Optimizing traffic signal using VISSIM software at signalized intersection

Smita Pataskar*, Aditya Koulaskar, Saniya Pathan Vaibhavi Waghmare, Pratik Solas

*Assistant Professor, Civil Department, D.Y.P.C.O.E, Akurdi, Pune, India Students,
Civil Department, D.Y.P.C.O.E, Akurdi, Pune, India*

ABSTRACT

In the modern landscape, the amalgamation of Urbanization and Industrialization has triggered a notable surge in traffic congestion, wielding significant influence over a nation's developmental trajectory. This burgeoning challenge is particularly pronounced in developing nations, where a diverse array of vehicles, each characterized by distinct attributes, shares the same thoroughfares. This diversity engenders a complex mix that complicates the optimization of transportation systems. The exponential growth in vehicular traffic has ushered in a multitude of predicaments, spanning diminished average speeds, extended travel durations, pervasive delays, and amplified safety concerns, particularly within urban hubs. Addressing this pressing issue necessitates the deployment of advanced methodologies, with the "Traffic Micro-Simulation Model" emerging as an indispensable solution capable of dissecting intricate traffic models that surpass the confines of traditional analytical or numerical treatments. This study centres on empirically assessing real-time traffic scenarios across one distinct intersection. Harnessing the computational prowess of Vissim Software, the paper aims to simulate these traffic conditions, meticulously fine-tuning signal timings to effectively mitigate conflicts and streamline the flow of vehicles. The signal time is optimized to present minimal queue length of vehicle at the intersection.

Keyword: - *VISSIM Software, Simulation, Optimization, Queue Length*

1. INTRODUCTION

Traffic simulation, a core aspect of traffic engineering and transportation planning, involves mathematically modelling transportation systems. This encompasses a wide array of systems, from freeway junctions to downtown grid structures, utilizing computer software. Its primary aim is to assist in the efficient planning, design, and operation of transportation networks. This discipline holds significant importance in today's landscape, with numerous national and local transportation agencies, academic institutions, and consulting firms leveraging simulation techniques to manage transportation systems effectively.

The utilization of simulation within transportation is crucial for several reasons. It enables the conduct of experimental studies and facilitates a detailed analysis that might not be feasible through traditional analytical or numerical approaches. Additionally, it offers visually engaging representations of both current and future scenarios, thereby aiding in better decision-making processes. A key advantage lies in its ability to accurately portray the dynamic nature of traffic, encompassing continuous flow and varying traffic volumes, in a stochastic manner. These models not only save time and costs but also demonstrate higher accuracy compared to classical methods.

Furthermore, traffic simulation plays a pivotal role in examining both signalized and un-signalized intersections. To comprehend simulation thoroughly, understanding the concept of system state is fundamental. This refers to a collection of variables containing sufficient information to describe the system's evolution over time.

2. METHODOLOGY

The methodology consists of an organized process with multiple important stages:

1. **Site Selection:** This phase entails establishing the standards and limitations necessary for assessing the site. Considerations include infrastructural availability, demographic data, geographic factors, accessibility, and regulatory considerations. Potential locations are evaluated in accordance with these standards using tools such as Google Earth, combining remote sensing methods and field surveys to provide comprehensive data.

2. Literature Evaluation: A thorough analysis of previous research, academic papers, and pertinent literature is done. This step guarantees a comprehensive comprehension of previous research, pinpoints knowledge gaps, and guides the direction of the technique.

3. Data Gathering from Traffic Surveys: In this stage, empirical data is gathered using traffic surveys. Information on traffic volume, patterns, and behaviour at places can be gathered using a variety of techniques, including manual counts, automatic counters, or video-based surveys.

4. Modelling and Analysis using VISSIM: VISSIM software is used to model and analyse the collected data. With the help of this traffic microsimulation program, virtual models that mimic actual traffic situations can be created. VISSIM is used to study and optimize parameters including traffic flow dynamics, lane designs, and signal timings.

5. Outcomes: The conclusions drawn from the modelling and analysis stage are closely examined and explained. These findings include information about traffic behaviour, patterns of congestion.

