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Economic Evaluation of Traffic Congestion & Design of Traffic Signal with Simulation at Ottapalam

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Abstract: Traffic congestion is the most outstanding performance of the negative externalities of urban road traffic, which is characterized by the negative effects of time delay, energy waste, air pollution and many other impacts. It affects people's daily life and could cause stress other than time and monetary loss. Traffic congestion causes negative impacts to transport sector and cause a massive increase in the transportation cost. Time is a precious commodity that we all have an equal amount of, and it is something that should not be wasted. A lot of our time is being wasted due to traffic congestion. Therefore, the study of impact of delay at important and busy road stretches in monetary terms is important. This study evaluates the traffic congestion cost at Ottapalam city which prevail heterogeneous traffic conditions. Congestion cost estimations are done by considering the factors including delay, traffic volume, passenger occupancy, and value of travel time of different vehicle types. The results obtained indicated that there was a considerable monetary loss due to traffic delay in the form of opportunity costs. So, there was a need to reduce this monetary loss by bringing suitable measures. The traffic condition of the selected road is found out using simulation by PTV Vissim software after implementing a traffic signal at a busy intersection between the road stretch. The reduction in traffic congestion shows the rightful implementation of the traffic signal.
Keywords: Congestion, Monetary loss, Delay, Traffic volume, Passenger occupancy, Value of Travel time, Opportunity costs, Simulation.

I. INTRODUCTION

A. General

Rising traffic congestion is an inescapable condition in large and growing metropolitan areas across the world. Peak hour traffic congestion is an inherent result of the way in which modern societies operate. Traffic jams can cause delays in many areas of our life and that delayed time may cause so much inconvenience to people. Other negative effects of traffic jams are time delay, energy waste, air pollution and many other impacts. Traffic congestion causes severe impacts on economic loss.

Traffic congestion is the most outstanding performance of the negative externalities of urban road traffic, which is characterised by the negative effects of time delay, energy waste, air pollution and many other impacts. These will also have a bad impact on the entire market economy.

Traffic delay is the additional travel time experienced by a driver, passenger or pedestrian due to circumstances that impede the desirable movement of traffic. Passenger Occupancy is the total number of people carried by the vehicle, usually an average or typical number for a specific set of conditions. Value of travel time refers to the cost of time spent on transport. It includes the cost to businesses of the time their employees and vehicles spend on travel, and costs to consumers of personal time spent on travel. Traffic volume is defined as the number of vehicles crossing a section of road per unit time at any selected period.

Traffic congestion causes severe impacts on economic loss. Metropolitan cities experience more economic loss. To reduce this huge loss necessary steps, have to be taken and these steps have to be followed. Considering these facts, sites with major congestion in Ottapalam city are selected for cost estimation.

B. AIM

To evaluate the cost incurred by traffic congestion at the road stretch between Mayannur Bridge Road Junction to Lakshmi Theatre Road Junction, Ottapalam and designing a traffic signal based on the data and simulating it using PTV Vissim software.

C. Objectives

1) To determine the opportunity cost of different modes of transport along the specified study area.
2) Designing a traffic signal.
3) To evaluate the performance of the traffic signal after simulating it using PTV vissim software.

D. Scope

The scope of the present study is confined to evaluation of costs incurred by different vehicles along the specified road stretch. Plying area is a 1.1 km stretch of traffic corridor that starts from Mayannur Bridge Road Junction to Lakshmi Theatre Road Junction, Ottapalam. This study gives an idea about current traffic condition of that road stretch and can be used to reduce the traffic in the future by bringing a traffic signal and simulating it using PTV Vissim software to evaluate its performance.

E. Organization Of The Report

Chapter 2: Contains the literature review of the journals related to economic analysis, delay time of congested roads, Webster method and PTV Vissim software for simulation.
Chapter 3: Brief description about the methodology of the project and details of the various data collected from the field using different methods.
Chapter 4: Analysis of the data collected and determination of congestion cost.
Chapter 5: Design of traffic signal.
Chapter 6: Simulation using PTV Vissim software.
Chapter 7: Results & Discussions.
Chapter 8: Conclusions.

II. LITERATURE REVIEW

Muneera C P (2019).[1] This study encompasses calculation of congestion cost by finding out the traffic volume, traffic delay, passenger occupancy and value of travel time. This study pointed out that promoting the usage of public vehicles by reducing the personalized vehicle reduces the congestion cost to a great extent. This study evaluates the traffic congestion cost at signalized intersections located in Kerala, India which prevail heterogeneous traffic condition. The study area selected as Thiruvananthapuram, which is having a greater number of entities are signalized intersection in the urban road network The mode share of 75% of total traffic and which has the maximum share of traffic compared to public vehicles. Therefore, this study considers a candid relief measure proposal as mode shift to public transport from private vehicles.
Bivina G R (2016).[2] This paper discusses the estimates in monetary terms, the cost of traffic delay-increased travel time, increased fuel consumption and increased pollution, taking one of the corridors in Thiruvananthapuram, the capital of Kerala, India as a case study. This is an opportunity cost which also includes travel time variability losses arising from unpredictability of the journey time and vehicle operating costs which includes fuel loss that arise due to the idling of vehicles. Along with this, there is another form of cost associated, which is environmental externality.
Ashna P B, Fathima S, Shamnath M, Swathy S Thilakan (2021).[3] This study evaluates the traffic congestion cost at signalized intersections located at Ernakulam city, with heterogeneous traffic conditions. This study also points out ways to reduce private vehicles and promote the usage of public vehicles and to get to know about the importance of flyovers, metros and traffic less junctions. The study area selected is Ernakulam city. Ernakulam city is the second most heavy traffic city in Kerala, which has a large amount of traffic volume and signalised intersections are provided to divert the vehicle in proper directions and thereby we can reduce the traffic jam. The main objective of the study was to determine the overall economic loss due to traffic congestion of four signalized intersections at Ernakulam city. This study proposes a demand side policy to the Indian city along with the congestion cost estimation at signalized intersections. This study also points out ways to reduce private vehicles and promote the usage of public vehicles and to get to know about the importance of flyovers, metros and traffic less junctions.
B. Sudharshan Reddy, N. Venkata Hussain Reddy (2016).[4] This journal consists of the designing of a traffic signal in a T-intersection by using Webster method formula. The number of phases to be given and the calculation of cycle length of those phases are obtained from this journal. And various other data like the standard saturation flow rate is also given in this study. The aim of this research is to reduce traffic congestion in their selected study area by providing a traffic signal which could reduce delay and congestion.
Lu, M., & Yan, S. (2019).[5] This paper conducts on-the-spot investigation on the traffic flow of each entry and exit road during the early peak period of the case intersection, and uses the data obtained from the survey to make accurate calculations to obtain the capacity and delay time of the current intersection, and then use PTV Vissim. They proposed a new signal optimization solution based on PTV Vissim software can reduce the delay time of the intersection and improve its traffic capacity.

