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Estimation of Delay at Signalized Intersection in Heterogeneous Traffic using PVT VISSIM and Comparing it with other Delay Models

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***Abstract*- Signalized intersection in India is considered as the most time consuming, maximum delay occur at signalized intersection due to heavy and heterogeneous traffic condition. For calculation of delay in heterogeneous traffic conditions can be done by various modified models such as modified webster model given by Arpita Saha and Satish Chandra (2017), HCM model and other models developed in past, these methods are manual but with increase in technology software are developed for calculation of delay and stimulation of traffic one of software is PVT VISSIM which help us to find delay and signal timing for a signalized intersection. In this paper we will calculate delay using PVT VISSIM and comparing it with various delay models provided in past after calculation stimulation of traffic for selected intersection is done. Result will help us to consider the best model for calculation of delay in heterogeneous traffic condition.**

Keyword:- Heterogeneous, PVT VISSIM, Webster model, Arpita Saha Satish Chandra 2017, HCM model, Stimulation.

I. INTRODUCTION:

In India estimated population is 1.3 billion and maximum number uses their private vehicle for completing a trip instead of public vehicle which increase delay and conflict on intersection. Planning trip in India is calculated according to travel time plus stopped time and the delay at signalized intersection. In country like USA, Russia has homogeneous traffic condition which has strict lane restriction and traffic rules are mandatory to follow, but traffic condition is India is heterogeneous which is mixed traffic condition and no lane restriction. Delay at signalized intersection can be of different type such as stopped time delay, travel time delay, control delay.

All these models are very old and with increase in technology many software are introduced such as PVT VISSIM which has capability of stimulating traffic and calculation of delay and providing graph and other statistic which will help in improving signal timing and removing conflict for signalized intersection. One of the advantages of using software like PVT VISSIM is to reduce time in calculation of delay and we can stimulate and improve timing of signals for reduction in delay and conflict. The more we will get use to this software it will help to improve the developer of software to make software more accurate for heterogeneous traffic condition just like in India. In this paper we will consider 5 signalized intersection in Lucknow, Uttar Pradesh, India for collection of data and for calculation of delay. Comparision of manual delay model and PTV VISSIM for the best result.

II. LITERATURE REVIEW:

1. Arpita Saha, Satish Chandra, Indrajit Ghosh(2017)., The main purpose of this paper to calculate delay by using HCM model, and developing a mathematical equation for calculation of delay for mixed traffic condition keeping in mind of no rules violation. Conventional HCM and Webster model give best result for homogeneous traffic condition with proper lane and all rule that are to be followed but in India there are mixed traffic condition with no lane rule are followed and LHD left hand drive is considered in condition like India. For data collection 15 signalized intersection which are located in 5 different cities which are Delhi, Chandigarh, Patiala, Mumbai and Punch Kula are taken using two video camera, one is placed before the signal so that the coming vehicle and the signal timing could be recorded and the other camera is placed for recording the rate of vehicle which passes from the intersection. After the collection of data delay was calculated using modified HCM model and estimating it by Simpson's $1/3^{rd}$ rule. The result was accurate and the proposed model was successful for heterogeneous traffic condition.

2.Chai Shien Qin, Mohd Amin Shafii, Eunice Chai Mei Ling, Ekarizan Shaffie(2020)., The main objective of this paper is to calculate Level of service (LOS) by using HCM delay model for the calculation of delay the more the delay at intersection the worst the level of service. There are six main criteria which are depended on the stopped time in second, if the stopped delay is smaller than 5 sec then it is considered as very low level and it is put in A category of LOS, if the stopped time is between 5.1 to 15 second then it is considered as low level and it is put in B category of LOS and further there are 4 more i.e C, D, E, F according to the stopped time. With the help of field data Traffic peak period, Traffic phases and stages, Traffic volume, Signal timing are collected and analysis is done. After the analysis of data the LOS of all the peak time were calculated.

