Three Phase Signal Design by Webster Method and Survey for Public Transport Development in Small City: A Case Study on District Alirajpur

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Abstract: The growth of traffic volume at the intersection has been on the rise which has resulted in many problems like congestion, road accident and conflicts. The traffic signal is used to regulate diverse streams of pedestrians and vehicular traffic in most of the intersections. Three-phase signal design is proposed for Dahod Naka District Alirajpur by the Webster method. The layout of the location is seen and manually data is collected like road length, traffic count, determination of peak hour, number of phases, normal flow, saturation flow, etc.According to the traffic signal, signal time is most important and how much full red time is to be introduced for pedestrian crossing. According to IRC guidelines, traffic signal is designed.With the increasing population in a small city, the demand for affordable and easily accessible public transport is increasing. A Public survey is done to get an idea of the public's needsand suggest a suitable route for public transport.

Keywords: Signal design, Intersection, Traffic count, Webster method, Public transport, and Public Survey.

I. INTRODUCTION

1.1 Traffic signal

Traffic signals not only regulate the flow of traffic, it also reduces road accidents and congestion. In this paper, a three-phase signal is introduced at the junction of three roads. Three-phase signal is designed by the Webster method as it is most analytical approach to determining the optimum signal cycle time (it is based on total lost time). The optimum signal cycle timedepends upon the geometric details of the intersection and the volume of traffic approaching the intersection. National Highway (NH-56) is passed from the Dahod Naka intersection also two-state boundaries Gujrat and Maharashtra are connected to Alirajpur District.It is an important junction andis subjected to heavy traffic congestion at that location which also raisesthe chances of accidents. Simple progressive systems (The phase and interval at each signal installation may be different but each signal units work as a fixed time signal, with equal signal cycle length) have to be introduced at the location. In the future,four lanes will be built from Ratlam to Alirajpur via Jhabua around 200km (proposed by the government),hence road density will moreat this junctionso a traffic signal is necessary at that location.

1.2 Public Transport

In Alirajpur city there is limited public transport facility available in cityand,there is no fare regulation by authority which makes available resources costly. Due to this circumstances, people are using their private vehicle to move inside the city.It increases noise pollution, air pollution and in many areas of Alirajpur traffic congestion takes place. So need to introduce public transport in Alirajpur and nearby places. On 30 October 2019, a new railway line was inaugurated between Alirajpur station and Pratapnagar station in Vadodara so from railway station there is no public transport available for public and they are using private vehicle for travelling and spending more money. To overcome these problems public transport need to be introduced.

II. OBJECTIVE

- To design a traffic signal at Dahod Naka of Alirajpur district.
- To collect necessary data, traffic count at the location.
- To take public opinionon the use of public transport in Alirajpur by Questionnaire survey.
- To suggest the public transport routes in Alirajpur.

III. METHODOLOGY

- For the design of the traffic signal the traffic count is conducted at Dahod Naka.
- Conversion of traffic count pcu/hr and road width measurement
- Designing by Webster method and approximation according to necessary IRC code.
- For public transport the household and road interview survey has been conducted.
- Analysis of data collected from the survey and checking whether public transport is requiredby the people or not.

3.1 Traffic signal design:-Alignment of intersection

Figure 1: - Location of intersection.

Figure 2: - Data collection at intersection.

Design Steps of Traffic Signal by Webster Method

S.No.	Average no. of vehicle in pcu/hr (Passenger car unit per hour)
Road-1	591.42
Road-2	490.07
Road-3	652.57
Road-4	506.28
Road-5	744.85
Road-6	699.28

• Webster's Method is the most analytic approach of determining the optimum cycle time. It is based on total lost time. It depends upon geometric details of the intersection and the volume of traffic approaching the intersection. Numerically Optimum cycle time is calculated as;

$C_o = \frac{1.5L+5}{1-Y}$

1. In the present study the traffic field study is used to calculate the traffic volume at Dahod Naka. The survey was conducted for one hour for 7 days to calculate the traffic volume in pcu/hr which is used in design steps.
2. As there are 6 directions at a junction, we have done survey for each direction for continuous seven days and collected the traffic count.
3. Traffic count is converted into pcu/hr according to the individual pcu units. As per IRC: 93 1985.

