Vehicle Scheduled Simulation at Irinjalakuda Junction using Anylogic

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I. INTRODUCTION

Rising traffic congestion is an inescapable condition in large cities and peak hour traffic congestion is an inherent result. The alarming issue is that in spite of many of the remedies that are tested out to reduce the traffic congestion, there has not been any major improvement in this aspect. The traffic is only getting worse with every passing year. Hence to optimize the performance and efficiency of the movement of people, goods, and transportation, traffic engineering comes into place. Traffic engineering is a branch of civil engineering that uses engineering techniques to achieve the safe and efficient movement of people and goods on roadways. It focuses mainly on research for safe and efficient traffic flow, such as road geometry, sidewalks and crosswalks, cycling infrastructure, traffic signs, road surface markings and traffic lights. The traffic problems at peak hours is to be controlled.

Irinjalakuda town is located about 25 km from Thrissur city, the headquarters of Thrissur district. Being a part of Thrissur Lok Sabha constituency, Irinjalakuda is a revenue division and the headquarters of Irinjalakuda Taluk. Now the municipality has 41 wards and it is a Grade 2 municipality. It is known for the Koodalmanikyam Temple & the Thachudaya Kaimals who had princely status until 1971. It is an emerging suburb of Thrissur city.

Irinjalakuda district congestion studies are made at main two junctions where SH 61 and SH 22 intersects.

- Tana junction where Irinjalakuda-Kodungallur Rd, Thrissur Rd, Railway Station Rd and Irinjalakuda Main Rd intersects.
- Chandakunnu Junction where Potta- Moonupeedika Highway, Market Rd intersects with Irinjalakuda – Kodungallur Rd.

3. DATAS COLLECTED

3.1 Road Inventory Survey

This survey is carried out initially to study the road features. In order to find the width of pavement and shoulder. To obtain a base plan of the area, a total station survey was conducted. Details regarding the radius of curvature and the sight distance are also important as the project area are two intersections.

3.2 Traffic Volume study

Traffic volume is expressed as the number of vehicles that cross a given transverse line of road during unit time. Determination of volume of each vehicle class separately to find total volume is called classified traffic volume studies. Each vehicle class is converted to passenger car unit (PCU). As the traffic flow is dynamic, it is studied by recording direction wise counts of each vehicle class at selected intervals. Traffic volume studies are conducted to decide priority of road for improvement design of road way facilities and to compute road capacity. It is also used for analysis of traffic patterns and, plan traffic operation, design of pavements and signal timings, etc.

3.3 Accident study

Road accident data is the base measure of safety and without it the scale and nature of road safety problems cannot be established with certainty. The purpose of crash data is to help decision-makers understand the nature, causes, and injury outcomes of crashes. This information provides context for the design of strategies and interventions that will reduce crashes and their consequences. The accident data for five years (2015-2019) were collected from Irinjalakuda police station. It was found that most of the accidents at Irinjalakuda occurs at Tana junction.

3.4 Speed study

A speed survey is the tool we use to determine what the speed limit should be for a particular section of roadway. Speed studies are necessary because actual speed of vehicles on...
a particular road may vary depending on various factors such as geometric features, traffic conditions, time, and site conditions. Speed of travel on the roads is used in classifying routes as highways, arterials, collectors and local streets. Level of service based on speed is an indicator of quality of traffic flow or mobility.

3.5 Pedestrian study
A clear understanding of pedestrian crossing behavior under mixed traffic conditions is needed for providing necessary infrastructure and also for enhancing pedestrian safety at signalized intersections. There are many problems related to the safety security of pedestrians. The number of pedestrians crossing the major street must be 150 or more pedestrians/hr to satisfy warrant for signal installation. Peak hour pedestrian movements at both the junctions are counted from the video graph.

4. ANYLOGIC SOFTWARE

AnyLogic is a leading simulation modelling software for business applications, utilized worldwide by over 40% of Fortune 100 companies. Anylogic simulation models enable analysts, engineers, and managers to gain deeper insights and optimize complex systems and processes across a world range of industries. AnyLogic is a multimethod simulation modeling tool developed by the AnyLogic Company (former XJ Technologies). It supports agent-based, discrete event, and system dynamic simulation methodologies. Anylogic is a cross-platform simulation software designed exclusively for Windows, macOS, and Linux. AnyLogic simulation modeling provides a Road Traffic Library, enabling traffic flow simulation with the power to deliver the most efficient road traffic engineering and design. We have used AnyLogic Version 8.5.2. Clear visualizations quickly aid development, with density maps highlighting congestion, and animations demonstrating traffic flow and bottlenecks. The freedom to experiment, and the ability to optimize accurate models, with traffic simulation software, provides the best platform for success in road traffic planning and engineering.

