OPTIMIZATION OF QUEUE CLEARANCE FOR DUDHESHWAR 3-LEG AND DAFNALA 4-LEG INTERSECTION

Harshaketukumar M. Bodar[1], Mr. V.J. Chitaria[2]

[1]*P.G. Student & Dept. Civil (Transportation Engineering), LDCE.*

[2] *Associate Professor, Dept. Civil Engineering, LDCE, Ahmedabad, Gujarat, India.*

[1]harshbodar@gmail.com ,

Abstract: *In a city like Ahmedabad, vehicles travel on road all day as compared to other districts of Gujarat. In Ahmedabad Traffic includes a different type of transportation mode on road like bikes, scooters, cars, trucks, auto-rickshaws, BRTS, AMTS, etc. So queue clearance is an important factor which helps to increase the flow of vehicles. Optimization of queue clearance can be achieved with help of proper channelization of traffic, road marking, and improvisation in traffic signals. It helps to reduce the delay of vehicles and proper management of the platoon. This can be achieved by analyzing the traffic parameters at an intersection under mixed traffic conditions with help of macroscopic traffic parameters and Microscopic traffic parameters. In this study first of all I will evaluate the present condition of intersection by conducting a pilot survey for getting the basic idea of the queue length and queue clearance time at Dudheshwar Y (3-leg) intersection and Dafnala crossroad (4-leg intersection). After that collected data and analysis of that data will help to formulate and solution of a new algorithm for queue management with help of Regression analysis of the collected data from different surveys and simulation by PTV VISSIM software.*

Key Words: **Signalized intersection, Queue clearance, Delay, VISSIM simulation, Heterogeneous traffic**

1. INTRODUCTION

Traffic volume is an important input required for planning, analysis, design and operation of road systems. Indian traffic is highly heterogeneous in nature, where small vehicles like bicycle to very heavy vehicles like truck and buses are moving on the same road at a time with very little lane discipline.

In city like Ahmedabad, vehicles travel on road all day as compare to other district of Gujarat. Where the traffic involve different type of transportation mode on road like bikes, scooters, cars, trucks, auto rickshaws, BRTS, AMTS etc. So queue clearance is important factor which help to increase the flow of vehicles.

Optimization of Queue Clearance: - Optimization of queue clearance can be achieve with help of proper channelization of traffic, road marking and improvisation in traffic signals. It helps to reduce a delay of vehicles and proper management of platoons.

As heterogeneous traffic can be seen in Ahmedabad road, there is more chances of creating queue on road which ultimately causes delay on traveling time so road user can not able to enjoy seamlessly driving experience. So that, to provide better traveling experience. It is required to reduce delay time, to increase the flow of vehicles, for the reduction in fuel consumption, to reduce noise pollution and to reduce air pollution. This can be achieved with the help of better queue management.

1.1. Objectives of the study

1. To analyze the traffic parameters at an intersection under mixed traffic conditions.
    - Macroscopic traffic parameters

- Microscopic traffic parameters

2. To manage queue formation at selected two intersection so that traffic flow is maximized by efficiently using all green time at intersection.
3. To calculate and optimize the effectiveness of the performance measure attributes at intersection under mixed traffic.
4. To develop the mixed traffic performance measure model.

2. LITERATURE STUDY

The literature review is required because: It describes; the proposed research is related to previous research in statistics. It shows the originality and relevance of the research problem and also finds out the gap in the research problem. In the present, literature is carried out of methodology for Queue clearance at signalized intersection.

Bing Li studied the mixed platoon dispersion model and modify it based on the variation of queue length to estimate the arrival of cars and buses.

The heterogeneous traffic flow parameters are analyzed using the heterogeneous traffic flow model and the queue length is estimated with the shock waves of the mixed classes. This approach fully describes the relationship between upstream traffic arrivals and the variation of the incremental queue accumulation, and makes up for the shortcomings of the uniform arrival assumption in previous research.

The results show that a vehicle arrival estimation model based on mixed platoon dispersion model can reflect the stochastic arrival phenomenon of different flow classes well. The computational complexity of the model is relatively low and it is convenient for use in engineering and design.

Several directions for future research can be summarized as follows:

- This paper assumed that vehicle lane changing has no effect on vehicle arrival characteristics.
- The next step is to optimize and perfect the model with an estimation of the travel time and the selection of shorter interval parameters.