3. Xiaobo Qu, Mina Ghanbarikaekani, Michelle Zeibots, Weiwei Qi(2018)., This paper focus on minimizing the average delay at signalized intersection via Pre signals and speed control on public vehicle like bus which have more carrying capacity than any

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private vehicle and clearing the lane for public vehicles so that the reduction in conflict may increase remarkably. Pre signals are commonly seen in cities like New York and other well developed cities, an extra signal is installed before the intersection for public vehicle like bus so that a certain time could be fixed for these public vehicles so that the delay could reduce. Speed control helps all the vehicles to reach on intersection in an definite time period so that the delay could be reduced. Four signalized intersection were taken in consideration two of them were applied with pre signal and speed control and two of them were normal signalized intersection, after the collection of data comparison was done and conclusion was made that by giving pre signal and exact time to the public transport for crossing an intersection people got encouraged and started using public transport instead of private vehicles and reduction in delay and conflict were seen on those intersection which has pre signal and speed control.

4. Preethi P, Aby Varghese, Ashalatha R(2016)., The main purpose of this paper is to determine delay using modified webster 1958 model and comparing it with traditional method to get the exact value for delay. Data was collected from 11 different urban area of Kerela using video camera, global positioning system GPS is used and data is extracted using AVS video editor version 6.2 is used and vehicle are characterized in four different criteria such as car, bus, two and three wheeler vehicles. In the old webster model the second term which is semi empirical adjustment is remove and a field delay adjustment is added for heterogeneous traffic condition like in India then the result is compared and conclusion is made which is the proposed modified webster model varies with different condition of traffic with control condition of traffic.

5. Sumaiya Afrose Suma, Birol Roy, Dr. Md. Hadiuzzaman, Saurav Barua, Sk. Md.Mashrur(2020)., In this paper the main objective was to compare the passenger car equivalent PCE values provided by Roads and Highway Department RHD and dynamic passenger car equivalent to optimize delay at signalized intersection in mixed traffic condition. Eight signalized intersections of Bangladesh were taken into consideration. First step is to do field survey of respected intersection taken in consideration using video camera from November to December 2018 different vehicle composition like bus, rickshaw, electric rickshaw and a large number of car and bikes were taken in consideration. Second is estimation of PCE in which direction wise PCE , synchronous regression, and vehicle composition is calculated and compared with RHD manual based PCE. Then estimation of saturation flow in PCE/hour is calculated. The conclusion for this research was that the PCE value of vehicle which is turning right is not the value given in RHD manual based PCE value and the method provided in this research is more exact than the value provided in RHD manual.

6.Hyung Jin Km, Bongsoo Son, Soobeom Lee(2004)., The main purpose of this paper is to improve the signal timing in urban signalized intersection by using Intelligent Transportation System(ITS). For the estimation of delay five main model which are Akcelik, Webster, HCM, Hurdel, Transyt-7F models are used and then compared with conventional model like cumulative arrival and departure technique. From the above comparison it was clear that the conventional model were very sensitive according to the flow of traffic and the flow of saturation, so the signal timing T1 and T2 are changed according to the ITS and new timing was proposed for the smooth low of traffic at signalized intersection.

7. Rahul Sharma, Pinakin Patel, Nekzad Umrigar, Dr. L.B.Zala(2018)., The main objective of this paper is creating a model for traffic condition in India because all the traditional method including HCM, Webster, Arpita Saha models etc. are created for homogeneous traffic condition but in India it is mixed traffic condition and no lane restriction is their. Data is collected from 3 signalized intersection of Ahmedabad city of Gujrat and data was extracted. Classified volume count CVC was collected by taking fifteen minutes interval for ten hours. The proposed model was **Delay = 80.640+0.039*c-0.048*V-5.539*Rp** where c = capacity, V=flow rate, Rp= platoon ratio. Then the data is compared with all the traditional method and the conclusion is made that the proposed method has the least amount of Mean Absolute Percentage Error MAPE and the model could be used in other condition also.

8. Alfia Magfrirona, Nurul Hidayati, Ika Setiyaningsih, Gotor Slamet(2015)., The main purpose of this paper is to calculate delay for signalized intersection using Area traffic control system ATCS and field survey method and then comparing both values. The data is collected from Kerten intersection of Surakarta in peak hour of the day. ATCS uses green wave method which is if a car gets a green signal on an intersection then he will receive green on the next signal this all management is done by ATCS to reduce queue, For the calculation of delay two methods was used HCM and field delay method and comparison is made after the comparison it was clear that field delay is lower than HCM delay which is caused by difference in traffic flow condition. This method can also be used in mixed traffic condition just like in India.

