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Delay Analysis Of Signalized Intersection Under Heterogeneous Traffic Condition

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Abstract - *The systematic handling of highly heterogeneous traffic is a difficult task for traffic engineers. High traffic growth, a lack of proper road traffic management, and lane indiscipline all contribute to vehicle delays, particularly at intersections. Traffic signal delays are a major issue in urban areas. The aim of this study is to analyze delay at four-legged signalized intersections using the HCM delay model equation and validate it using the VISSIM software.*

Key Words: Delay, Signalized intersection, Traffic volume, Vissim

1. INTRODUCTION

Delay is an important variable in signalized intersection performance evaluation. The most significant of these is vehicle delay, which refers to the amount of time a vehicle loses when crossing an intersection. Due to the non-deterministic nature of vehicle arrival and departure processes at intersections, as well as the influence of various variables with uncertainties and ambiguity, especially under heterogeneous traffic circumstances, delay is a parameter that is difficult to measure. For traffic engineers and transportation planners, modelling vehicle delay has been an intriguing topic.

Road users are experiencing delays during peak hours due to heavy traffic flow. Excessive traffic flow, insufficient road capacity, a lack of parking areas, poor pedestrian infrastructure, parking of heavy vehicles on main roads, and other factors all contribute to congestion, resulting in delays and excessive queue lengths.

We have selected four signalized intersections for our study. All the intersections chosen were four legged intersections. Delay was calculated using HCM delay model equation.

$$d_c = \frac{0.5C\left(1-\frac{g}{C}\right)^2}{1-\left[\frac{\min(1,X)\,g}{C}\right]} + 900T\left[(X-1)+\sqrt{(X-1)^2+\frac{4X}{cT}}\right] \quad [1]$$

Where d_c is the delay of the vehicle, g is the effective green time (s), C is the cycle length (s), X is the degree of saturation, c is the capacity (PCU/hr) and T is the analysis period (s).

Delay calculated using HCM delay model equation was validated using VISSIM software. VISSIM is a microsimulation model that helps to create the real time road condition.

2. DATA COLLECTION

For collecting the data, four signalized intersections selected where as follows:

1. Angamaly KSRTC Junction
2. Thodupuzha - Vengalloor Junction
3. Thrissur- Para Junction
4. Ernakulam – Kaloor Junction

Video recording technique was used to collect data. Suitable building was selected for placing the camera. Camera were placed at sufficient height so that the signal timing and volume count can be extracted from the recordings.

Figure - 1 : Angamaly KSRTC Junction

Figure - 2 : Thodupuzha - Vengalloor Junction

Figure - 3 : Ernakulam – Kaloor Junction

Figure - 4 : Thrissur- Para Junction

3. DATA EXTRACTION

Video was played on laptop and signal timing and vehicle count of different classes of vehicles were retrieved. Saturation flow was determined by counting the vehicles passing in the first twenty seconds. The PCU values for different classes of vehicles were obtained from IRC.

4. DELAY CALCULATION

After determining the cycle length, effective green time, capacity, degree of saturation and analysis period delay was calculated and table was formulated.

ANGAMALY

Table 1: Delay in north approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
18	4	50	10	85	19.96
15	4	65	8	93.5	31.49
9	4	50	2	59.9	10.27
17	7	58	7	85.5	21.52
29	4	62	5	86.3	21.14

Table 2: Delay in south approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
16	3	57	4	74.2	13.38
15	8	54	4	72.9	22.48
23	2	49	5	70.7	16.75
26	3	48	6	73.8	9.85
12	4	53	6	75	16.26
12	3	41	7	65.4	7.69
21	6	48	10	84.7	21.16

THODUPUZHA

Table 3: Delay in north approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
25	2	21	1	32.1	48.86
17	5	20	3	35.5	39.67
6	2	21	4	34.8	43.23
12	4	20	1	28	59.44
19	2	20	3	34.9	65.34
18	1	17	1	25.6	83.45
26	5	22	1	34.6	71.69
19	4	20	2	32.9	74.18
14	1	16	4	31.8	76.49

Table 4: Delay in south approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
20	1	14	4	31.6	92.42
12	4	18	2	28.8	58.9
26	1	26	4	45.4	34.01
21	0	17	2	28.9	34.34
17	2	20	2	31.5	42.42
19	4	17	3	32.7	50.9
19	4	16	3	31.7	64.87
26	5	21	2	36.4	43.75
19	3	17	1	26.7	59.58
20	4	16	5	37.6	41.07
23	2	17	3	33.1	40.13

KALOOR

Table 5: Delay in north approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
61	14	34	4	69.1	27.66
53	8	53	1	74.9	19.31
57	10	32	0	53.1	13.62
58	11	40	1	64.6	12.52
78	13	48	0	76.6	14.08
74	15	32	2	65.8	12.29
81	16	46	0	76.7	18.85

Table 6: Delay in south approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
79	29	50	2	90.9	26.31
76	23	61	2	98.6	34.91
86	25	47	3	91.2	33.72
78	14	54	4	94.2	19.38
75	13	48	2	81.3	26.22
81	18	38	2	75.1	23.33
64	11	38	2	67.2	15.94
67	9	64	1	90.5	44.67
78	18	42	4	83.8	27.93