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To improve the service level of the intersection, this paper uses the change of signal timing, that is, using Webster calculation method and delay analysis to find the most suitable signal period for the intersection of Ziyun Road and Qinglongtan Road, and calculate the calculation of each imported lane again.

Khan et al (2013).[6] He defined the congestion cost as composed of mainly costs, namely, travel time costs, vehicle operating costs and externality cost due to delay and environmental damages. The study calculated Travel Time Costs, TTC (using Value Of Time, VOT approach) and Vehicle Operating Cost, VOC, due to traffic congestion directly. The study is intended to explore how traffic congestion creates a social problem and effect on our economic, social and health of urban dwellers in Dhaka city. Overall, this study contains an analytical discussion of social, economic and health impact of road congestion problem in Dhaka city.

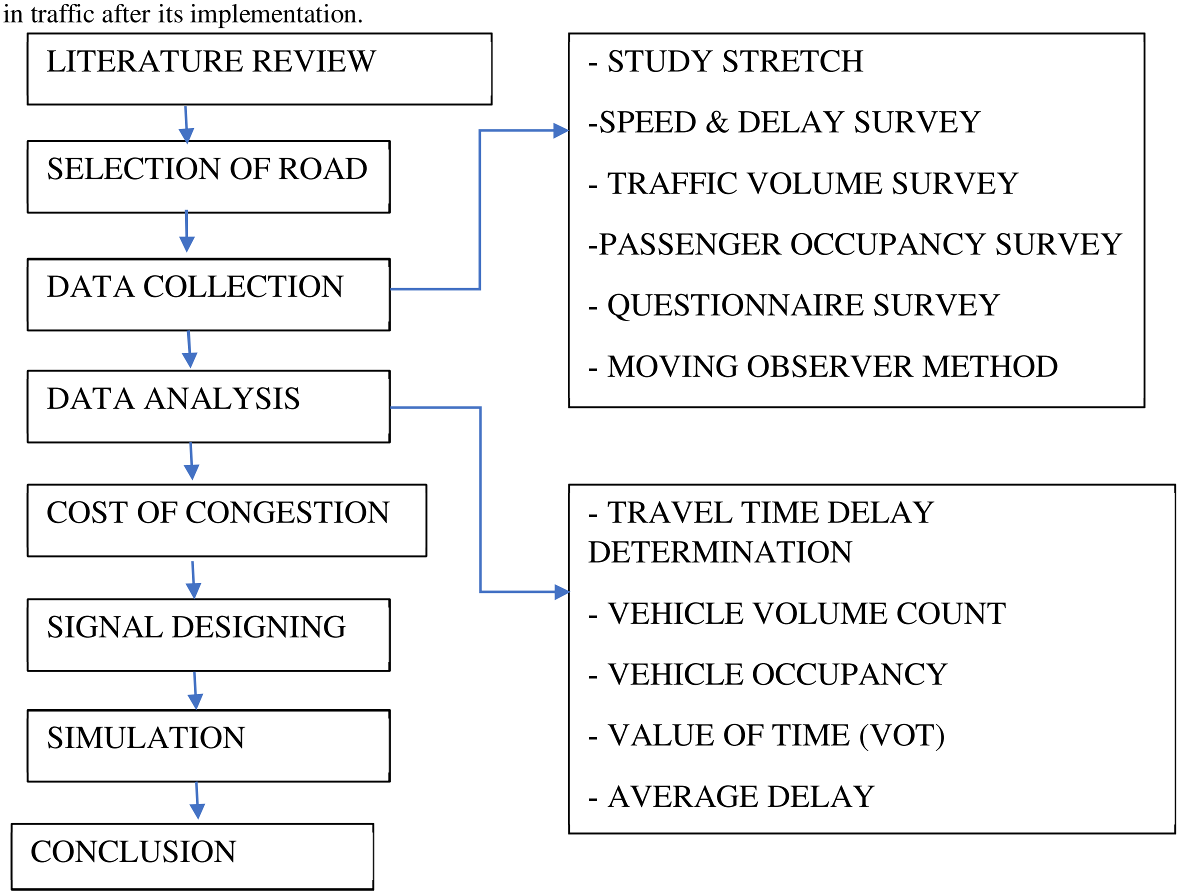
LITERATURE OUTCOME

With the help of above papers, we got information regarding various case studies on traffic congestion and the economic losses incurred by the congestion and how it affected the lives of people. Designing of traffic signal and its simulation using latest software was done referring these journals which helps reduce traffic congestion.

III. METHODOLOGY

A. *General*

The study started with the selection of study area followed by data collection. At first, we studied and inspected about the road stretch and collected various details. Then we conducted speed and delay survey using License Plate method, traffic volume survey using videographic method. The average passenger occupancy was determined using manual observation technique. Then we conducted questionnaire survey to get details about different road users and to estimate value of travel time (VOT) savings. Using the VOT, cost of travel time loss is estimated. Those values are used to determine the total monetary value of traffic delay along the study stretch. The average delay along the specified road stretch is found out using moving observer method. Then, based on those data's, a traffic signal is designed by Webster's method and its simulation is done using PTV vissim software so as find out the reduction in traffic after its implementation.



B. Data Collection

Primary data collection included the conduct of the following:

1) Details about the study stretch
2) Speed and delay survey
3) Traffic volume survey
4) Passenger occupancy survey
5) Questionnaire survey
6) Moving observer method

a) Details About The Study Stretch

The selected study stretch is 1.1 km long road starting from Mayannur Bridge Road junction to Lakshmi Theatre Road Junction, Ottapalam. We have selected this as our study area due to the following reasons:

- It is one of the main part of the Palakkad -Ponnani state highway which connects major parts of Palakkad District.
- Study area comprises of various commercial buildings, residential buildings, bus stand, government services like Railway station, Police station, Post office, Court, Educational institutions, etc.
- So many vehicles are passing through that area such that the traffic volume exceeds the capacity of the road.
- During working days, in the morning and evening peak hours (9am-11 am and 4.30 pm-6.30 pm), the people travelling through that area are facing traffic delays, as obtained from questionnaire survey.
- The detailed study and inspection of selected road stretch is done and following details were obtained:
- Various shops including grocery, textiles, hotels, restaurants, book store, banks, residential buildings, Government institutions such as railway station, police station, post office, court, educational institutions, bus stand, etc. are present in the study area.
- Road width is not sufficient to accommodate vehicles in such a busy area.
- Not enough shoulder width and curb width to accommodate both parking and pedestrians.
- So, it results in illegal parking and pedestrians walking through roads and thus causing congestion in that area.