9. Z. Mpanza and H. Ncube(2018)., The main purpose of this paper is to calculate delay using queuing model which is developed by Webster. Vehicle approaching signal have three main parts arrival, queue which also involves service facility and departure after the signal is green. The data is collected from intersection in Victoria park in North of Johannesburg site was selected due to the increase in congestion in area. The data which is needed in the field survey are queue length, timing of signal, headways and other basic data which is required. After the analysis of data Saturation flow rate, Effective green time, Capacity of lane, Volume to capacity ratio and Effective green time ratio are calculated. After the calculation was one delay was calculated which is 18.6 sec/vehicle, This delay can be eliminated by changing the signal timing. Conclusion was made that by using technology which can count number of vehicle at an intersection an allow enough green time for flow of vehicle and increase level of service LOS which is very important for the proper growth of nation.

III. DATA COLLECTION.

The survey was conducted on 4 intersection namely –

1. Lohia intersection
2. Patrkaar intersection

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3. Manoj pandey intersection
4. Kathuta intersection

The survey was conducted for 2 hours on every intersection the time was about 12pm to 2pm which is considered as the peak hour time. Recording was done using two mobile phone camera of aperture f1.4 and Nikon d3500 camera is used. Exact number of commercial vehicle, cars, bike and cyclist were recorded and was converted into PCU/hr. The signal timing was also recorded for the calculation of delay and comparing it to calculation made by PTV VISSIM.
The collected data is as follows :-

3.1 Lohia intersection.

Types Of Vehicle	Number Of Vehicle (Veh/hr)	PCU/PCE (Veh/hr)
BIKE	2368	1183
CAR	1534	1534
AUTO	467	467
BUS	27	81
TOTAL	4396	3265

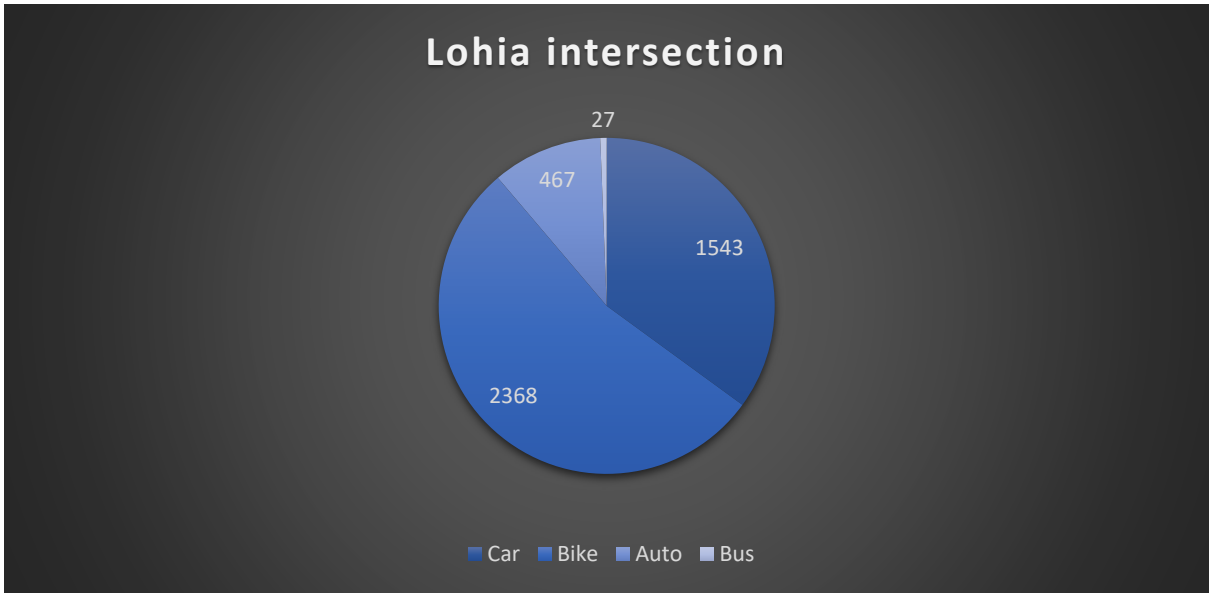

Figure 1 Pie Graph representing number of vehicles at Lohia Intersection

3.2 PATRKAAR INTERSECTION.

Types Of Vehicle	Number Of Vehicle (Veh/hr)	PCU/PCE (Veh/hr)
BIKE	1132	566
CAR	425	425
AUTO	623	623
BUS	7	21
TOTAL	2187	1635