Seunghyeon Lee introduce offset in a signal plan and lane-based turning proportion on the proposed framework to explain vehicular spillbacks in an individual lane and a grid lock for pursuing coordinated traffic movements along arterials and in signalized urban networks.

The integrated Convolution Neural Network (CNN) – Long Short-Term Memory (LSTM) method shows excellent performance to estimate queue lengths in individual lanes in seconds compared to the other approaches applied in this paper. They create core architecture of the CNN to decide whether there is a residual queue at the end of each cycle using cycle-based imaged dataset, involving occupancy rates and impulse memories in an individual lane.

The results demonstrated that the proposed method was accurate for the estimation of lane-based queue lengths in real time under a wide range of traffic conditions.

S. P. Anusha estimated queue and delay at intersections for the scenario when the queue ends within the advance detector using the data obtained from loop detectors installed at the entry and the exit of the intersection. A detailed analysis of the data obtained from loop detectors revealed that there were errors in the data.

The results showed that the queue clearance based method was performing better while estimating queue and delay compared to the occupancy based method. Thus, the queue clearance based method would be valuable for the estimation of queues and delays while implementing with erroneous field data.

Shi Ming Wang studied the variable queue clearance time model is derived by analyzing the relation between the adjacent upstream intersection's departure traffic flow pattern and the offset time.

To take the variable queue clearance time into consideration, the proposed revised maxband model combines the variable queue clearance time model and traditional maxband model.

The proposed green wave band model is combined with the variable queue clearance time model to take variable queue clearance time into consideration. This model can be transformed to a Mixed Integer Linear Programming problem after the process of variant substitute and then it is able to be solved easily by Bound-and-branch Algorithm.

Shoufeng, Lu integrates traffic flow dispersion with MAXBAND model to formulate MAXBAND-Dispersion model. For the three-intersection artery, they solve MAXBAND Dispersion model. Revised model will more effectively optimize bandwidth.

Signal setting methods separate broadly into two classes.

1. The first class consists of methods that maximize bandwidth and progression. This group develops from single artery to arterial network, and from uniform bandwidth to variable bandwidth.
   - Maxband is the base of subsequent bandwidth optimization models. The deficiency of Maxband was redeemed in the Maxband-86 model that can handle closed grid networks of arterial streets. These two models generate uniform bandwidth.
2. The second group contains methods that seek to minimize delay, stops, fuel consumption or other measures of disutility. Examples are the combination method, TRANSYT, SCOOT.

3. METHODOLOGY

Methodology gives the idea about the method or best practice can be applied for the study for any topic. Methodology is the strategy which shows the way of the study conducted in which study is to be undertaken. It gives general idea of the study includes the techniques required for the study

For achieving objectives, the work should be carried out in various stages. The first three steps; Problem Statement, Objective & Scope of Study and Literature Review are discussed in previous chapters. As discussed in this chapter study area were two intersection of Ahmedabad city. The data has been collected through video-graphic survey. The data are extracted from video by playing the video multiple times. All extracted data were compiled in excel sheet. The regression models were developed from compiled data. The variation in value of queue clearance time required to vehicle with different traffic characteristics will be analyzed. Based on results findings and conclusion were achieve.

4. DATA COLLECTION

The data collection is significant undertaking in research work. Field information for the current investigation was gathered for selected intersection. The data

collected for the current investigation are classified volume count, speeds of vehicles, road inventory data. The videography was done on 12th February 2021 to 25th February at Dafnala cross-road and Dhudheshwar Y-intersection gather grouped volume count and speed of vehicles data. A video recording of the part was accomplished for 9:00-11:00 A.M. furthermore, 6:00-8:00 P.M. hours for morning and evening peak hours. The video was subsequently replayed and information on classified volume count was gathered. The spot speed information were additionally gathered and investigated.

4.1 Primary data

Primary data includes

1. Road inventory Survey
2. Classified Volume Count
3. Spot Speed Survey

Road inventory Survey

Geometrical data of the chosen road-links are needed for the examination. This information contains numbers of the lanes, Signal Cycle Length and Central Island Radius. Road inventory survey was done to gather this information. Table representation the street width at all intersection and showing distance between two crossing points of road-link.