S.No.	Vehicle	pcu/hr (As per IRC : 93-1985 Appendix 3)

1.	Bike and Cycle	0.5
2.	Car and Three Wheelers	1
3.	Truck and Bus	3
4.	Tractor	4.5
5.	Small Bullock Cart	6
6.	Large Bullock Cart	8
7.	Horse Drawn Vehicle	4

4. The average pcu/hr is calculated in each direction and we have calculated the road width that is

S.No.	Roads	Width
1	Road 1,2	6.35
2	Road 3,4	7.899
3	Road 5,6	6.248

5. As per IRC SP-41 saturation flow rate isestimated: -

Width (m)	3	3.5	4	4.5	5	5.5	More than5.5
Saturation flow Rate (PCU/HR)	1850	1890	1950	2250	2350	2900	525/m width

- Saturation flow $s_{1,2}$, $s_{4,3}$ and $s_{5,6}$

  $s_{1,2}$= 3333.75 pcu/hrs, $s_{4,3}$ = 4146.97 pcu/hrs and $s_{5,6}$ = 3280.2 pcu/hr

6. Calculation of critical flow ratio in each direction(As per IRC : 93-1985 Appendix 3) and critical flow ratio is taken in those direction which has maximum of two way traffic:-

$y = \frac{q}{s}$

y= Critical flow ratio

q = Normal flow

s = Saturation flow

For three phase system, there will be three critical ratio i.e. y_1, y_2 and y_3

$y_{1,2} = y_1 = 0.17$, $y_{3,4} = y_2 = 0.15$, $y_{5,6} = y_3 = 0.22$

$Y = y_{1,2} + y_{3,4} + y_{5,6}$, $Y = 0.17+0.15+0.22 = 0.54$

7. Calculation of total lost time per cycle including all phases (As per IRC : 93-1985 Appendix 3) which is given as

$L = (2n + R)$

Where, n = no. of phase and R = All red time (may be provided for pedestrian crossings)

So, $L = (2 \times 3 + 9) = 15m$

8. By all the above data, we can calculate optimum cycle time i.e.

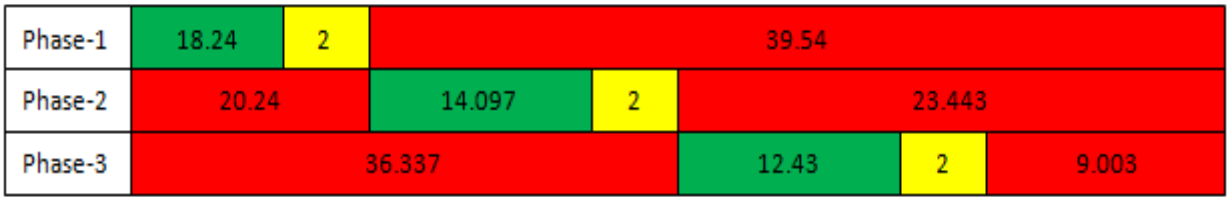
$C_o = \frac{1.5L+5}{1-Y} = \frac{1.5\times15+5}{1-0.54} = 59.78$ sec

9. Green time calculation

$G_{1,2} = \frac{Y_{1,2}}{Y}(C_o - L) = \frac{0.17}{0.54}(59.78 - 15) = 14.097$ sec

$G_{4,3} = \frac{Y_{4,3}}{Y}(C_o - L) = \frac{0.15}{0.54}(59.78 - 15) = 12.43$ sec