3.SITE SELECTION

The site selected is having signalised intersection at a busy square named "BHONDVE CORNER" in Akurdi, Pune, Maharashtra State, India

Figure 2: Pune　　　　**Figure 3**: Site location　　　**Figure 1**: Maharashtra

3.TRAFFIC SURVEY

Visual based traffic counting was done for 3 days consecutively this strategy provides a scalable and effective way to manage and monitor traffic. Manual vehicle counting is the process of having human observers count and note how many cars pass through a specific location over a predetermined amount of time. When automated systems are unavailable or to verify data obtained from automated systems, this conventional approach is frequently employed.
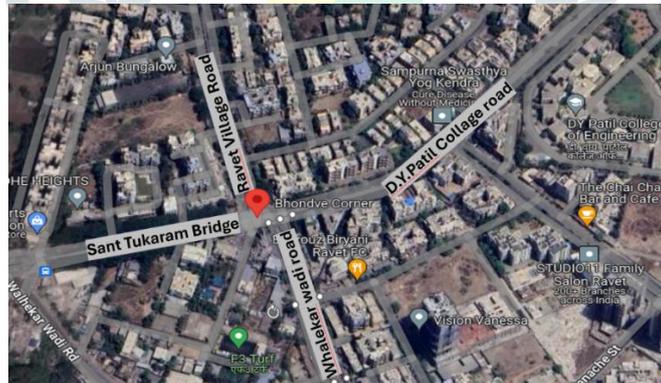

Figure 4: Site Location (BHONDVE CORNER)
Table - 1: Vehicle Count at Peak hour.

Time	From D.Y Patil Road (A)			From Sant Tukaram Bridge (B)			From Walhekarwadi (C)			From Ravet (D)		
	B	C	D	A	C	D	A	B	D	A	B	C
7 pm to 8 pm	1764	184	232	1992	436	372	160	456	288	128	384	364

3.1 Vehicle Composition

The observed vehicle count was converted into PCU using IRC SP 106:1990 and is represented as given in table 2.

Table - 2: Vehicle Composition

Vehicle class	Relative Flow
Two Wheelers	61.12%
Cars	32.56%
HMV	2.15%
LMV	4.17%

3.2 Route determination from relative flow:

Relative flow is the distribution of traffic clow in various directions at the intersections. For determining the percent of flow from one end to another, the ratio of directional flow to total traffic is taken which is represented as given in table 3.

Table - 3: Route determination from relative flow

D.Y Patil Collage Road (A)			Walhekarwadi Road (B)			Sant Tukaram Maharaj Bridge Road (C)			Ravet Village Road (D)		
B	C	D	A	C	D	A	B	D	A	B	C
0.084	0.809	0.106	0.177	0.504	0.318	0.716	0.155	0.132	0.145	.41	0.43

3.3 Existing Signal Timings at intersection:

The existing signal times for each direction is noted as given in the table 4. This input is given for determining queue length at peak hours in the

Table – 4: Existing Signal Timing

Direction of vehicular flow	Signal time (sec)	Signal cycle (sec)	Queue length (m)
D.Y Patil Road	45	140	119
Walhekarwadi Road	25	140	55
Sant Tukaram bridge	45	140	100
Ravet Village Road	25	140	60

4. SOFTWARE MODELING

For Determination of Site Location VISSIM uses GOOGLE MAPS and BING Maps. For Student Version Site location is restricted to 1 km X 1 km

Road network: For construction of road network links and connectors are the primary tools in VISSIM. links are referred to long continue lines used for replicating roads in network were as connectors are used to join to links and provide a smooth turn with Constanta radius as present in practical life
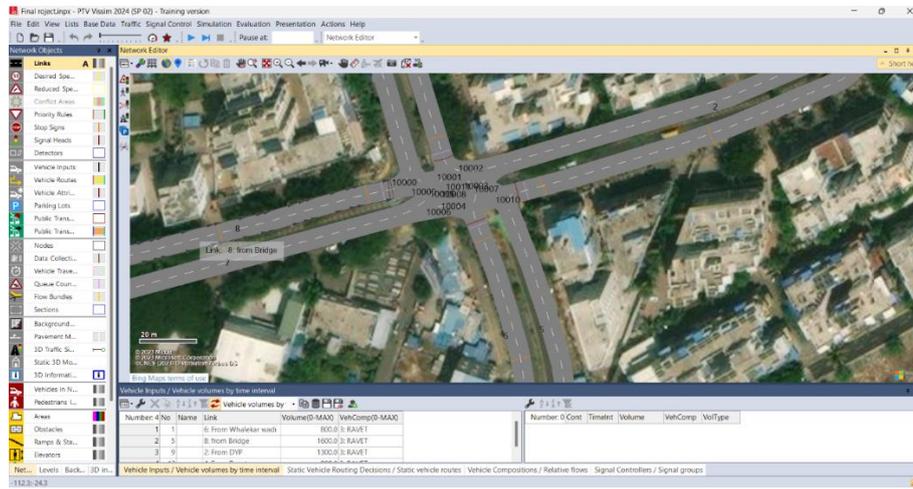
Figure 5: Road network and Vehicle Inputs