Table 1 Road Inventory Data

Approach	No. of Lane	Central Island	Signal Cycle Length (R+A+G)
From Commi. Office	3	31 m	129+44+2
From Delhi darwaja	3		140+33+2
From Dadhichi Bridge	2		150+24+2

Table 2 Road Inventory Data

Approach	No. of Lane	Central Island	Signal Cycle Length (R+A+G)
From Airport	2	21 m	118+91+3
From Shahibag	2		180+29 +3
From Riverfront	2		175+34+3
From Civil	2		164+44+3

Classified Volume Count

Traffic Flow: - Traffic stream is characterized as the rate at which vehicles that have been holding up in a line during the red interval cross the stop line of an intersection approach path during the green interval.

Volume is the amount of vehicles at a given point on the intersection. Traffic stream is typically expressed in passenger car units per hour (PCU/h).

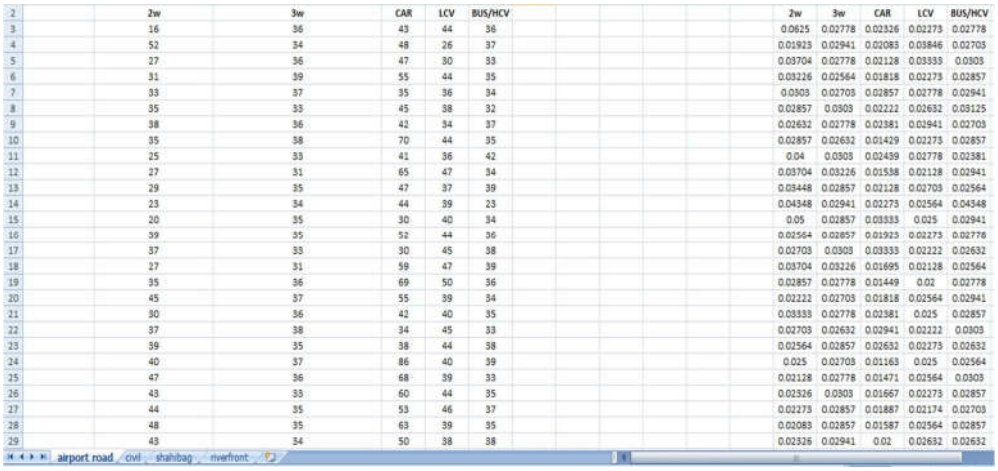
Table 3 Dafnala Cross Road (From Airport road to Shahibag)

Time (9:15 – 11:15 A.M.)	2W	3W	Car	L.C.V.	H.C.V./Bus	Non-Motorized	
09:15 - 9:29	124	54	88	12	4	6	
09:30 - 9:44	126	62	85	9	3	5	
09:45 - 9:59	125	59	83	12	4	3	
10:00 - 10:14	128	57	87	9	5	4	
10:15 - 10:29	126	53	78	12	3	3	
10:30 - 10:44	129	56	84	11	4	5	
10:45 - 10:59	128	59	74	13	6	4	
11:00 - 11:14	126	58	79	14	7	2	
Total	1012	458	658	92	36	32	
Total (Veh/h)	506	229	329	46	18	16	1144
Total (PCU/h)	202.4	114.5	329	50.6	28.8	4.8	730.1

Videography Method

Videography Method In this investigation speed estimated by stop watch strategy and extra variable find by Videography. The information were gathered for morning and evening top hours. Speeds were assessed from videography. From such information, the connection between Delay, Queue Lane, Heavy vehicles and speed was set up.

The spot speed of vehicles were estimated by recognizing the time taken by the vehicles to go through a longitudinal part of Dafnala inter-section and Dhudheshwar Y-inter section.