b) Speed And Delay Survey

Speed and delay survey was conducted to evaluate congestion, level of service and the deficiencies in the road network. License Plate method was used to determine the journey speeds and delays for cars, 2 wheelers, 3 wheelers, Light Commercial Vehicles (LCV) and Heavy Motor Vehicles (HMV). Delay for bus is taken as the difference between actual travel time along the study stretch for off peak and on peak hours taken manually by travelling in the corresponding mode as there is a bus stand present in our study stretch (Because buses in that study area enters the bus stand and could have a halt, so it affects the calculation of delay time. So, it is done manually).

Speed and delay survey was done during the peak hours 9.30 –11.00 in the morning and 4.30 –6.00 in the evening. Off-peak hour data is taken during the hours 6:00- 7:30 in the morning.

c) Traffic Volume Survey

Traffic volume studies are conducted to determine the number, movements, and classifications of roadway vehicles at a given location. These data help to identify critical flow time periods, determining the influence of large vehicles or pedestrians on vehicular traffic flow.

Traffic Volume Count is counting of number of vehicles passing through a road over a period of time. It is usually expressed in terms of Passenger Car Unit (PCU) and measured to calculate Level of Service of the road and related attributes like congestion, carrying capacity, V/C Ratio, identification of peak hour or extended peak hour etc. Traffic volume survey was done using video-graphic method. Volume count of different types of vehicles was taken during the peak hours 9.30 –11.00 in the morning and 4.30 – 6.00 in the evening and off-peak hours 6:00- 7:30 in the morning.

d) Passenger Occupancy Survey

Passenger occupancy survey for 2-wheeler, 3-wheeler, car, LCV, HMV and bus was conducted at selected locations along study stretch. It was done manually and recorded the observations in an observation table.

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e) Questionnaire Survey

A questionnaire survey was conducted in the study area in which there were about 50 respondents. Respondents of the survey included road users who use different types of vehicles through that road. The questionnaire covered details such as type of mode used, profession, purpose of using the road stretch, delay time caused in the stretch, average income, vehicle operating cost, causes of congestion, suggestions for improvement, etc.

f) Moving Observer Method

By the speed and delay survey, we get the average delay of individual vehicle types. So, in order to find the average delay of all vehicle types, moving observer method is used. The observations are taken for both peak (9:00am – 11:00am) and off-peak hours (4:30pm – 6:30pm).

Although there are many variations to the moving observer method, it basically involves the use of an observer (or observers) in a moving vehicle travelling along a section of road. The observer records the number of oncoming vehicles met, the number of vehicles overtaken by the observer, and the number of times the observer is overtaken by other vehicles. If this and additional information, such as the average speed of the vehicles, the observer speed and the length of the road section are known, then the flow rate can be estimated. In order to obtain a more accurate estimate of the flow rate a number of trips down the same section of road is carried out.

The moving observer method was developed in the UK by the Road Research Laboratory (Traffic and Safety Division) and was first described in a paper by Wardrop and Charlesworth (1954). Their method involved a series of runs in a test vehicle made travelling 'with' and 'against' a one-way traffic stream. The observers in the test vehicles record the following information for each run:

- The number of opposing vehicles met;
- The number of vehicles overtaking the test vehicle while it was travelling;
- The number of vehicles the test vehicle overtook;
- The average speed of the test vehicle and the distance of the run (or alternatively the journey times of the observer, with and against the stream).

C. Summary

A brief description about the methodology of the project and various data collection methods are described in this chapter such as details about the study area, Speed and delay survey, Traffic volume survey, Passenger occupancy survey, Questionnaire survey and Moving observer method for finding out various traffic congestion related data's and parameters.

IV. DATA ANALYSIS

A. General

The analysis of the data collected above is done in this chapter. The travel time delay, Traffic volume count, Vehicle occupancy, Value of travel time, Average delay and the cost of congestion (Opportunity cost) is determined in this chapter.

B. Travel Time Delay Determination

Speed and delay survey was done during the peak hours 9.30 –11.00 in the morning and 4.30 –6.00 in the evening and off-peak hours 6:00- 7:30 in the morning. The readings obtained are tabulated in the Appendix chapter 1 in Table 15 & 16.

Traffic delay is the difference between time taken by a vehicle to pass through a specified section of road during peak hour and time taken by that vehicle to pass through the same section during off-peak hour.

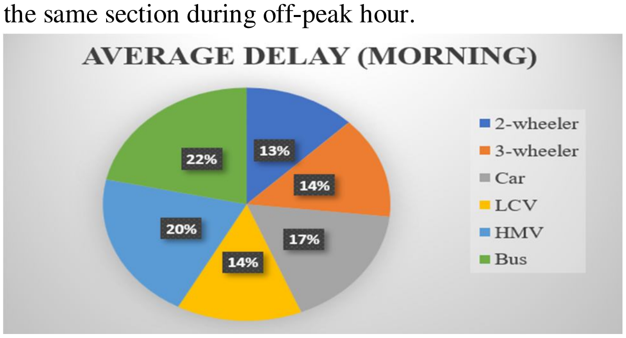

Fig 5: Average Delay Time (Morning)

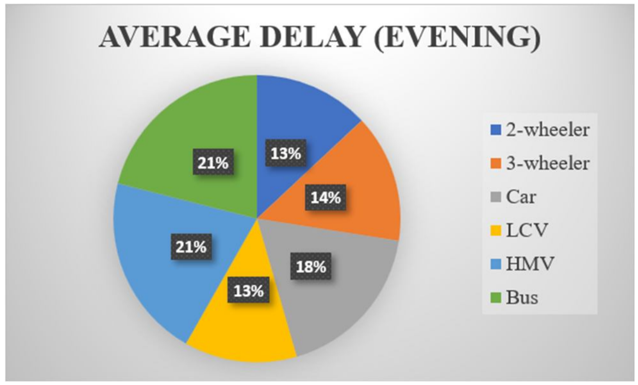

Fig 6: Average Delay Time (Evening)

C. Vehicle Volume Count

Passenger Car unit PCU: It is a vehicle unit used for expressing highway capacity. One car is considered as a single unit, cycle, motorcycle is considered as half car unit. Bus, truck causes a lot of inconvenience because of its large size and is considered equivalent to 3 cars or 3 PCU.