4.2 Signal Controller

A signal controller in PTV VISSIM is used to operate traffic signals at intersections and other points of control in the simulation network. Add signal heads in intersection and create new signal controller from menu bar and define signal timing configuration assign the program to the controller and link and test the results of queue length and corresponding adjust the controller programming according to desired results. For determining optimal queue length, following three alternatives were considered:

1. Trial 1 - Cycle time: 140 sec
2. Trial 2 - Cycle time: 120 sec
3. Trial 3 - Cycle time: 145 sec
(1) Assign a signal timing of 140 sec +12 sec for amber light. assign red signal time for signal group 1 i.e. DYP (A)
(2) Then give green signal time and then Amber light time i.e. 3 seconds and then continue their process for remaining signal programmer at last signal programmer
(3) The total signal cycle time of 152 seconds is given for making signal controller perfectly programmed. Refer Fig. 6.
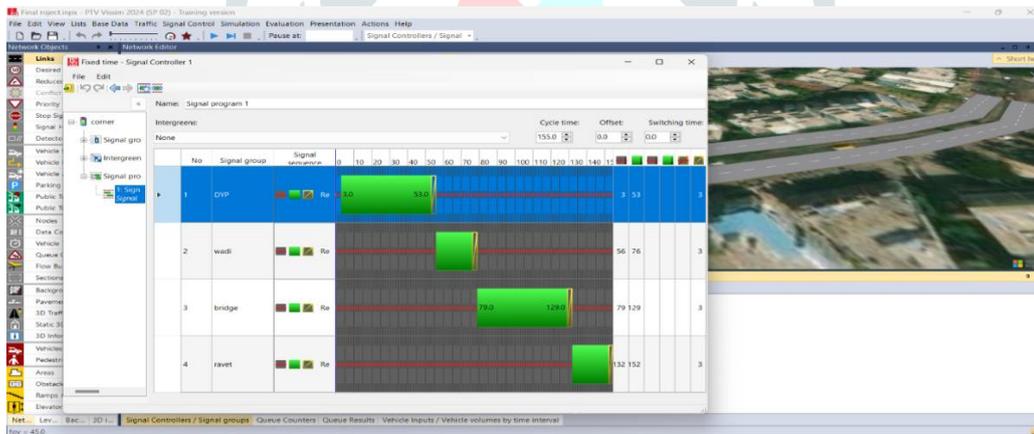

Figure 6: Signal Controller Programming

(4) The signal controller programming is distributed for all the signals as per relative flow in each direction which is mentioned in table 5.

Table - 5: Signal Controller programming for 140 sec signal cycle.

Signal Programmer	Red Signal Time	Green Signal Time	Amber Signal Time
DYP	0	50	3
Walhekarwadi wadi	53	73	3
Sant Tukaram Maharaj Bridge	76	126	3
Ravet Village Road	129	149	3

5.

RESULT

5.1 Trial and Error Method

Using trial and error method 3 trials were conducted as given in table 6 with different signal timing and different signal cycle. From simulation here we can clearly observe the difference in queue length from Figure 7

Table – 6: Queue length obtained from trial methods.

	Trial 1		Trial 2		Trial 3	
	Signal Time	Queue length	Signal Time	Queue length	Signal Time	Queue length
D.Y Patil Road	50	103	40	117	47	120
Walhekarwadi Road	20	51	20	57	25	56
Sant Tukaram bridge Road	50	98	40	100	48	100
Ravet Village Road	20	70	20	65	25	64
Signal cycle	140 sec		120 sec		145 sec	

6. DISCUSSION

From above three trials to for determination of optimum result arithmetic mean method is used.
Arithmetic mean of queue length for existing signal timing after simulation is

$$\sum E = \frac{119+55+100+60}{4}$$

$$= 83.5 \text{ m}$$

Similarly, queue lengths for the three trials are obtained by running the simulation for 4000 seconds. These are mentioned in the table 7.

Table - 7: Arithmetic means of queue lengths

	Arithmetic mean
Trial 1	80.5
Trial 2	84.75
Trial 3	85

From above table 7, it is concluded that trial 1 is most effective and can reduce queue length by %. Hence, signal timing of trial 1 are most effective. Below graph shows the reduced queue length from proposed new signal timings.