	2w	3w	CAR	LCV	BUS/HCV	2w	3w	CAR	LCV	BUS/HCV
3	16	36	43	44	36	0.0625	0.02778	0.02326	0.02273	0.02778
4	52	34	48	26	37	0.01923	0.02941	0.02083	0.03846	0.02703
5	27	36	47	30	33	0.03704	0.02778	0.02128	0.03333	0.0303
6	31	39	55	44	35	0.03226	0.02564	0.01818	0.02273	0.02857
7	33	37	35	36	34	0.0303	0.02703	0.02857	0.02778	0.02941
8	35	33	45	38	32	0.02857	0.0303	0.02222	0.02632	0.03125
9	38	36	42	34	37	0.02632	0.02778	0.02381	0.02941	0.02703
10	35	38	70	44	35	0.02857	0.02632	0.01429	0.02273	0.02857
11	25	33	41	36	42	0.04	0.0303	0.02439	0.02778	0.02381
12	27	31	65	47	34	0.03704	0.03226	0.01538	0.02128	0.02941
13	29	35	47	37	39	0.03448	0.02857	0.02128	0.02703	0.02564
14	23	34	44	39	23	0.04348	0.02941	0.02273	0.02564	0.04348
15	20	35	30	40	34	0.05	0.02857	0.03333	0.025	0.02941
16	39	35	52	44	36	0.02564	0.02857	0.01923	0.02273	0.02778
17	37	33	30	45	38	0.02703	0.0303	0.03333	0.02222	0.02632
18	27	31	59	47	39	0.03704	0.03226	0.01695	0.02128	0.02564
19	35	36	69	50	36	0.02857	0.02778	0.01449	0.02	0.02778
20	45	37	55	39	34	0.02222	0.02703	0.01818	0.02564	0.02941
21	30	36	42	40	35	0.03333	0.02778	0.02381	0.025	0.02857
22	37	38	34	45	33	0.02703	0.02632	0.02941	0.02222	0.0303
23	39	35	38	44	38	0.02564	0.02857	0.02632	0.02273	0.02632
24	40	37	86	40	39	0.025	0.02703	0.01163	0.025	0.02564
25	47	36	68	39	33	0.02128	0.02778	0.01471	0.02564	0.0303
26	43	33	60	44	35	0.02326	0.0303	0.01667	0.02273	0.02857
27	44	35	53	46	37	0.02273	0.02857	0.01887	0.02174	0.02703
28	48	35	63	39	35	0.02083	0.02857	0.01587	0.02564	0.02857
29	43	34	50	38	38	0.02326	0.02941	0.02	0.02632	0.02632

airport road | civil | shahibag | riverfront

Figure 1 Spot speed study at Dafnala intersection from Airport road

4.2 VISSIM input data

VISSIM programming is an arranged idea to characterize and give vehicle data at various roads all in the application. In VISSIM vehicles are arranged into various sorts as car, LCV, HCV, bus, bicycle. VISSIM has not recognizing three wheelers as a vehicle type. So, to coordinate with Indian heterogeneous traffic condition, three-wheeler is added in VISSIM as one vehicle type by characterizing its length, width, model, color, and so forth, without any difficulty of graphical interface.

All the information in regards to characterized volume counts, traffic composition and velocities were acquired from videography, which was accomplished for morning and evening peak hours. That information are utilized as contribution for CVC data which is used in vehicle composition, vehicle input and in vehicle route assign in model, reproduction and from that space mean speed and reenacted volume check information are gathered.

The ideal speed circulation for every vehicle class is given as contribution for the model in VISSIM. The greatest and least upsides of the velocities and total speed appropriation were characterized as contribution to the model. The ideal speed profile for the vehicle type vehicle is given as an illustration in Fig.