Table 3: PCU for different vehicles (IRC SP 41)

Vehicle type	PCU
Car, LCV, 3-wheeler	1
2-wheeler	0.5
HMV, Bus	3

The traffic volume count taken during peak and off-peak hours are given in the appendix chapter 1 in Table 17 & 18.

Average vehicle count:

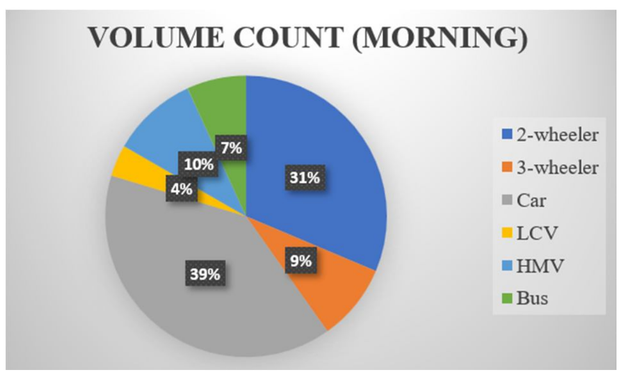

Fig 7: Traffic volume count (Morning)

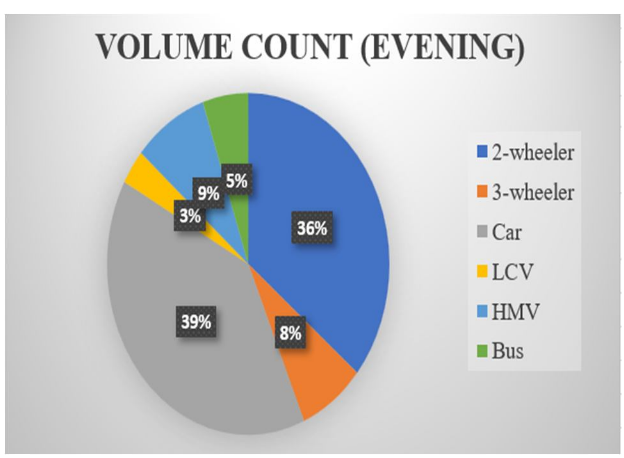

Fig 8: Traffic volume count (Evening)

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D. Vehicle Occupancy

The observations obtained after manual counting during peak and off-peak conditions are tabulated in Table 19 given in Appendix chapter 1.

Average vehicle occupancy of different modes of vehicle:

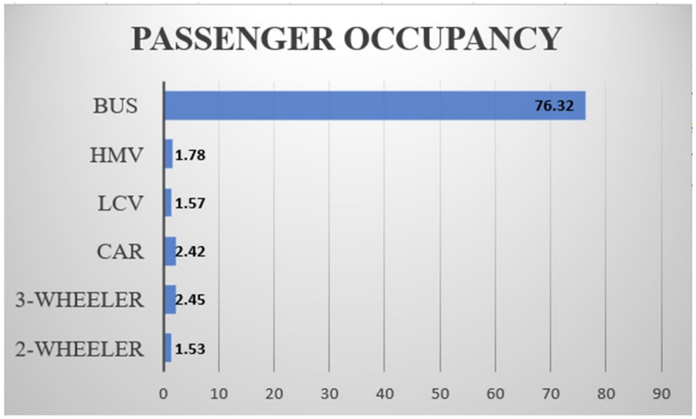


Fig 9: Average Passenger Occupancy

E. Value Of Time (VOT)

Value of travel time can be defined as the price people are willing to pay to acquire an additional unit of time. VOT depends on many factors, i.e., socio-economic condition of the traveller, trip purpose, condition of travel or the mode types, time of travel and there are lots of estimates available in literature regarding VOT depending on the various factors that affect VOT. Along with the travel time losses, there is another important cost arising from the unreliability or unpredictability of the journey times (mostly at peak periods of the day). This adds to the actual value of VOT.

VOT (Rs. /hr.) = annual average income per person/ (365*24)

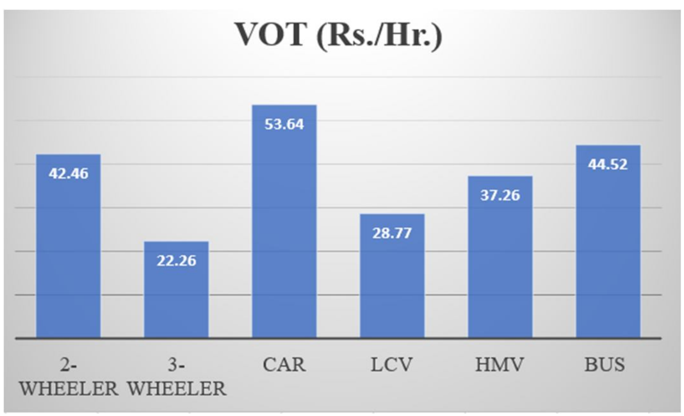


Fig 10: Value Of Time in (Rs/Hr)

F. Average Delay Determination

From Moving observer method,

Traffic Flow, $Q = (x + y) / (t_a + t_w)$

Average journey time, $t = t_w - (y/Q)$

Where, x = no. of vehicles met in the opposite direction

y = no. of overtaking vehicles – no. of overtaken vehicles

t_a = journey time against the flow

t_w = journey time with the flow

t = average journey time

(i) For peak hour:

Table 7: Moving observer method observation for peak hour

Direction	Run No.	Journey Time (minutes)	Vehicles met in the opposite direction			Vehicles in the same direction	
			2W	3W, Car, LCV	HMV, Bus	Overtaking vehicles	Overtaken vehicles
N-S	1	5.6	21	24	6	7	5
	2	5.68	17	20	5	6	6
	3	5.9	14	25	5	8	4
	Total	17.18	52	69	16	21	15
	Average	5.73	143/3 = 48			7	5
S-N	1	5.32	11	19	5	5	3
	2	5.14	17	26	4	9	5
	3	5.56	19	23	6	8	2
	Total	16.02	47	68	15	22	10
	Average	5.34	137/3 = 46			7.3	3.3

