In the Fig. 7 vehicle number 53 is being shown separately, in the initial part vehicle comes and reaches to the Signalized Intersection and deceleration delay takes place there, they're after there is a bit movement of vehicle but not much, which depicts that delay is incurred there. The delay which is there that is due to the right turning traffic, Leading towards fuel consumption, time loss and discomforts to every individual.

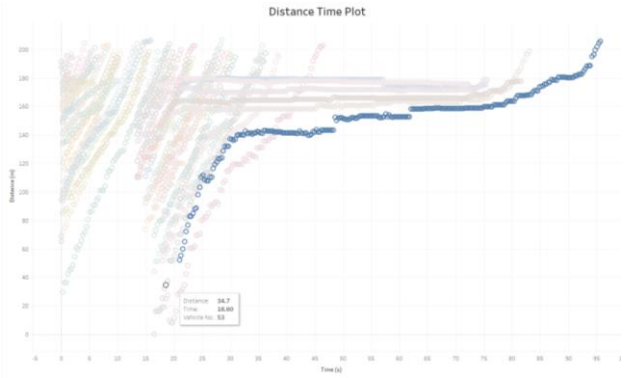

Fig 7: Delay due to Right Turning Traffic

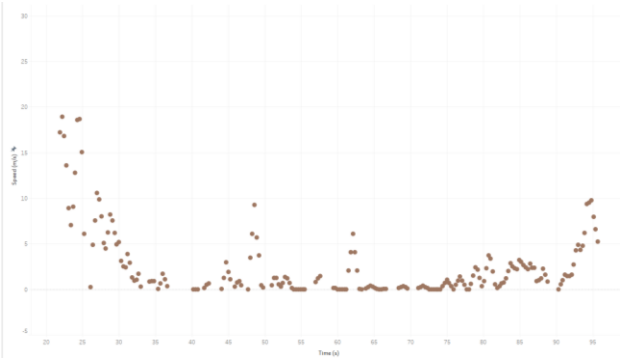

Fig. 8: Speed profile for Right Turning Traffic at Three-legged OMR intersection at Indra Nagar Chennai.

Fig 8 and 9 is showing the speed profile of traffic and the effect of signals on the right turning traffic, vehicle are moving at very slow rate and at times there is stoppage as well during green period, the reason being this, isthere are no exclusive right turning lane and the vehicle which do not interested in right turning traffic they are also leading to delay therefore the total delay is being increased twice the cycle length. The best possible solution is being discussed very briefly in the results and conclusion.

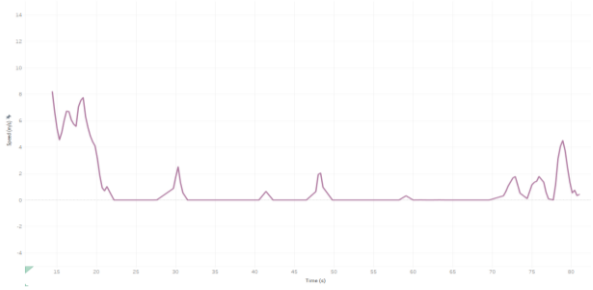

Fig. 9: Effect of Signal on Right Turning traffic

Fig. 10 is showing effect of signals on through traffic, that graphical representation is of non-peak hour when the traffic is quite less, but still there are delays which can also be minimized at intersection, at times there is movement of traffic or at time there is delay. However, during non-peak the flow of traffic can be continued by means of temporary island especially when there are non-peak hours. Some of the best solution is recommended below.

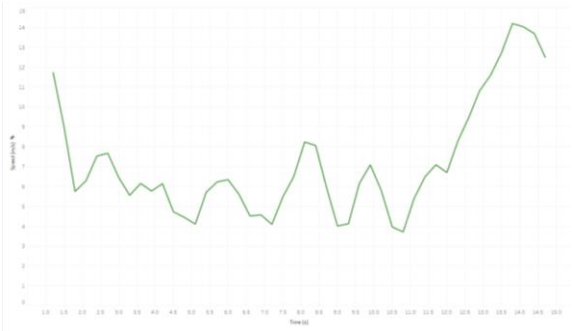

Fig. 10 Effect of signal on through Traffic

VI. RECOMMENDATION AND SUGGESTION

They're certain steps which should be taken into consideration in both the cities that is Chandigarh and Chennai.

- There should be exclusive right turning traffic lane at three legged and four-legged signalized intersection, by doing so delay can be minimized to a great extent.
- During non-peak hours,Intersections can be turned into temporary Rotary or Roundabout by means of temporary islands, they can be of anything like drums or some other temporary structure hence there will be quite less delay, and there will be continue movement of traffic for a certain period of time.

VII. RESULTS

The outcomes of Signalized intersections depict that there is improper movement vehicle, which is leading to delay,and the delay can be curtailed as well. The numbers of video recording of peak and non-peak hour have been taken is account, and several results have been found.

In the analysis, graphical representation is showing that the most shared type of delay is happening due to right turning traffic, that is due to improper movement of traffic, even if there is green period still there is delay for through traffic and the level of service reaches to D to F.

While there is low traffic or we could say during non-peak hours the volume of vehicle is quite less but the total delay incurred there is quite high, due to pre-timed signals installed there.

VIII. CONCLUSION

Delay studies of three legged and four legged intersections is alarming an alarm for the future needs. It is depicting that there is requirement of clover leaf in the near future, reason being the total cycle length of signal has been increased over 150 seconds in the well-planned cities, whereas there is even worse scenario in the other cities. And the total delay incurred there due to lane changing behavior of vehicle and the right turning traffic is making the delay twice the total cycle length.

Three-legged signalized intersection is depicting that the major cause of delay is right turning traffic, and the mobility has reduced to a great extent. Hence, inclusive right turning lane should be there.

During non-peak hours signalized intersection can be turned into rotary and temporary islands can be established for certain period of time, therefore there will be continue movement of traffic, and hence mobility can be increased and delay can be minimized.

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