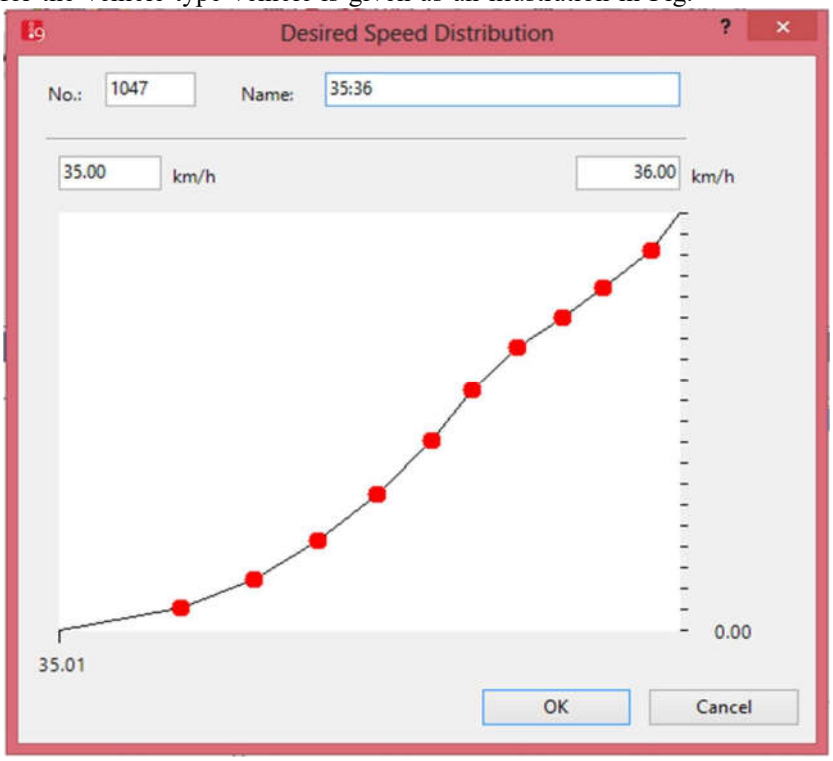


Fig -2 Desire speed distribution chart for one approach in VISSIM

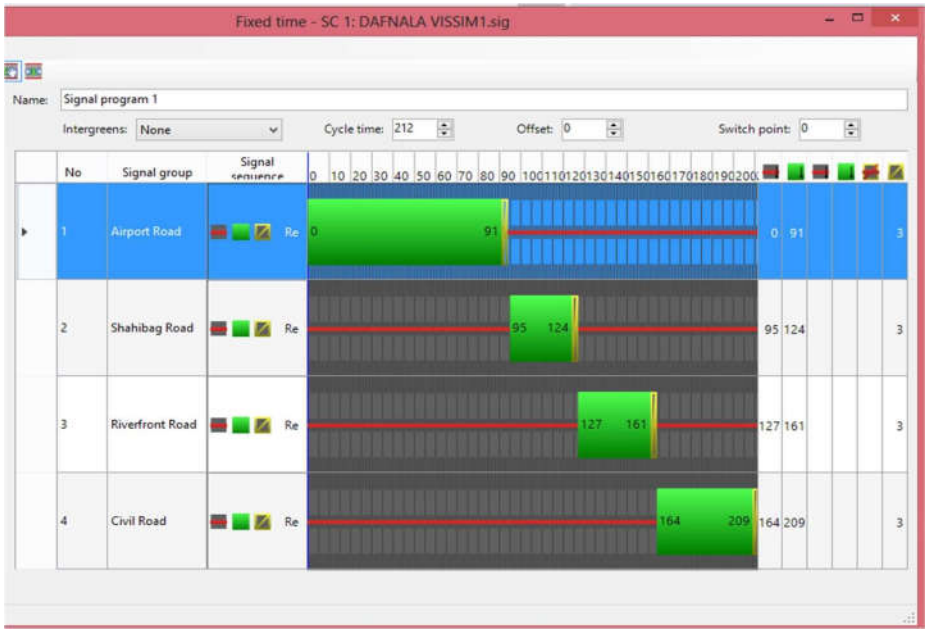


Fig -3 Actual signal cycle length

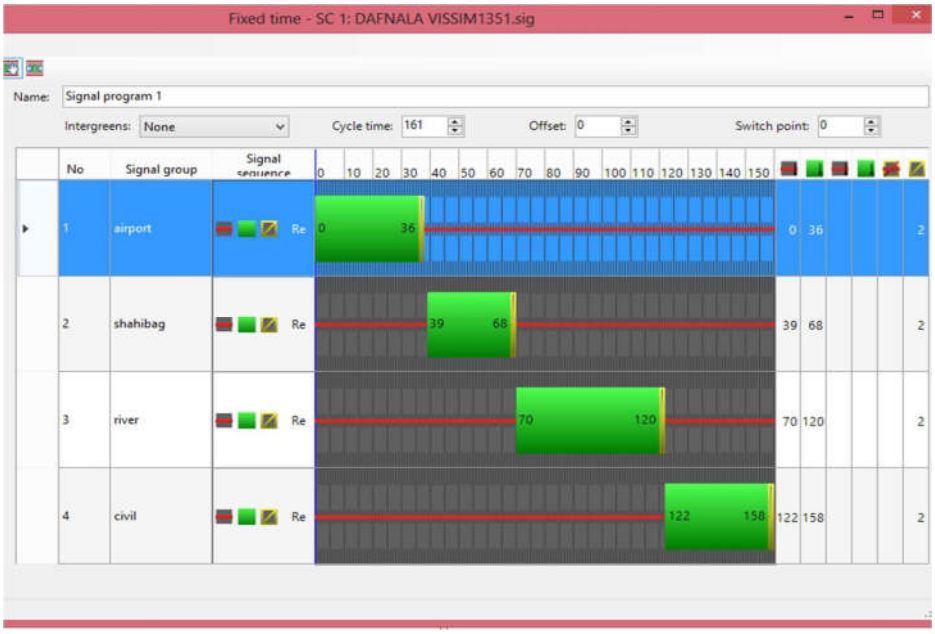


Fig -4 Optimized signal cycle length

For Dhudheshwar Y-intersection				
	Red	Green	Amber	Signal Cycle length
Dadhichi Bridge	101	52	2	155
Commissioner Office Road	99	54	2	155
Delhi Darwaja Road	112	41	2	155