In N-S direction:
Traffic flow, $Q = (x + y) / (t_a + t_w) = (48+ [7-5]) / (5.34+5.73) = 4.52$ PCU/min =272 PCU/hr
Average journey time, $t = t_w - (y/Q) = 5.73 - ([7-5]/4.52) = 5.29$ min
In S-N direction:
Traffic flow, $Q = (x + y) / (t_a + t_w) = (46+ [7.3-3.3]) / (5.73+5.34) = 4.51$ PCU/min =270 PCU/hr
Average journey time, $t = t_w - (y/Q) = 5.34 - ([7.3-3.3]/4.51) = 4.45$ min
Average journey time during peak time = (5.29 + 4.45)/2 = 4.87 min
(ii) For Off-peak hour:

Table 8: Moving observer method observation for off-peak hour

Direction	Journey Time (minutes)	Vehicles met in the opposite direction				Vehicles in the same direction	
		2W	3W, Car, LCV	HMV, Bus	Average	Overtaking vehicles	Overtaken vehicles
N-S	3.23	8	13	4	29/3=10	5	3
S-N	3.47	5	17	2	26/3=9	4	1

In N-S direction:
$Q = (x + y) / (t_a + t_w) = (10+ [5-3]) / (3.47+3.23) = 1.79$ PCU/min =107 PCU/hr
$t = t_w - (y/Q) = 3.23 - ([5-3]/1.79) = 2.11$ min
In S-N direction:
$Q = (x + y) / (t_a + t_w) = (9+ [4-1]) / (3.23+3.47) = 1.79$ PCU/min =107 PCU/hr
$t = t_w - (y/Q) = 3.47 - ([4-1]/1.79) = 1.79$ min
Average journey time during off-peak time = (2.11+1.79)/2 = 1.95 min
Traffic delay is the difference between time taken by a vehicle to pass through a specified section of road during peak hour and time taken by that vehicle to pass through the same section during off-peak hour.
Therefore, average delay of vehicles as obtained by moving observer method:
Average delay = Average journey time during peak time - Average journey time during off-peak time
= 4.87 min - 1.95 min = 2.92 min = 175 sec

G. Cost Of Congestion

There are many costs related to traffic congestion. In this study, we are determining the costs incurred due to time lost by traffic congestion, that is, opportunity cost of different vehicular users in the selected study stretch.

1) Opportunity Cost

Time spent in travel is time that could be devoted to other pursuits, such as earning income or engaging in leisure activities. The value of these other pursuits represents the opportunity cost of travel time.

Opportunity cost (Rs) = Avg delay x Vehicle count x Vehicle Occupancy x Value of Time

Table 9: Calculation of opportunity cost

Peak hour	Mode	Avg delay(hr.)	Vehicle count	Vehicle occupancy	VOT (Rs/hr.)	Opportunity cost	Delay (Rs/hr.)
Morning	2-wheeler	0.059	216	1.58	42.46	854.95	15005.59
	3-wheeler	0.066	61	2.51	22.26	224.94	
	Car	0.08	272	2.38	53.64	2777.95	
	LCV	0.066	25	1.61	28.77	76.43	
	HMV	0.096	68	1.77	37.26	430.52	
	Bus	0.101	47	50.35	44.52	10640.8	
Evening	2-wheeler	0.083	262	1.55	42.46	1431.17	24337.05
	3-wheeler	0.092	55	2.48	22.26	279.34	
	Car	0.115	287	2.22	53.64	3930.26	
	LCV	0.081	24	1.3	28.77	72.71	
	HMV	0.132	62	1.6	37.26	487.9	
	Bus	0.134	38	80	44.52	18135.67	

H. Summary

After the analysis the conclusions is that the maximum amount loss during congestion is due to cars and buses. Opportunity cost was mainly incurred for buses and two wheelers. Opportunity cost obtained was Rs. 15005.59 /hr and Rs. 24337.05 /hr for morning and evening respectively.

V. DESIGN OF TRAFFIC SIGNAL

A. General

The traffic congestion in our study area causes serious economic loss in the lives of the people travelling regularly through that area. So, reduction in vehicle delay would help in the reduction of the economic loss due to congestion. In order to reduce delay, we are providing a traffic signal in a busy intersection found in that road stretch. The designing of traffic signal by Webster method is included in this chapter.

B. Design Of Traffic Signal By Webster's Method

Traffic signal is a usually used traffic operation management system at urban roadway intersections. The capacity of urban road network mainly depends on the capacity of the traffic signals. Traffic Signals, also known as traffic lights, traffic lamps, signal lights, stop lights, and traffic control signals, are signaling devices located at road intersections, pedestrian crossings, and other locations to control conflicting flows of traffic. Traffic signals are an important element of traffic control devices.

The increasing of traffic volume at our intersection has been arisen a problems like road accidents, conflicts and congestion. These problems can be solved by providing an efficient traffic signal control at the intersection for continuous and efficient movement of vehicles through the intersection. According to traffic signals, signal timing is most important which is used to decide green time of the traffic light shall be provided at an intersection. Webster's method is a rational approach for designing traffic signals. It is simple and is based on the formulae given by Webster.

The signal design procedure involves six major steps. They include the

1) Phase design
2) Determination of amber time and clearance time

3) Determination of cycle length
4) Apportioning of green time
5) The performance evaluation of the above design.

The objective of phase design is to separate the conflicting movements in an intersection into various phases, so that movements in a phase should have no conflicts. If all the movements are to be separated with no conflicts, then a large number of phases are required.

Here we are adopting a Two-phase traffic signal. Two phase system is usually adopted if through traffic is significant compared to the turning movements. Before getting into the Webster method, it is important to understand some of the technical terms related to traffic signals as discussed further.

a) Cycle Length

Traffic signals work according to the time-sharing principle. Cycle length is the time taken to complete one full cycle of the signal at an intersection. For instance, it is the time taken for a signal to go from red, yellow, green, and then come back to the red signal.

b) Green and Red Interval

The green and red interval is the amount of time for the green and red signals respectively.

c) Phase

Phase is the number of paths crossing at an intersection. For example, in a four-armed intersection, the number of phases is also four.

d) Lost Time

In a traffic signal, once the signal is green, the vehicle that is first in queue will take some time to react to the signal and start moving. The second vehicle will take slightly less time than the first vehicle and so on. This time will decrease and will eventually reach a constant time called the headway.

e) Saturation Flow (s)

Saturation flow is the highest amount of vehicular flow that is possible. It is given as the inverse of headway. If the headway is in seconds, then the saturation flow is given as,

Saturation flow = 3600/headway in vehicles per hour.

f) Observed Volume (v)

Observed volume is the actual observed volume of traffic flow that is happening at the intersection. It is also represented as vehicles per unit time.

g) Critical Flow Ratio

The critical flow ratio at a phase is the ratio between the observed volume of flow to the saturation flow occurring at all the phases of an intersection. It is given as,

Critical flow ratio at 'i'th phase = observed volume / saturation flow = v/s at 'i'th phase

C. Optimum Cycle Length By Webster Method

The Webster method is a critical approach of determining the optimum signal cycle time Co corresponding to minimum delay to all the vehicles at the approach roads of the intersection.