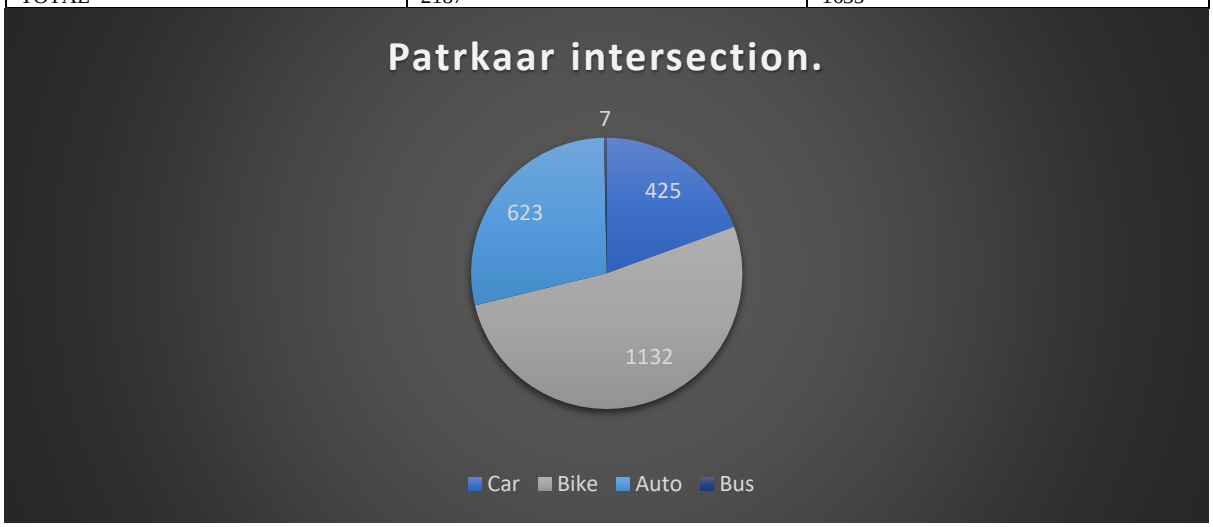

Figure 2 Pie graph representing number of vehicles at Patrkaar Intersection

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3.3 MANOJ PANDEY INTERSECTION.

Types Of Vehicle	Number Of Vehicle (Veh/hr)	PCU/PCE (Veh/hr)
BIKE	1246	623
CAR	533	533
AUTO	698	698
BUS	10	30
TOTAL	2487	1884