Table 4 Optimized signal cycle length for Dudheshwar Y-Intersection

For Dafnala Intersection				
	Red	Green	Amber	Signal Cycle length
Airport Road	123	36	2	161
Riverfront Road	109	50	2	161
Civil Road	123	36	2	161
Shahibag Road	130	29	2	161

Table 5 Optimized signal cycle length for Dafnala Intersection

5. DATA ANALYSIS

Composition of Traffic

Following vehicle composition is seen from 9:00-11:00 A.M. furthermore, 6:00-8:00 P.M. hour overview for various selected intersection. Traffic composition is introduced as pie graph. From the pie chart, obviously, significant traffic is shared by followed by substantial vehicles which incorporate car, Light Commercial Vehicles and Weighty Commercial Vehicle.

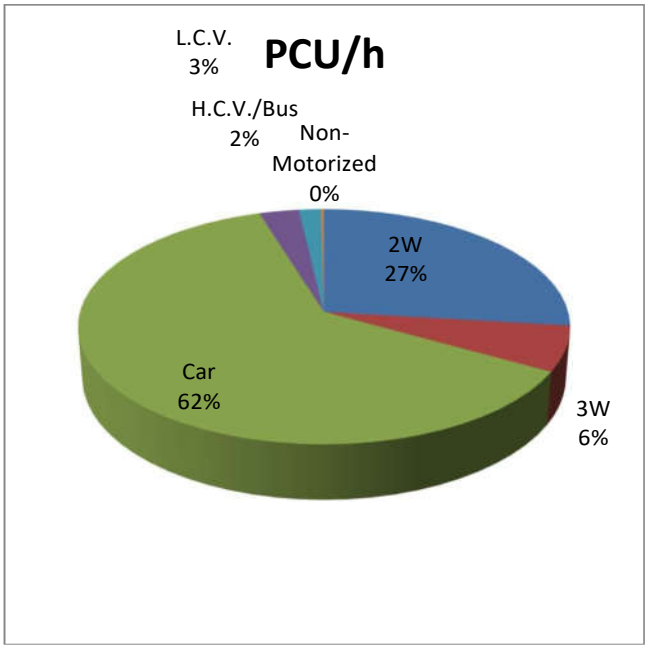


Figure 5 Vehicle composition at Dafnala Cross Road (At Airport road)

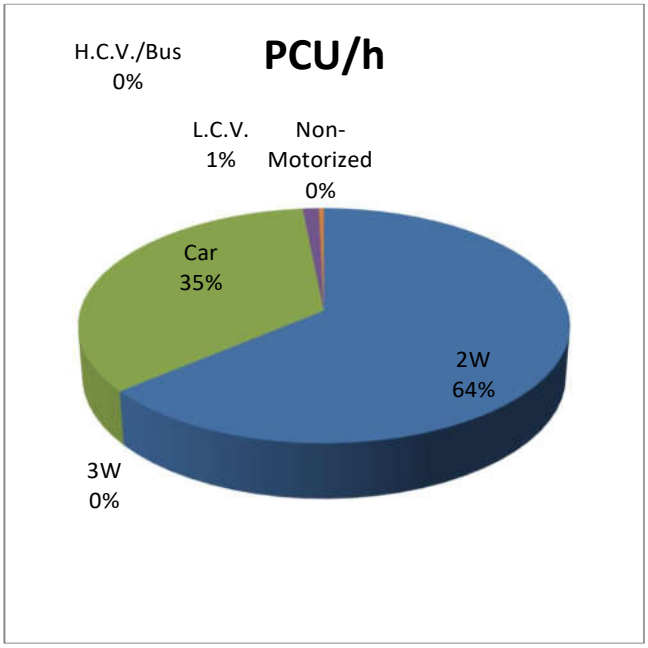


Figure 6 Vehicle composition at Dafnala Cross Road (At Riverfront)

