CORRIDOR NETWORK ANALYSIS USING MESOSCOPIC SIMULTION SOFTWARE

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Abstract:

This research paper seeks to contribute in improving the performance of selected traffic network corridor, comprising of a section of network which includes exclusive bus movement (BRTS) lanes in middle, along with normal traffic movement on either side in opposite directions. In order to improve the performance attributes, we use the mesoscopic simulation tool and signal timing design (FIXED+TSP) is done with the help of Webster's method. BRTS has been given the priority at intersection We have compared the simulation results between existing traffic signal and calculated one. Videography traffic survey has been carried out traffic volume data has been obtained manually. Origin and Destination details are obtained with the help of INRO EMME software. With the help of EMME matrix input in mesoscopic simulation tool INRO DYNAMEQ, modelled counts are generated, which is then calibrated and validated. Efforts are made to reduce the travel time, vehicle hour delay, increase network average speed of PCU'S, BRTS bus. The corridor section constitutes of seven major intersections with a BRTS specific lane, at each intersection signal priority is given with the help of phase insert TSP mode.

I Introduction

Traffic sustainability is still a challenge in urban areas. Mathematical models of network help in spotting the problems and with these network models, decision making becomes easy. Our study area Indore city, is the commercial capital of Madhya Pradesh, is in a state of exponential urbanization. The city is developed around a major arterial road known as AB ROAD, which is a part of the National Highway connecting cities of Agra and Mumbai while covering 3 major states including, U. P., M. P. and Maharashtra while covering a small portion in the 4th state of Rajasthan. This corridor comprises of exclusive public transportation lanes as well as heterogeneous mixed traffic condition. The smart city projects emphasis on smooth traffic management system. Due to rapid development of the city, we are faced with an exponential increase in traffic volume along this major arterial road, which often leads to jam conditions, congestion and an overall deterioration in travel experience. To remedy this, we try to redesign the traffic signals and prioritize BRTS for ease of passage. Mesoscopic simulation tool and webster method for signal timing used to optimize the corridor network result.

II Objective

- To study traffic flow pattern on selected corridor section during peak hour period.
- To conduct traffic survey, to take the real-world turning count and calculate origin and destination matrix with the help of INRO EMME.
- To calibrate and validate the real-world count and modelled count with the help of O-D matrix as input in INRO DYNAMEQ,
- To design new signal timing by Webster method.

- To compare the results and comment on the improvement in travel experience during peak hour period.

III Methodology

a) Site Selection:

The site selected is a section of AB ROAD corridor. The section has a 4.91 km distance and consist of six signalized intersection and one unsignalized intersection. The section taken is from Palasiya Intersection to Bhawarkuan Intersection

The section of road is located between coordinates 22.723803477184187, 75.88661376689036 and 22.692830950818195, 75.86767187060242.