AnyLogic is used for:

* Traffic planning, the simulation of changes, additions, or subtractions to a road network.
* Throughout analysis, including generating statics for congestion and traffic jams.
* Traffic light timing and sequencing to develop system wide optimization
* The integration of public objects and buildings into road networks, traffic impact assessment.

5. WEBSTER METHOD OF TRAFFIC SIGNAL DESIGN

Webster method of signal is an analytical approach of determining the optimum cycle time \( (c_0) \) corresponding to minimum total delay of all the vehicles at the approach road of the intersection. The field work consist of determining the following sets of value on each approach near the intersection.

1) The normal flow \( q \) on each approach during the design hour.

2) The saturation flow \( S \) per unit time.

The normal flow values are determined from field studies conducted during the peak 15 minutes period or design hour. The saturation flow values are taken from IRC code for signal design based on the width of the roads meeting at the intersection. In the case of mixed flow traffic, it is necessary to covert the different classes of the vehicles in the terms of suitable PCU values at the signalized junction. The normal flow of the traffic on approach roads may also be determined by conducting field studies during the off-peak hours to design different sets of signal timings during the period of the day also as required so as to provide different signal settings.

\[
c_0 = \frac{(1.5L + 5)}{(1 - Y)}...
\]

\[
L = \text{Total lost time per cycle, sec} = 2n + R...
\]

\[
n = \text{no of phases}
\]

\[
Y = y_1 + y_2...
\]

\[
y_1 = \frac{q1}{s1}...
\]

\[
y_2 = \frac{q2}{s2}...
\]

\[
G_1 = \frac{(y_1/Y)}{(c_0 - L)}
\]

\[
G_2 = \frac{(y_2/Y)}{(c_0 - L)}
\]

### Table 1. Vehicular volume

<table>
<thead>
<tr>
<th>From</th>
<th>Towards</th>
<th>Count in PCU/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chalakkudy</td>
<td>Kodungallur</td>
<td>373</td>
</tr>
<tr>
<td></td>
<td>Thrissur</td>
<td>322</td>
</tr>
<tr>
<td></td>
<td>Koodalmanikyam temple</td>
<td>715</td>
</tr>
<tr>
<td>Thrissur</td>
<td>Chalakkudy</td>
<td>478</td>
</tr>
<tr>
<td></td>
<td>Kodungallur</td>
<td>738</td>
</tr>
<tr>
<td></td>
<td>Koodalmanikyam temple</td>
<td>380</td>
</tr>
<tr>
<td>Koodalmanikyam temple</td>
<td>Chalakkudy</td>
<td>573</td>
</tr>
<tr>
<td></td>
<td>Kodungallur</td>
<td>487</td>
</tr>
<tr>
<td></td>
<td>Thrissur</td>
<td>345</td>
</tr>
<tr>
<td>Kodungallur</td>
<td>Thrissur</td>
<td>820</td>
</tr>
<tr>
<td></td>
<td>Chalakkudy</td>
<td>308</td>
</tr>
<tr>
<td></td>
<td>Koodalmanikyam temple</td>
<td>552</td>
</tr>
</tbody>
</table>

**Sample Calculation**

Here we are providing for phase signal

For example traffic from Chalakkudy

Total volume \( q_1 = 1410 \)

Width = 15m

Saturation flow = 525W

\[
= \frac{525 \times 15}{7875} = 7875
\]

\[
y_1 = \frac{q1}{s1} = \frac{1410}{7875} = .179
\]
\( y_2, y_3, y_4 \) are similarly finding out as per the phases.

\[
\begin{align*}
y_2 &= .213 \\
y_3 &= .178 \\
y_4 &= .202 \\
Y &= y_1 + y_2 + y_3 + y_4 \\
Y &= .772
\end{align*}
\]