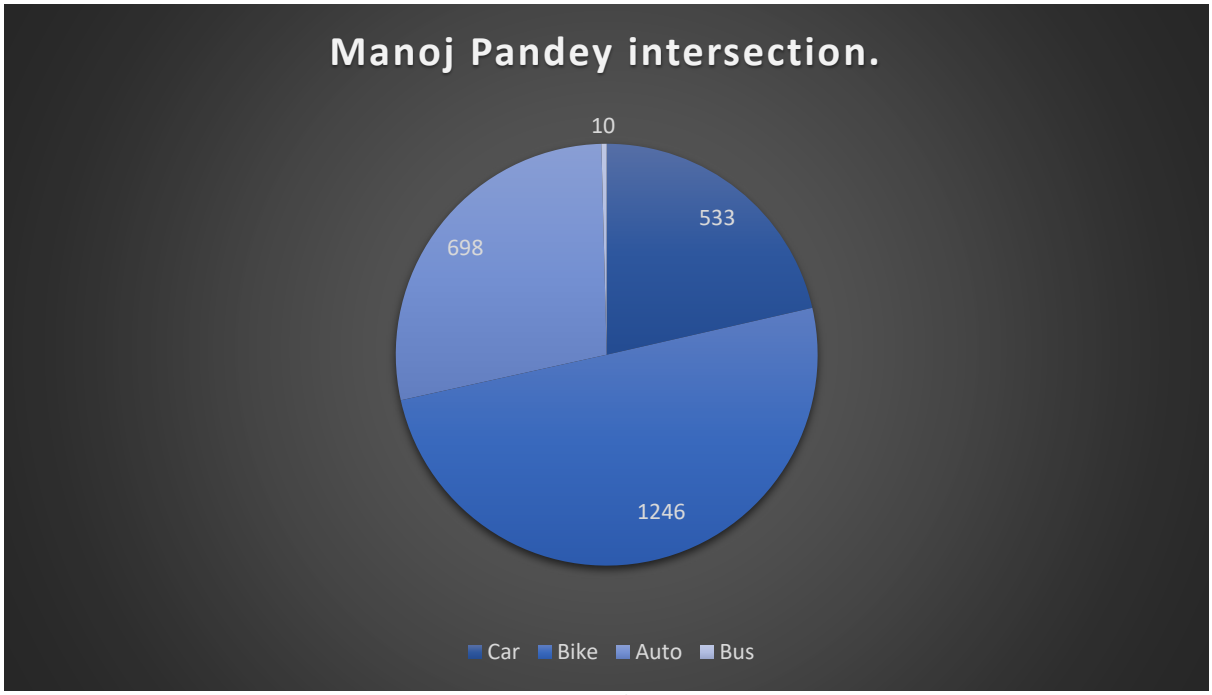

Figure 3 Pie graph representing number of vehicles at Manoj Pandey Intersection

3.4 KATHAUTA INTERSECTION.

Types Of Vehicle	Number Of Vehicle (Veh/hr)	PCU/PCE (Veh/hr)
BIKE	1074	537
CAR	328	328
AUTO	724	724
BUS	2	6

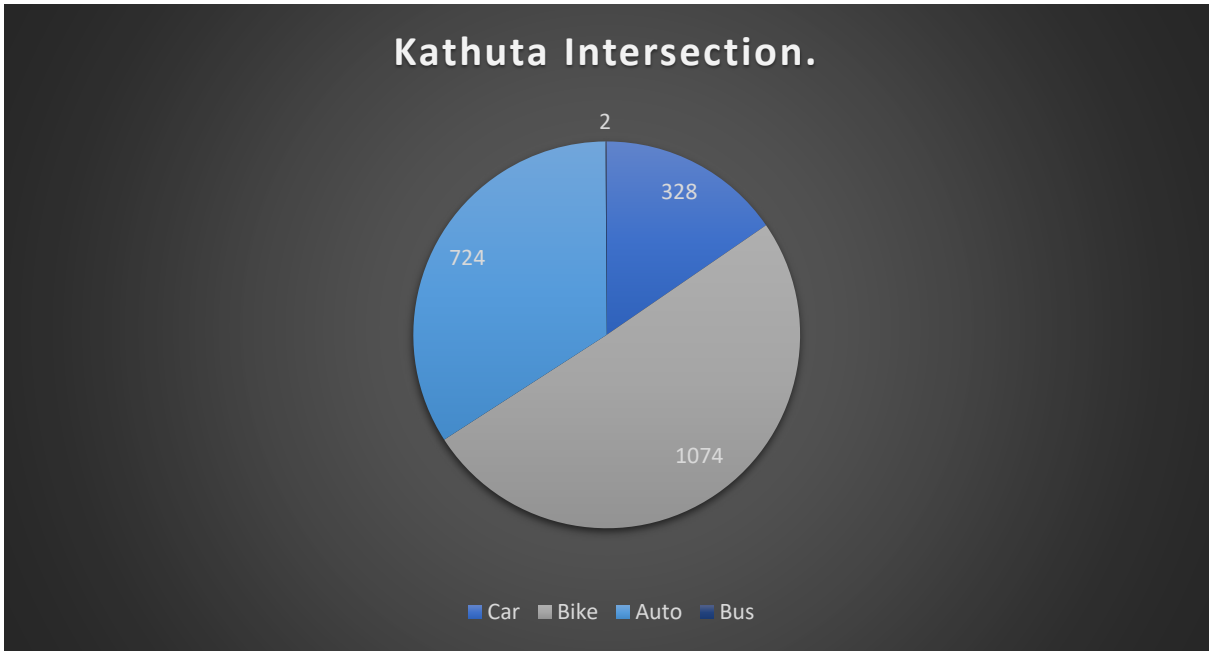

Figure 4 Pie graph Representing number of vehicles at Kathuta Intersection

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3.5 Composition of each type of vehicle at all intersection.