COMPARISION OF QUEUE LENGTH OF EXISTING AND PROPOSED TIMINGS
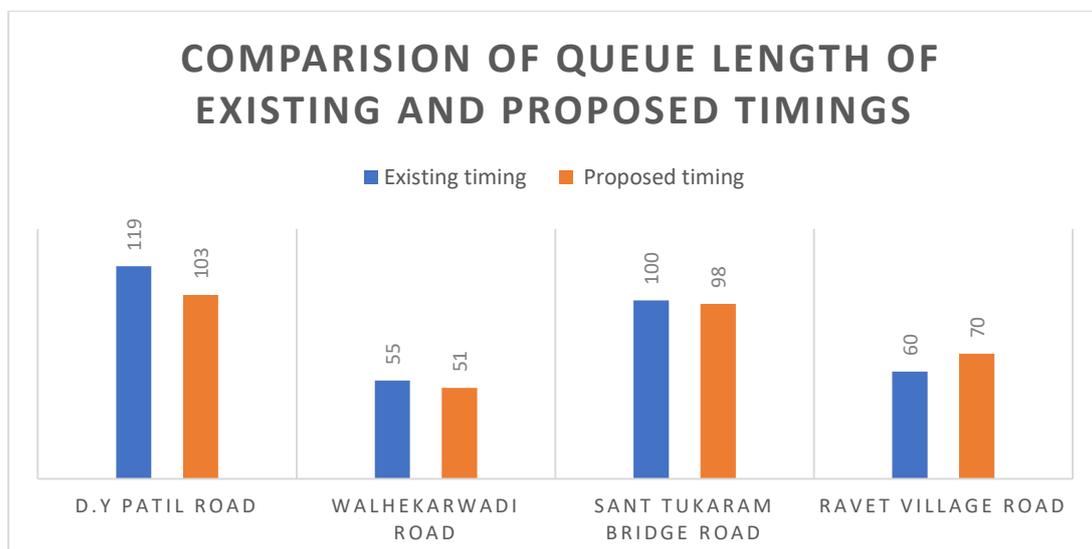
7. CONCLUSION

Traditional signal timing provided causes conflicts and unnecessarily long queues. Providing a signalized intersection on the roundabout and optimizing signal timing removes the conflict and shortens the queues. Therefore, adding signals at the roundabout and using optimized signal timings are very helpful to society and environment.

From three conducted trials we can clearly observe that results for trial 1 had successfully reduced queue length of three vehicle inputs and proposed signal time is given below in table 5.

Table – 5: Proposed signal Timing and its queue length.

	Proposed signal timing	Reduced Queue length
D.Y Patil Road	50	103
Walhekarwadi Road	20	51
Sant Tukaram bridge Road	50	98
Ravet Village Road	20	70

7. REFERENCES

1. 1.Traffic Congestion in Mundhwa Chowk Pune : Causes and Solutions Asst. Prof. Uday kakde1, Tarachand Shegar2, Vidnyan walawalkar3, Omkar batwal4, Vipul jagtap5
2. Jana Fabianova*, Peter Michalik, Jaroslava Janekova, and Michal Fabian Design and evaluation of a new intersection model to minimize congestions using VISSIM software
3. A Case Study: Simulation Traffic Model as a Tool to Assess One-Way vs. Two-Way Traffic on Urban Roads around the City Centre Peter Bindzar 1,* , Janka Saderova 1 and Magdalena Tutak 3
4. VISSIM-based Simulation Analysis on Road Network of CBD in Beijing, China Dong LIN, Xiaokuan YANG, Chao GAO* Transportation Research Center, Beijing University of Technology, NO.100 Pingleyuan, Chaoyang District, Beijing, 100124, China
5. VISSIM simulation-based analysis for improving traffic conditions in Bandung Indonesia Eko Wahyu Utomo 1,2, Fadillah Ramadhan*,3, Arif Imran3
6. Analysis of congestion cost at signalized intersection using Vissim 9 (Case study at Demak Ijo Intersection, Sleman)
7. VISSIM simulation-based analysis for improving traffic conditions in Bandung Indonesia Eko Wahyu Utomo 1,2, Fadillah Ramadhan*,3, Arif Imran3
8. Traffic Characteristics Evaluation and Traffic Management Measures: A Case study of Dharwad City Devaraj Hanumappa1,*, Raviraj H. Mulangi2 and Nityanand S. Kudachimath3
9. VISSIM: A microscopic Simulation Tool to Evaluate Actuated Signal Control including Bus Priority