$Co = (1.5L+5) / (1-Y)$

Where,

L= Total lost time per cycle sec = 2n+R

n = is the number of phases

R= all-red time or red-amber time;

Y = y1+y2

y1= q1/s1 and y2= q2/s2

G1= y1/Y (Co-L), G2 = y2/Y (Co-L)

The field work consists of determining the following set of values on each approach road 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 q1, q2 and q3 on road 1, road 2 and road 3 are determined from field studies conducted during the design hours or the traffic during peak and off-peak 15 minute's period. The saturation flow of vehicles is estimated as per IRC SP-41. According to Webster, the standard values for saturation flow, S, for widths 3 to 5.5 meters are listed in the table below.

Table 10: Saturation flow values

Width in m	3.0	3.5	4.0	4.5	5.0	5.5
PCU / Hr.	1850	1890	1950	2250	2550	2990

Based on the selected values of normal flow, the ratio y1=q1/S1, y2=q2/S2 and y3=q3/S3 are determined on the approach roads 1, 2 and 3. In the case of mixed traffic, it is necessary to convert the different vehicle classes in terms of suitable of PCU values at signalized intersection; in case these are not available they may be determined separately. The normal flow of the traffic on the approach roads may also be determined by conducting field's studies during off-peak hours to design different sets of signal timings during other periods of the day also, as required so as to provide different signal settings.

Table 11: Flow values at selected junction

Name of the junction	Conflict	Normal flow during peak hours (PCU/hr.)
Ottapalam Junction	Towards Shoranur	696
	Towards Palakkad	525
	Cherplassery to Shoranur	121
	Cherplassery to Palakkad	192

Based on the data obtained and visual observation at the site during off-peak hours, traffic signal is not needed during off-peak hours as there is no problem of traffic congestion during those hours. So, we are providing signal only during peak hours. During off-peak hours, the traffic signal would be turned off.

a) Normal flow values obtained:

Table 12: Normal flow value of selected roads

ROAD	NORMAL FLOW (q) in PCU/Hr. Peak hours
Road 1 - q1	696
Road 2 - q2	525
Road 3 - q3	313

b) Saturated flow value:

Road width as measured from the field:

Table 13: Width of selected roads

ROAD	LANE WIDTH
Road 1	5m
Road 2	5m
Road 3	3m

From table 7.1, the saturated flow values for these roads are:

Table 14: Saturated flow value of selected roads

ROAD	SATURATED FLOW (S) in PCU/Hr.
Road 1	S1= 2550
Road 2	S2= 2550
Road 3	S3= 1850

Calculation of Cycle length for peak hour Session:
For the calculation of cycle length, saturation value, S is required, and it is taken as 2550 as the length of lane is 5 m for the main road and 1850 for road 3 whose width is 3m.
Critical flow ratios,
$y1=q1/s1=696/2550=0.27$
$y2=q2/s2=525/2550=0.20$
$y3=q3/s3=313/1850=0.17$
The straight traffic through roads 1 & 2 are significant compared to the turning movement from road 3. So, we are providing a two-phase traffic signal here. So, greater value between y1 and y2 is taken as the critical flow ratio of the main road.
$Y=y1+y2 = 0.27+0.17 = 0.44$
Cycle length according to Webster method is calculated using the formula
$Co = (1.5L+5) / (1-Y)$
Where, $L= 2n+R = (2*2) +9 = 13$ sec (n= no. of phase=2, provide all red time [R] of 9 sec)
Therefore, $Co = (1.5*13 +5) / (1 – 0.44) = 44$ sec
Calculation of Green time:
Phase 1: $G1 = (y1/Y) *(Co−L) = (0.27/0.44) *(44-13) =19$ Seconds
Phase 2: $G2 = (y2/Y) *(Co-L) = (0.17/0.44) *(44-13) = 12$ seconds
Considering all pedestrian time = 9 seconds, Amber time = 2 seconds for each phase = 4 seconds for two phases.
Total Cycle length = 19+12+4+9 = 44 seconds.

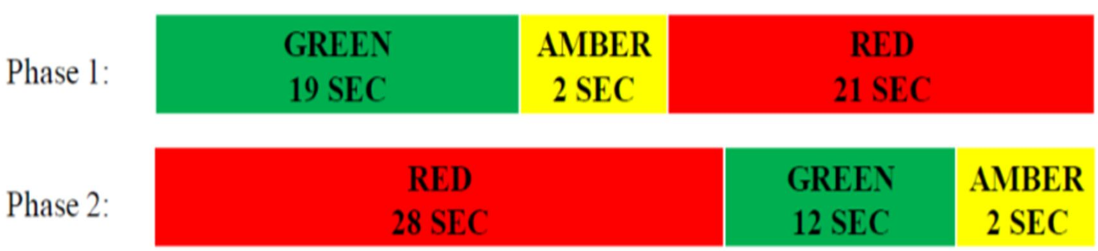


Fig 11: Signal Phase Diagram for peak hours

D. Summary

Our proposed two-phase traffic signal at Ottapalam junction will help to reduce traffic congestion, will make traffic flow easier, and also reduce noise pollution. Based on the calculations done on the PCU values obtained from the traffic survey, the Signal Cycle Length for Peak hour session is 44 seconds, and signal is not required during off peak hours. There will be a reduction in the conflicts after providing traffic signal. And also, there will be an orderly movement of traffic in the cross- section of the roads. Also, there is no necessity of traffic police to regulate the traffic at that junction.

VI. SIMULATION

A. General

Simulation involves the idea of virtually testing and optimizing infrastructure projects before they are implemented in the real world. The cost involved in experimenting can be avoided with help of simulation. The implementation of the traffic signal in our area is virtually tested using simulation to evaluate its performance in the reduction of delay.

B. Traffic Simulation

A traffic simulation is a virtual replica of real traffic scenarios. In this digital environment, planners can model junctions and corridors and basically any infrastructure - from roads to interchanges and transport hubs. A transportation simulation, based for example on the software PTV Vissim, gives a realistic and detailed overview about multimodal traffic flows and the interaction of different vehicles and road users. Multiple "what if" scenarios can be defined to test and analyse traffic measures and their effects, before implementing them in the real world.