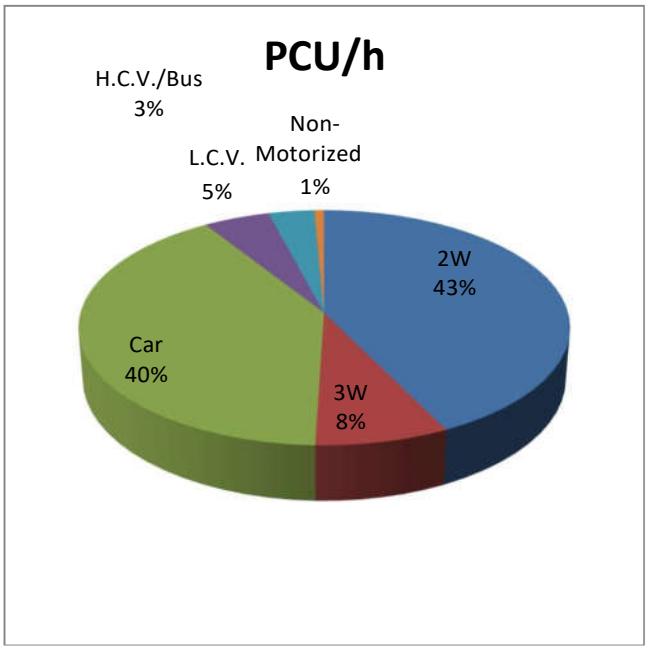


Figure 7 Vehicle composition at Dafnala Cross Road (At Civil Road)

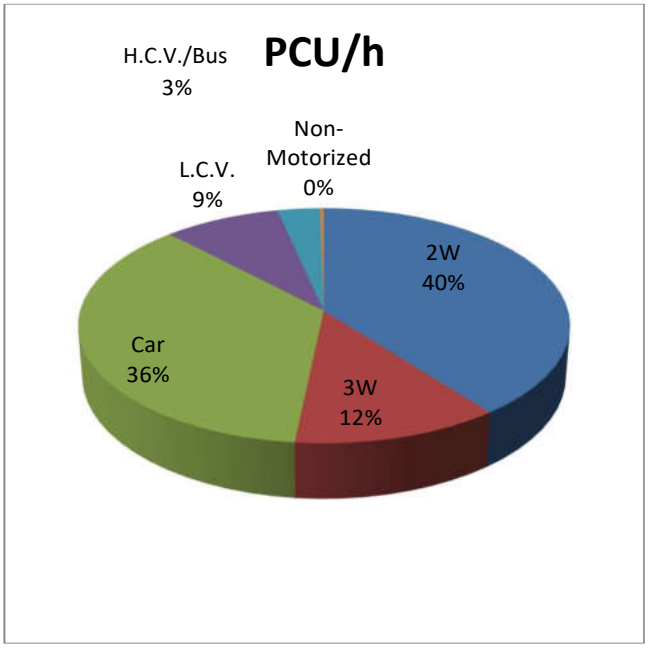


Figure 8 Vehicle composition at Dafnala Cross Road (At Shahibag Road).

Saturation flow and Delay

Delay at Signalized intersection

$$d = \frac{(1-\gamma)^2}{2(1-\gamma x)} + \frac{x^2}{2(1-x)} - 0.65\left(\frac{c}{q^2}\right)^{\frac{1}{3(2+5\gamma)}}$$

Where,

d = average delay per vehicle

γ = effective green time for the phase under consideration

x = the degree of saturation

c = cycle time

q = flow

6. MODEL DEVELOPMENT AND VALIDATION

In this section, the queue length forecast model is created utilizing statistical techniques. All in all, the model improvement measure is iterative in light of the fact that in this interaction numerous models are inferred, tried, and based upon until a model fitted the ideal rules. Likewise, this interaction included a few undertakings: underlying model definition (for example straight, remarkable, and so forth), request (power) evaluation, and boundary assessment.

Numerous kinds of factual procedures are accessible for the improvement of the Traffic Stream Expectation model. Multiple Linear Regression is picked for the examination of Traffic. It is used to determine the relationship between the Queue length with Delay time, Speed of Vehicles and the proportion of Heavy vehicles. Ultimately, affectability examination is completed for approval of the model.

Queue length Optimaization Model

For Dafnala Intersection

Y=0.7016X1-1.5783X2+1.1692X3+125.4729 (R2 = 0.9918)

Constrain to get optimum Queue clearance for Dafnala Intersection

48<=X1<=65 S

33 KM/H <=X2<=42 KM/H

X3<=35%

For Dhudheshwar Y-intersection

Y=0.6492X1-1.5709X2+1.456X3+110.3692 (R2 = 0.9901)

Constrain to get optimum Queue clearance for Dhudheshwar Y-intersection

48<= X1<=65 S

33 KM/H <=X2<=42 KM/H

X3<=30%

Where,

X1= delay in sec

X2= speed in km/h

X3= heavy vehicle percentage

The R square incentive for the model sounds great. It clarifies that yields are near the linear trend.