Intersection approach	Bike (%)	Car (%)	Auto (%)	Bus/Bus (%)
Lohia Intersection	53.86 %	34.89 %	10.62 %	0.61%
Patrkaar Intersection	51.76 %	19.57 %	28.48 %	0.32%
Manoj Pandey Intersection	50.10 %	21.43 %	28.06 %	0.40%
Kathauta Intersection	50.46 %	15.41 %	34.02 %	0.09 %

3.6 Signal Timing Two way :

Approach signal	Lohia Intersection (sec.)	Patrkaar Intersection (sec.)	Manoj Pandey Intersection (sec.)	Kathuta Intersection (sec.)
Red	50	240	240	204
Green	90	58	58	47
Amber	6	2	2	4
Cycle Time	146	300	300	255

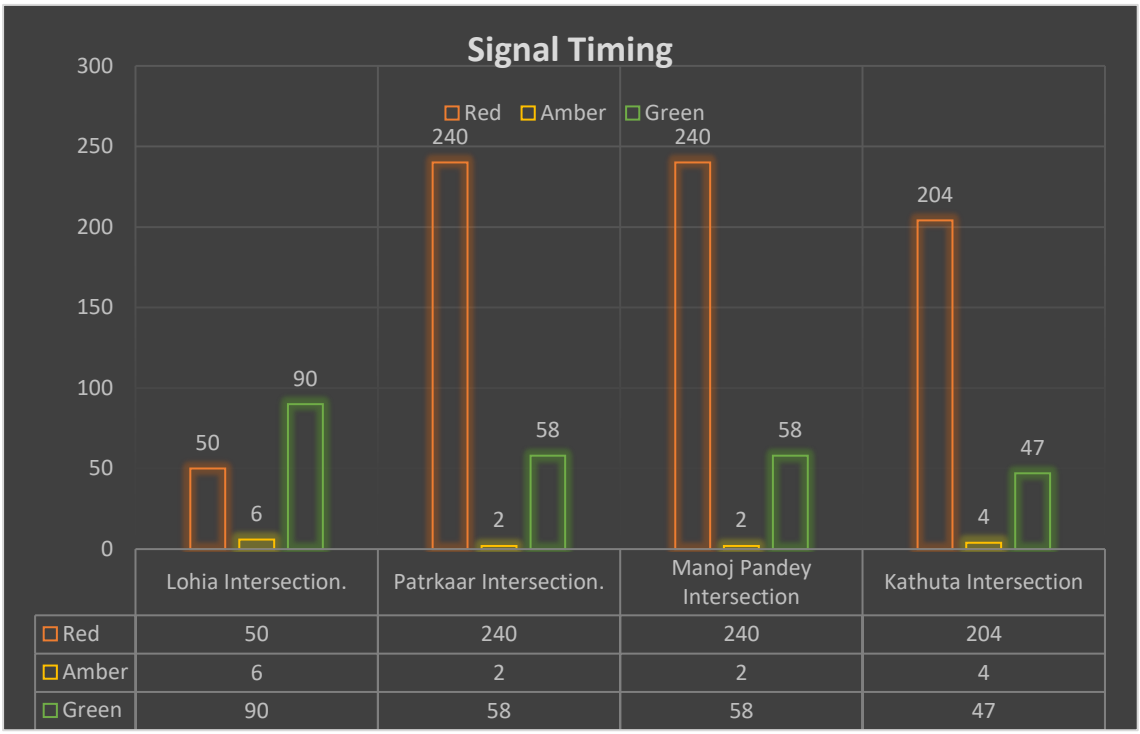

Figure 5 Graph representing Signal Timing

IV. METHODOLOGY.

Delay at an intersection can be calculated by manual method such as webster and IRC method and software like PTV VISSIM. After the delay is calculated the result are compared and stimulation of every signal is done. Here are the method which are considered in this research paper-:

1. Arpita Saha, Satish Chandra(2017).
2. HCM method
3. PTV VISSIM

4.1 Arpita saha, Satish Chandra (2017)- A mathematical equation is developed for calculation of delay at signalised intersection under mixed traffic condition by Arpita Saha, Satish Chandra in 2017 the equation is modified from Webster method and is as follows

$$d = 6.23 + \frac{0.5 \times C \times \left(1-\frac{g}{C}\right)^2}{1 - X \times \frac{g}{C}} - 15.35 \times Rp$$

Where d = delay, $\frac{g}{C}$ = green ratio , C = cycle time , X = volume capacity ratio, Rp = Platoon ratio (Rp = $\frac{PVG}{PTG}$) , where PVG = Percentage of vehicle arriving during green time, PTG = Percentage of time green.