Simulation in transportation is important because it can study models too complicated for analytical or numerical treatment, can be used for experimental studies, can study detailed relations that might be lost in analytical or numerical treatment and can produce attractive visual demonstrations of present and future scenarios.

C. Simulation Using PTV VISSIM Software

PTV VISSIM is a program used for 3-D modelling of traffic flow with various types of vehicles. VISSIM is a useful tool for modelling traffic flows, including cars, motorcycles, freight transport, buses, to pedestrians. In VISSIM, the types of vehicles that can be modelled include vehicles (cars, buses, trucks), public transport (trams, buses), cycles (bicycles, motorcycles), pedestrians, and rickshaws. Developing a simulation model using VISSIM requires a series of information on the transportation network to be simulated and modelled.

PTV Vissim (Planung Transport Verkehr Verkehr In Stadten SIMulation) is the world's most advanced and flexible traffic simulation software. PTV Vissim digitally reproduces the traffic patterns of all road users. PTV Vissim evaluates and improves the performance of your traffic facilities.

It enables planners to use available budgets and resources as efficiently as possible when expanding or reconstructing transportation systems. Simulation models help to understand the effects that different measures have on traffic volume and traffic flow under different circumstances. So, simulating traffic creates a solid basis for good and cost-effective decisions - making traffic and mobility safe, sustainable, equitable and resilient. In short, it helps to create future-oriented mobility.

1) Steps Followed In Traffic Analysis Using PTV VISSIM Software

Step 1: Loading the map of the selected area.

After opening the vissim software, load the map of our selected area using the ‘Edit basic graphic parameters’ available in the network editor tab and select the required map in the list shown. Here we have selected PTV Default map.

Step 2: Draw links.

Roads are drawn with the help of links option available in the network objects area. Links are drawn above the map loaded for the convenience of drawing. Draw all the roads you require using links option. Also provide details about the road such as no. of lanes, lane width, name of road, etc.

Step 3: Draw connectors between links.

Links or roads are connected at intersection with the help of connectors by clicking ctrl + right click and dragging the mouse between the points on the links required. The pink lines in the below picture represents the connectors while the blue lines represent the links.

Step 4: Insert vehicle input.

Select vehicle input in network objects and press ctrl + click at the road you want to input the vehicles. Enter the vehicle volume in the list given below the screen. Similarly, add the volume to all the roads required.

Step 5: Insert vehicle routes.

click vehicle routes option in network objects bar. Press ctrl + right click on the starting point and click on the ending point of the route. Do this for all the routes in all the roads.

Step 6: Remove conflict points.

Click conflict areas in the network objects bar. In the conflict areas, select the status as 1 wait for 2 in all cases or as per your requirement.

Step 7: Insert vehicle composition and desired speeds.

Click Traffic and select vehicle composition. Add vehicle type, desired speed and their relative flow in the list shown below the screen.

Step 8: Add reduced speed areas.

Click reduced speed areas in network objects. In the below list, add reduced speed ‘20km/hr.’ for all reduced speed areas.

Step 9: Insert signal control.
Click signal control in the menu bar and click signal controllers. Add signal control in the list given below. Edit the signal control and add the signal timings (green, red and amber).
Step 10: Find delay measurements.
Click vehicle travel time in network objects bar and press ctrl + right click on the points where delay and travel time measurements are required. Then click evaluation > configuration. Tick delay option and press ok. Click evaluation> measurement definition> delay measurements. Click evaluation> results lists> delay results.
Run simulation to get the delay of vehicles in the below list and run simulation for a second time to get average delay of all types of vehicles.

D. 2-D & 3-D View During Simulation

The screenshots of 2D (Fig 8.3) and 3D (Fig 8.4) view of the traffic flow during simulation is given in the figures below:

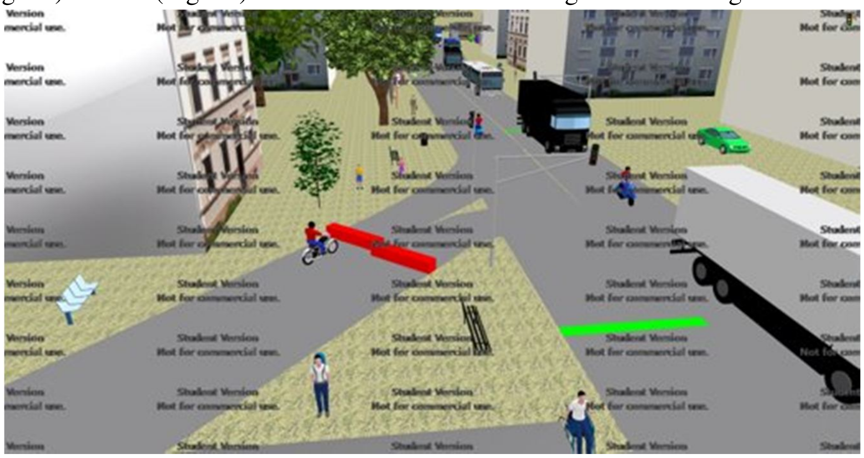


Fig 24: 3-D view during simulation

E. Average Delay Of Vehicles After Simulation

To reduce the traffic congestion and delay of vehicles in the selected area of study, we have introduced a traffic signal in one of the major junctions and have simulated it so as to measure its performance.
Various data like vehicle count, road width, no. of lanes, length of road, signal timings etc. are inputted into the software for simulation. After the simulation, the average delay of all the vehicles obtained from the software is given in the figure 8.2. Therefore, Average Delay of all vehicles as obtained in simulation = 22 sec. This result showed that there is a reduction in delay after implementing the signal.

VII. RESULTS & DISCUSSIONS

1) Opportunity cost obtained was Rs. 15005.59 /hr and Rs. 24337.05 /hr for morning and evening respectively. This was mainly incurred for buses and two wheelers.
2) The average delay of all type of vehicles as obtained by moving observer method was 175 seconds. Also, the average delay of all vehicles as obtained from simulated data was 22 seconds. Therefore, the reduction in delay of vehicles after the implementation of traffic signal with the help of simulation was obtained as follows:
3) Reduction in delay = {(average delay in normal condition – average delay after simulation) / average delay in normal condition} x 100 = (175-22) / 175 x 100 = 87.43%.
4) This result showed that the implementation of traffic signal would result in the reduction of delay and congestion in the selected area during the peak hours by 87.43% and makes the road users reach their destination faster and thereby reduces monetary loss and reduces the impact on the environment.