Assume 2 sec amber time is providing

Lost time = (2x4)+2 = 10 sec

Optimum cycle length = \((1.5L+5)/(1-Y)\)

\[
\begin{align*}
&= ((1.5\times 10)+5)/(1-.772) \\
&= 88\text{ sec}
\end{align*}
\]

Green time of first phase \( G_1 = \left(\frac{y_1}{Y}\right) \times (c0-L) \)

\[
\begin{align*}
&= (.179/7.72) \times (88-10) = 18\text{ sec}
\end{align*}
\]

Similarly the green time for other phase can be found out

\[
\begin{align*}
G_2 &= 21\text{ sec} \\
G_3 &= 17\text{ sec} \\
G_4 &= 20\text{ sec}
\end{align*}
\]

Figure 1. Phase diagram

6. SIMULATION OF TRAFFIC NETWORK AT TANA JUNCTION IN IRINGALAKUDA BY USING ANYLOGIC VERSION 8.5.2

In this study we use AnyLogic Traffic simulation software to model a major intersection of Irinjalakkuda, the Tana junction. We have used the software to check the efficiency of installing a signal at the junction. The vehicle delay at the intersection before and after installation of the signal were compared.

6.1 Data for making simulation model

• Satellite image of the study area.
• Physical features of road like number of lanes, median width, width of road, alignment etc.
• Vehicular volume.
• Speed of vehicle.
• Probability of vehicles on each leg.
• Number of Phases.
• Signal timing that we already calculated.
• Cycle duration.

6.2 General Procedure

• Conducting proper reconnaissance survey of the study area.
• The current condition of the area is determined.
• Conducted a total station survey to measure the physical features like road width, median width, and geometric alignment.
• Both vehicle volume and pedestrian studies are conducted to input the number of vehicles and pedestrian moving through the area per hour.
• Speed study is conducted for determining the average speed of the vehicles at intersection and for the turning traffic also.
• Calculated the maximum conflict points in the intersection.

6.3 Procedure of making simulation model

6.3.1 Road network creation based on satellite imagery

First step is making of a working platform that gives a clear idea about the study area. Working platform may be a satellite image or available maps. Start drawing the road network on the satellite image. Width of the road, number of forward and backward lanes, median width, median type, are also entered at the given spaces. By default, Any Logic draw some lane connectors. We can change them as per our need to customize the traffic directions.

6.3.2 Inserting flow diagrams

Second step is drawing of the flow diagrams. This part of flow chart include car source, car move to and car dispose. The road traffic library is interoperable with process modeling library and other standard libraries of AnyLogic. During this stage, we should also insert the probabilities of vehicles on each leg.
6.3.3 Traffic lights setup
Inserting the traffic lights as per the phases and signal timing that are already found. Then run the model and start simulation.

6.3 Output

Figure.4. Screenshot of simulation
After the installation of signal at Tana Centre, a histogram was developed to check the traffic flow of the entire model. In order to check the effectiveness of the installed signal two simulations were done: before signal and after signal. So another histogram was developed for the junction for without signal condition.

**Figure.5. Mean delay before the installation of signal**

The collected datas from the traffic survey was substituted in the Webster method and thus the phase time was calculated. The calculated time was given in the model.

**Figure.6. Mean delay after the installation of traffic signal**

From the histogram we get the mean delay of traffic flow at both the intersection. From our simulation of almost 1333 samples we were able to see that the mean delay time decreased from 25.39 to 21.98 at the signalized intersection. So we can say that the installed traffic signal is effective at that intersection.

7. CONCLUSION

From the simulation we can conclude that installation of traffic signal is one of the best method to regulate traffic flow at Tana Centre. Traffic signal also helps to reduce the conflict between vehicles. It was also understood from the simulation that installation of a traffic signal at Tana Junction reduced the traffic congestion at Chandakunnu junction which is at a distance of 500m. In this paper, we developed a model of TanaCentre and Chandakunnu Junction which represents the present heterogeneous traffic condition of the Junctions. A traffic simulation software like AnyLogic can be used for effective simulation of these junctions.

8. REFERENCES


[6]. IRC-93-1985 Guidelines on design and installation of road traffic signals.

[7]. IRC-SP-41-1994 Guidelines for the design of at-grade intersection in rural and urban areas.

[8]. IRC-106-1990- Guidelines for capacity of urban roads in plain areas.