4.2 HCM method- The HCM (2010) model state that delay at an intersection under heterogenous traffic condition can be calculated by plotting a trapezoid or a triangle against length of cycle and cycle time. The area of the triangle represents the total

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delay associated with that cycle. For heterogeneous traffic condition the area of triangle may vary so for resolving the error Simpson's one-third rule is applied.

4.3 PTV VISSIM- PTV VISSIM is a software which is used for stimulation of traffic and calculation of queue delay and for removing conflict at an intersection in is widely used in foreign countries like USA and Russia for traffic stimulation. Many research paper have already been published in foreign countries. PTV VISSIM requires data like volume of vehicle, direction of vehicles, road width, length of observation, cycle time, green time, placement of signals. After input of data nodes are selected for observation and the software will be able to give result.

V. RESULT.

Delay at various intersection are shown in the chart - :

INTERSECTIONS.	ARPITA SAHA, SATISH CHANDRA 2017 (sec.)	HCM METHOD (sec.)	PTV VISSIM (sec.)
Lohia	114.56	111.43	94.66
Patrkaar	110.45	115.76	67.66
Manoj Pandey	101.22	95.52	74.83
Kathauta	104.34	107.09	100.67
Hazratganj	170.35	164.89	113.69

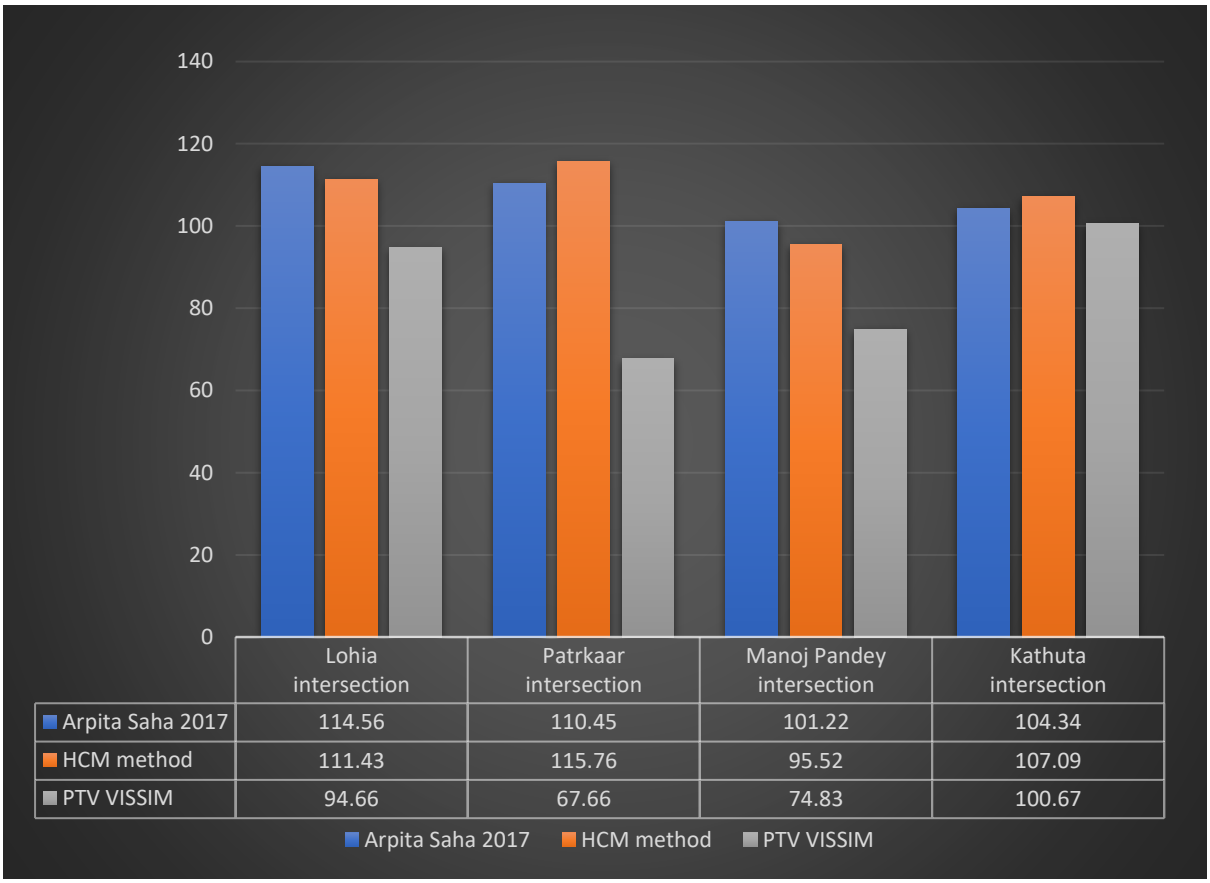

Figure 6 Graph representing Delay result

From above result it is clear that manual method are optimised for calculation of delay at signalised intersection but PTV VISSIM need to be more optimised for accurate calculation of delay. After some manipulation of data and avoiding violation of traffic we can reduce conflict in stimulation and accurate result could be calculated.

VI. CONCLUSION.

From analysing the data extracted from video the result is calculated that manual method like HCM 2010 , Arpita Saha method are more accurate in calculating delay as compared to software like PTV VISSIM. In heterogeneous traffic condition which includes various type of vehicle and traffic violation PTV VISSIM fails in calculation and many number of conflicts in an intersection can be seen.

After stimulation of traffic in PTV VISSIM of all 4 intersection selected the result varies of about 20 sec. from manual method like HCM 2010. Optimisation of software is needed for accurate result like violation of traffic in India is very common and in the software there is no option for violation of traffic. Crossing of traffic after the signal is red is a common violation but in PTV