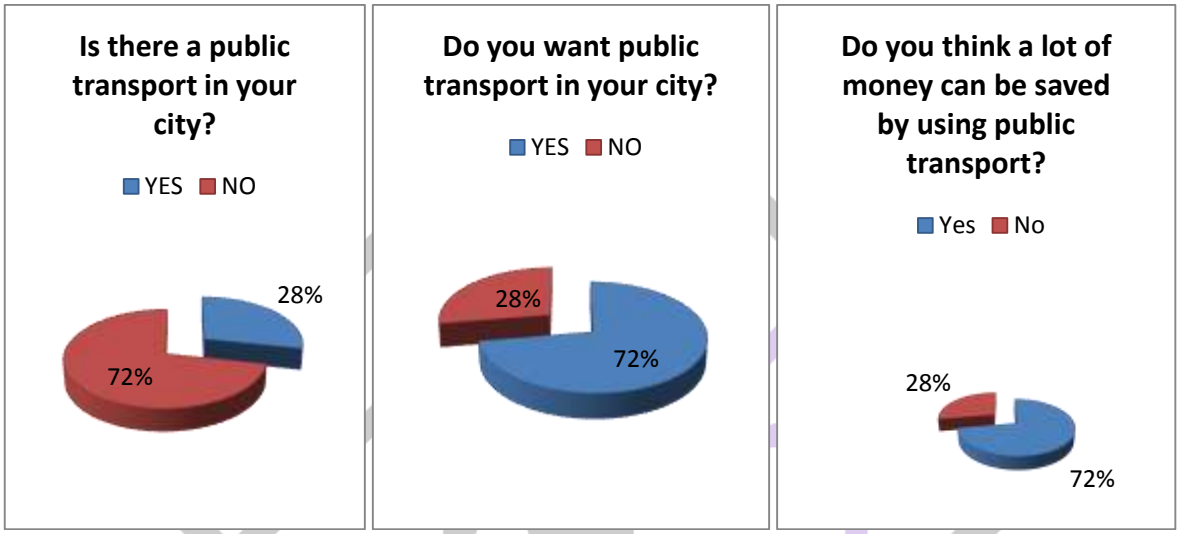
$G_{5,6} = \frac{Y_{5,6}}{Y}(C_o - L) = \frac{0.22}{0.54}(59.78 - 15) = 18.24$ sec