THRISSUR

Table 7: Delay in north approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
21	3	26	12	67.1	43.46
19	2	40	5	60.5	27.97
26	1	40	9	73.4	33.85
30	0	28	7	56.6	52.48
16	2	30	9	60.8	40.27
14	3	29	10	62.4	36.93
19	2	26	11	63.3	39.25
21	0	27	9	58.5	34.16
20	0	16	7	41.6	21.65
16	2	34	9	64.8	47.87

Table 8: Delay in south approach

2 W	3 W	4 W	Heavy vehicle	PCU	Delay
26	3	35	12	77.6	38.97
26	3	36	10	73	25.4
19	22	48	3	62.9	27.48
19	3	24	9	56.1	18.62
21	0	43	14	88.5	34.58
13	3	24	9	54.3	15.92
23	4	31	2	45.1	12.39
24	1	41	5	62.6	24.74
19	1	35	6	57.9	26.74
22	2	39	2	52	32.55

5. VALIDATION IN VISSIM

For the validation of data, VISSIM software was used. The existing traffic conditions of the signalized intersections was simulated on the software using geometric data, vehicle flow, vehicle classified count, turning moments and signal timing data. It was observed that 98 percent of the results from the software matched the data collected in the field.

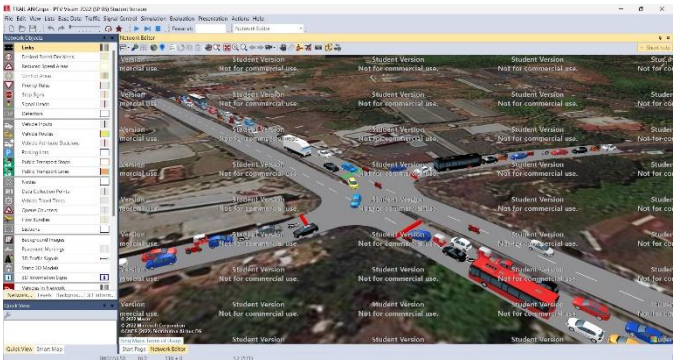

Figure 5 : Simulated 3D model of Angamaly

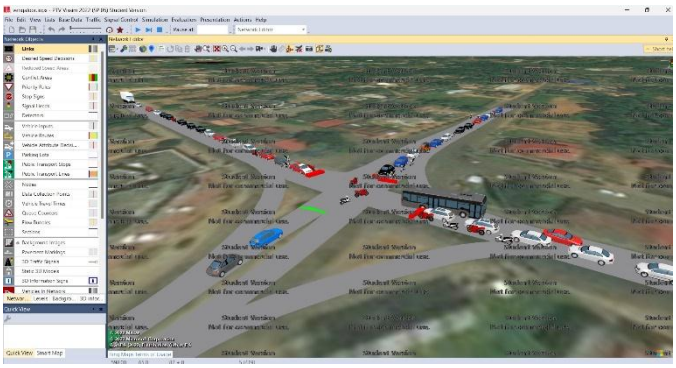

Figure 6 : Simulated 3D model of Vengalloor

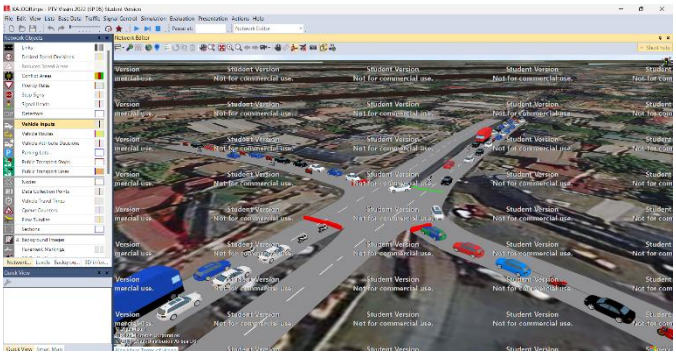

Figure 7 : Simulated 3D model of Kaloor

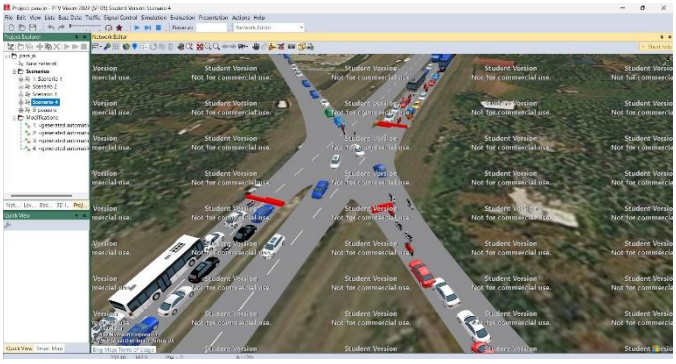

Figure 8 : Simulated 3D model of Para Junction

6. CONCLUSION

The main objective of the study was to analyze the delay at four signalized intersections. The delay was calculated using HCM model equation. The four intersections were created in VISSIM software and the delay obtained from the software was compared with that of HCM model. Validation obtained was matching up to a great extent.

7. REFERENCES

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