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VISSIM it is not allowed and traffic condition is also non lane based but software requires a lane based traffic system. If traffic is lane based and violation is non the result from the software would be very accurate from all the manual method.

VII. FUTURE SCOPE.

1. For calculation of delay of lane based traffic condition the result with PTV VISSIM will be very accurate.
2. Design of signal would be very easy with software like PTV VISSIM.
3. Stimulation of traffic for various use could be done with this software.
4. Optimisation of software is very important for calculation of delay for heterogeneous traffic condition.

VIII. REFRENCES.

[1] Arpita Saha, Satish Chandra, Indrajit Ghosh. "Study of delay at signalized intersection under mixed traffic condition". Journal Of Transportation Engineering, DOI:10.1061/JTEPBS.0000070, March 2017.
[2] Mohd Amin Shafii, Chai Shien Qin, Eunice Chia Ling, Ekarizan Shaffie. "Determination of delay at signalized intersection: A case study". ISSN: 04532198, Volume 62, Issue 03, April, 2020.
[3] Mina Ghanbarikarekani, Xiaobo Qu, Michelle Zeibots, Weiwei Qi. "Minimizing the average delay at intersections via pre-signals and speed control". Journal of Advanced Transportation, Volume 2018, Article ID 4121582, PP 1-8.
[4] Preethi P , Aby Varghese, Ashalatha R. "Modelling delay at signalized intersections under heterogeneous traffic conditions". 11th Transportation planning and implementation methodologies for developing countries, 10-12 December 2014.
[5] Birol Roy, Sumaiya Afrose Suma, Dr. Md. Hadiuzzaman, Saurav Barua, Sk. Md. Mashrur. "Optimization of delay time at signalized intersection using direction- wise dynamic PCE value". International Journal of Transportation Engineering, Vol.8/No.3/ (30) Winter 2020.
[6] Hyung Jin Kim, Bongsoo Son, Soobeom Lee. "Performance analysis of delay estimation models for signalized intersection networks". International Federation for Information Processing, PP. 661-669, 2004.
[7] Rahul Sharma, Pinakin Patel, Nekzad Umrigar, Dr. L.B Zala. "Delay at signalized intersection under heterogeneous traffic conditions". International research journal of engineering and technology, Vol:05 Issue:05, May 2018.
[8] Alfia Magfirona, Nurul Hidayati, Ika Setiyaningsih, Gotot Slamet. "The delay for signalized intersection using ATCS data and field survey method at Kerten- Intersection of Surakarta". Procedia Engineering 125(2015), PP 526-533.
[9] Z. Mpanza & H. Ncube. "Estimating delay at intersection using queuing models". South African journal of industrial engineering, March 2018, Vol.13, PP 1-3.