SUMMARY OUTPUT		
	Dafnala intersection	Dhudheshwar Y-intersection
Regression Statistics		
Multiple R	0.99593543	0.99019019
R Square	0.99188737	0.98047662
Adjusted R Square	0.99180402	0.98000044
Standard Error	1.86939024	1.81104053
Observations	296	127

Table 6 Queue length model Validation

ANOVA						Dafnala intersection		
	df	SS	MS	F	Significance F			
Regression	3	124762.3844	41587.461	11900.425	7.44E-305			
Residual	292	1020.429007	3.4946199					
Total	295	125782.8134						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	125.472994	1.166537043	107.56023	6.27E-237	123.177107	127.7688803	123.1771073	127.76888
X1	0.70161004	0.006758587	103.81016	1.53E-232	0.68830832	0.714911759	0.688308319	0.71491176
X2	-1.57830488	0.011747551	-134.3518	1.42E-264	-1.6014255	-1.55518428	-1.601425486	-1.55518428
X3	1.16928867	0.016903611	69.173899	4.06E-183	1.13602031	1.202557024	1.13602031	1.20255702

Table 7 Queue length model Validation For Dafnala Intersection

ANOVA						Dhudheshwar Y-intersection		
	df	SS	MS	F	Significance F			
Regression	3	20260.1971	6753.39905	2059.04611	6.523E-105			
Residual	123	403.423741	3.27986781					
Total	126	20663.6209						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	110.369154	3.19080304	34.5897735	3.1765E-65	104.053155	116.685153	104.053155	116.685153
X1	0.64915372	0.03829704	16.9504955	5.6777E-34	0.57334709	0.72496035	0.57334709	0.72496035
X2	-1.5708604	0.0251454	-62.471089	4.9496E-95	-1.6206342	-1.5210866	-1.6206342	-1.5210866
X3	1.45600995	0.03417363	42.6062478	1.671E-75	1.38836536	1.52365455	1.38836536	1.52365455

Table 8 Queue length model Validation For Dudheshwar Y-Intersection

7. RESULT AND CONCLUSIONS

Flow is valuable to decide the capacity of the intersection, signal design, and so on. Traffic in India comprises of both mechanized just as non-mechanized vehicles. Because of heavy traffic development rate lately has forced blockage on the urban streets. A few endeavors are made by the nearby bodies to improve the issues of blockage and contamination of air. In Indian situation because of a tremendous distinction in the pay, various kinds of vehicles are having a similar street with no actual isolation. Additionally, the absence of lane discipline and unhindered blending of the different kinds of vehicle in similar option to proceed makes the traffic stream heterogeneous in nature.

Results

- The queue generated at the study area is seen to range from 90 meters to 240 meters which can be problematic in coming years with the increase in usage of vehicles.
- From CVC data analysis, the overall traffic composition of Car, LCV, HCV/BUS and Non motorized is 67, 36, 49, 48, 31, 31 and 25 % at Airport

road, Riverfront, Civil Road, Shahibag road, Dadhichi Bridge, Commissioner Office road and Delhi darwaja road.

- The speed was found that the speed of the vehicles at the Dafnala intersection in the range of 12-75 kmph. And for the Dhudheshwar Y-Intersection the Range was 12-65 kmph.
- Queue length at the Dhudheshwar Y-intersection and Dafnala intersection can be reduced to 7 to 23 %.

Conclusions

- Mathematical model are developed using regression analysis considering various variables like Delay of vehicles, Speed of Vehicles and the proportion of heavy vehicles.
- The F-test statistics supported that with 95 % confidence any difference in standard deviation in is just due to standard error and data sets are statistically similar to each other; so we can use this model for future data prediction.
- CVC data indicates that the proportion of heavy vehicles is maximum and leads to high heterogeneous traffic conditions.
- Analysis shows that the percentage of a Car, LCV, HCV/BUS and Non motorized have a major impact on the traffic flow model, it affects negatively which lead to increase in Queue length.
- The Speed indicates that the improvement is required.
- With using optimized signal for the optimization of traffic flow for the efficient movement of vehicles results in the reduction in delay of traffic congestion and ultimately Queue length can be reduced.
- Which lead to optimization of Queue Clearance for selected intersection.

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