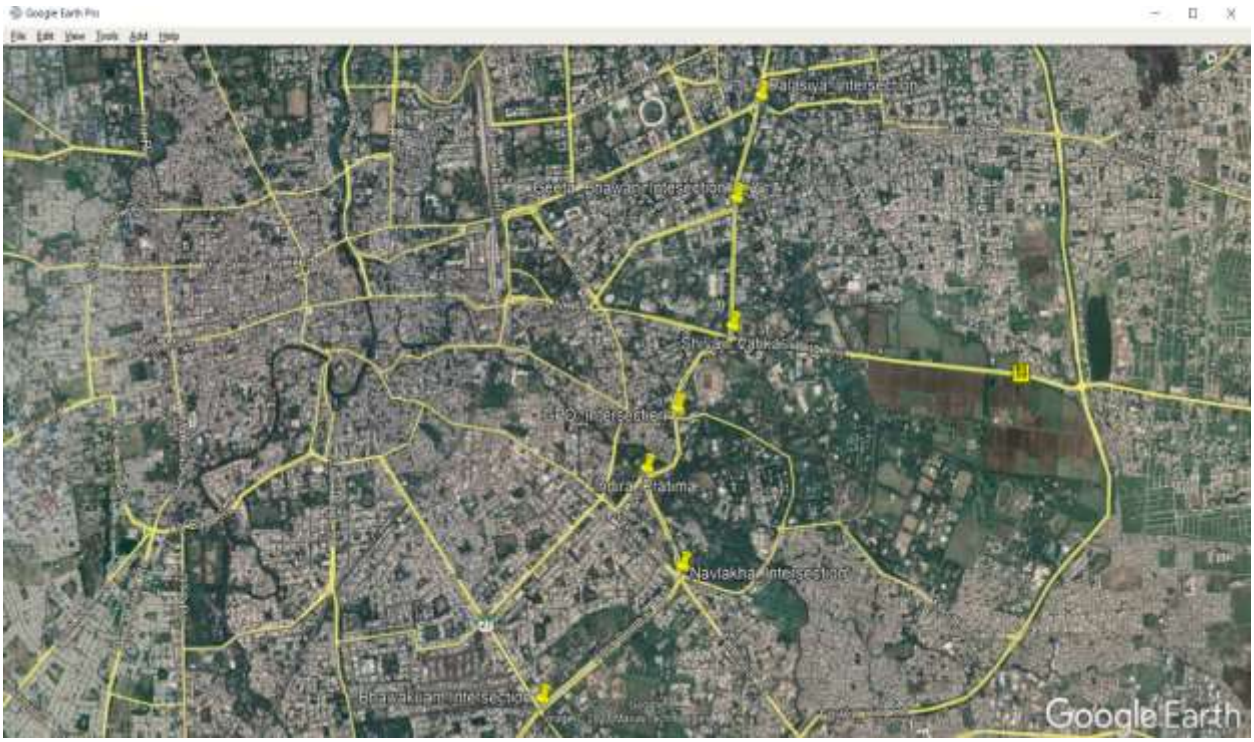

Figure 1- Site Location

b) Data Collection:

- Traffic volume survey by videography:

Field data of weekdays during 8a.m. to 8p.m. taken to determine traffic volume at intersections, peak hour period was arrived at and peak hour volumes for buses, 3 wheelers, cars, bicycles and motorcycles are derived separately before conversion of the mixed traffic into PCU values. The volume count of the same for each of signalled intersections and PCU calculation by HCM 2017 and a sample for the same is shown in table 1.

- Existing Signal Timing:

The prevailing Signal timings is collected from Indore Municipal Corporation.

c) Input in INRO EMME AND INRO DYNAMEQ:

The traffic count given to INRO EMME for O-D matrix, which is then used as input matrix in INRO DYNAMEQ (sample shown in Fig. 2).

d) Validation and Calibration:

- The corridor network is designed in simulation tool and modelled counts are calibrated and validated against the real-world counts and travel time respectively. Calibration and validation are done with the help of criteria

given in Traffic Appraisal of Road Schemes UK Voume 12, Asssignment Validation Table, Figure-3. Further the GEH values are calculated for five different random seed i.e. the initiation of probabilistic different random sequence for occurrence of an event. Table 2 shows the average of five different sequences.

e) Optimised Signal Timing by Websters Method:

The webster method of optimised signal design calculation can be referred by table-3. The new signal design is feed in simulation tool to obtain the corridor network results.

BHAWARKUAN INTERSECTION									
Rajeev Gandhi Leg		2W	Bicycle	Sedan	3W	Tractor	Truck	Bus	LCV
	PCU (HCM 2017)	0.5	0.42	1	1.2	5.4	5	4.5	3
	Left (Tower Square)	588	80	192	124	0	0	0	68
	Straight (Navlakha)	788	96	324	96	4	0	28	48
	Right (IT Park)	184	20	96	24	0	0	12	36
	Total Count	1560	196	612	244	4	0	40	152
	Total PCU	780	82.32	612	292.8	21.6	0	180	456
	PCU in Peak hour								2424.72

IT PARK LEG		2W	Bicycle	Sedan	3W	Tractor	Truck	Bus	LCV
	PCU (HCM 2017)	0.5	0.42	1	1.2	5.4	5	4.5	3
	Left (Rajeev Gandhi)	432	84	136	112	0	0	0	44
	Straight (Tower Square)	736	68	236	148	16	0	20	76
	Right (Navlakha)	368	48	148	28	12	0	8	52
	Total Count	1536	200	520	288	28	0	28	172
	Total PCU	768	84	520	345.6	151.2	0	126	516
	PCU in Peak hour								2510.8