VIII. CONCLUSIONS

From the analysis the conclusions obtained was that the maximum amount loss during congestion was due to cars and buses. This huge monetary loss can be avoided by the implementation of traffic signal which we have provided in our simulation.

This reduced the traffic congestion and delay by 87.43% as obtained after comparing the delay during normal condition and the delay after simulation using PTV Vissim software. Along with this, promoting other suitable remedial measures like usage of public transport, road widening, introducing bypass , providing adequate traffic signs, etc can reduce the traffic congestion to a large extent. and thereby helps in improving the lives of people and also reduces the impact on the atmosphere.

REFERENCES

[1] Krishnamurthy K, Muneera. (2020). "Economic Evaluation of Traffic Congestion at Intersection: Case Study from an Indian City", Transportation Research Procedia, vol. 48, pp. 1766-1777.

[2] G. Bivina, V. Landge, and S. Gupta. (2016). "Socio Economic Valuation of Traffic Delays", Transportation Research Procedia, vol. 17, pp.513-520.

[3] P. B. Ashna, S. Fathima, M. Shamnath and S. T. Swathy. (2021). "Economic Evaluation of Traffic Congestion at Intersection: Case Study from Ernakulam City", International Research Journal of Engineering and Technology (IRJET), vol. 8, e-ISSN: 2395-0056.

[4] B.Sudharshan Reddy, N.Venkata Hussain Reddy. (2016). "Signal design for T-intersection by using Webster's method in Nandyal town, Kurnool district of Andhra Pradesh", International Research Journal of Engineering and Technology (IRJET), vol. 3, p-ISSN: 2395-0072.

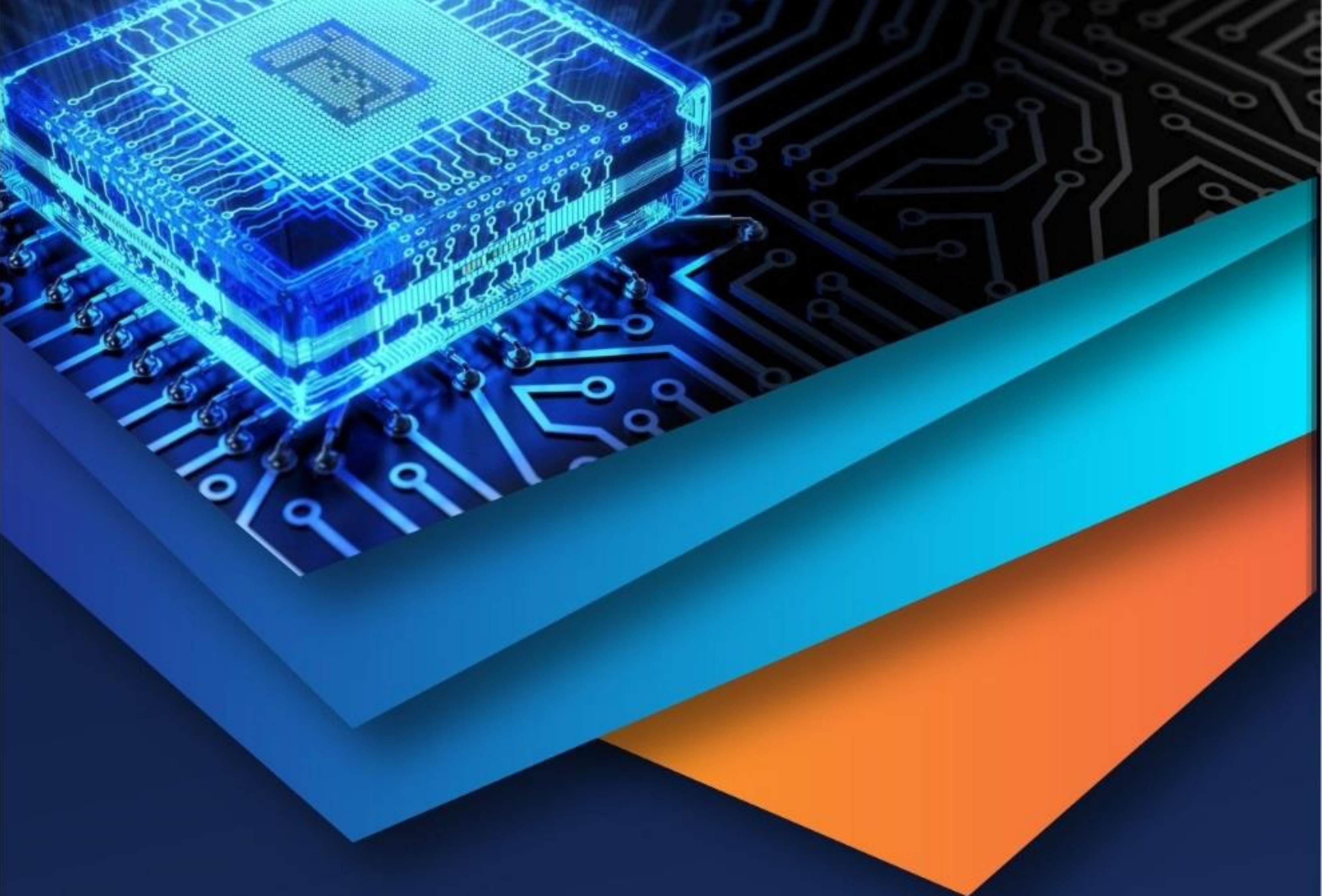
[5] Lu, M., & Yan, S. (2019). Signal Light Ptimization based on PTV Vissim Software. IOP Conference Series: Materials Science and Engineering, 688, 044003. doi:10.1088/1757-899x/688/4/044003.

[6] A. Chakrabartty and S. Gupta. (2015). "Estimation of congestion cost in the city of Kolkata—a case study," Current Urban Studies, vol. 3, no. 02, p. 95.

[7] S. Jayasooriya and Y. Bandara. (2017). "Measuring the economic costs of traffic congestion," Moratuwa Engineering Research Conference (MERCon). IEEE, pp. 141–146.

[8] C. R. Sekhar, P. Raj, P. Parida, and S. Gangopadhyay. (2013). "Estimation of delay and fuel loss during idling of vehicles at signalised intersection in Ahmedabad", Procedia-Social and Behavioral Sciences, vol. 104, pp. 1178–1187.

[9] Ramesh Surisetty, Soma N Sekhar. (2017). "Designing of a Traffic Signaling System at T-Intersection", Int. Journal of Engineering Research and Application, vol. 7, pp.82-86.



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