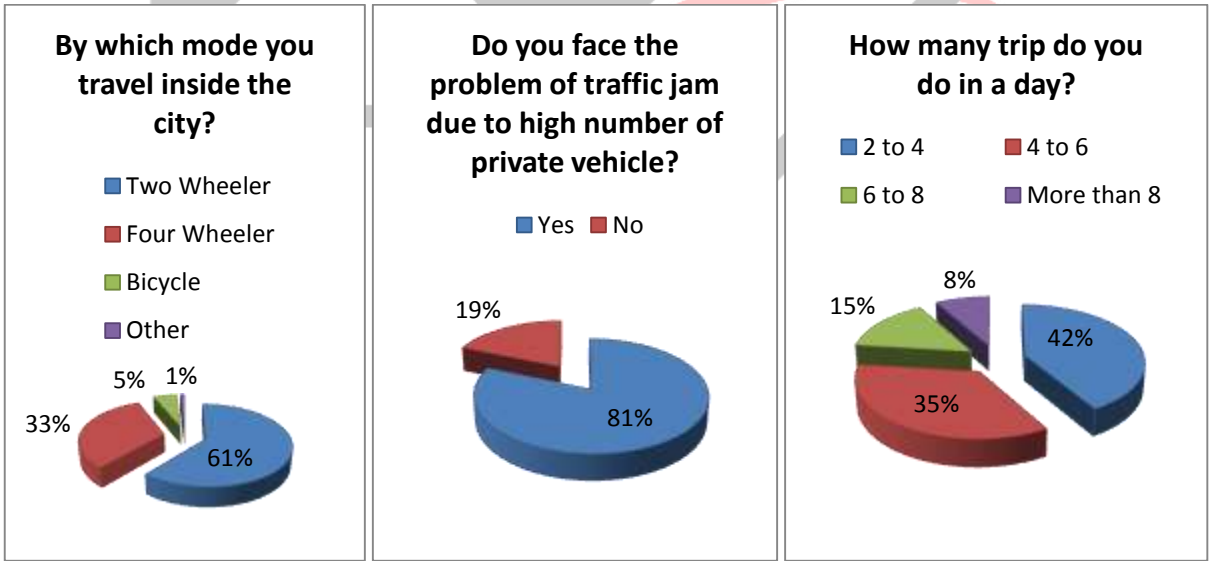


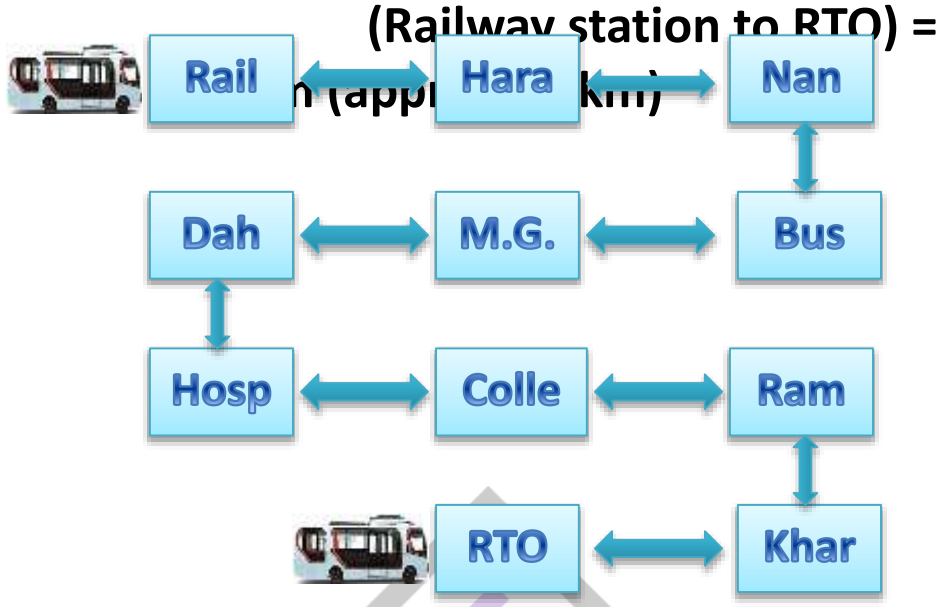
3.2 Public Transport

A detailed survey of around 1500 people was conducted to check the requirement for public transport. The survey consists of questions related to the need for public transport, safety in public transport, traffic congestion due to private vehicles, the safety of women in public transport, motiveand mode of transportation of people, etc. Google form was developed to conduct the survey and shared on various social media platformsamong various groups of Alirajpur people. Door to door survey, survey in various schools and colleges, and shopkeepers were included in this survey.

Figure 3:- Survey of public transport







IV. RESULTS

Traffic data was collected at Dahod Naka and we have proposed a traffic signal.With the help of the optimum cycle method, we have designed three-phase signal system.The optimum cycle time is estimated to be approximately 60 seconds. For the facility of public transport, the survey was conducted, and following responses we have received:

- It has been found that 72% of people need public transport in the city.
- 81% of people face traffic problems in their area via a private vehicle.
- 79% of people think that public transport is safe for women.
- 63% of people make the trip inside the city and 37% outside the city.
- 72% of people think public transport will be more economical as compared to use own vehicle.
- The average 2-4 trips make in a day is about 42%.
- 66% of people use two-wheelers.

V. CONCLUSION

As we have proposed three-phase traffic signal at Dahod Naka Alirajpur which will help to reduce traffic congestion, will make traffic flow easily, and also reduces noise pollution. This junction is important as future government project will also increase traffic volume at this junction. Infrastructure development of Alirajpur is important as it connects state boundaries of Gujrat and Maharashtra.

For the development of public transport within the city, we have proposed public transport routes and stops for travelling inside the city. Small size bus can be used as a public transport so that maximum people can take a benefit in affordable cost.

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