NAVLAKA LEG		2W	Bicycle	Sedan	3W	Tractor	Truck	Bus	LCV
	PCU (HCM 2017)	0.5	0.42	1	1.2	5.4	5	4.5	3
	Left (It Park)	360	104	168	84	0	0	0	48
	Straight (Rajeev Gandhi)	604	60	288	140	20	0	40	88
	Right (Tower Square)	420	288	180	48	8	0	0	60
	Total Count	1384	140	636	272	28	0	40	196
	Total PCU	692	20	636	326.4	151.2	0	196	588
	PCU in Peak hour								2662.4

TOWER LEG		2W	Bicycle	Sedan	3W	Tractor	Truck	Bus	LCV
	PCU (HCM 2017)	0.5	0.42	1	1.2	5.4	5	4.5	3
	Left (Navlakha)	404	96	136	76	0	0	0	96
	Straight (IT Park)	664	76	164	104	16	0	16	68
	Right (Rajeev Gandhi)	392	28	160	100	8	0	8	36
	Total Count	1460	200	460	280	24	0	24	200
	Total PCU	730	84	460	336	129.6	0	108	600

	PCU in Peak hour								2447.6

Table-1: Peak hour PCU of Bhawarkuan Intersection.

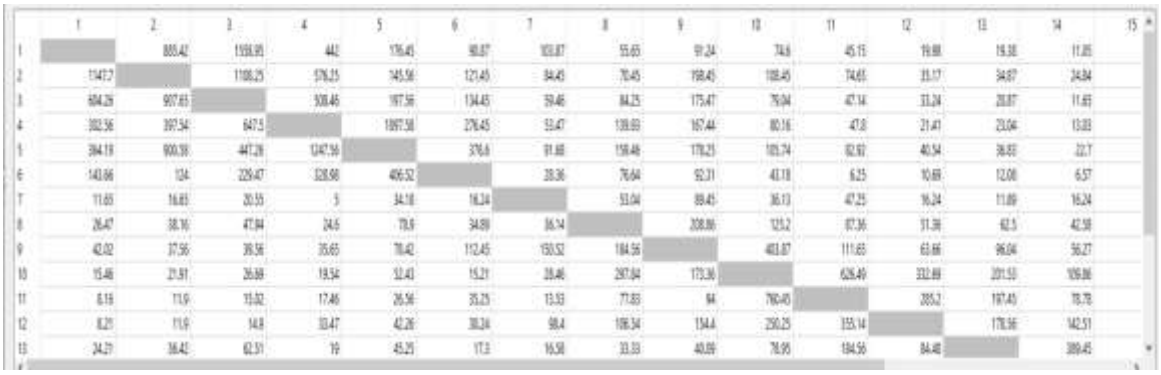

Figure-2 O-D Matrix Input in INRO DYNAMEQ.

Criteria and Measures	Acceptability Guideline
Assigned Hourly flows * compared with observed flows	
1. Individual flows within 15% for flows 700 - 2,700 vph	)
2. Individual flows within 100 vph for flows < 700 vph	) > 85% of cases
3. Individual flows within 400 vph for flows > 2,700 vph	)
4. Total screenline flows (normally > 5 links) to be within 5%	All (or nearly all) screenlines
5. GEH statistic:	
i) individual flows : GEH < 5	> 85% of cases
ii) screenline (+) totals: GEH < 4	All (or nearly all) screenlines
Notes	
+ Screenlines containing high flow routes such as Motorways should be presented both including and excluding such routes	
* links or turning movements (but see Paragraph 4.4.37).	

Figure-3 Assignment Validation: Acceptability Guidelines.

Figure-4 Modelled Count from Inro Dynameq.

S.no	Intersections	Direcctions		Real Word Counts	Modelled counts	GEH	Passing rate
1	Bhawakuan Square						
		Rajeev gandhi leg	694.6	2778.4	3009	4.28679337	23
		IT park Leg	665.26	2661.04	2911	4.73563696	
		Navlakha Leg	620.28	2481.12	2688	4.06935144	
		Tower square Leg	640.6	2562.4	2804	4.66412743	
2	Navalakha Square						
		Bhawarkuan Leg	753	3012	3068	1.01566675	
		Nemawar Leg	814.5	3258	3030	4.06624534	
		Azad nagar Leg	290.58	1162.32	718	14.490887 3	
		Gpo Leg	425.8	1703.2	1525	4.43549895	
		Agrasen Leg	549	2196	2200	0.08531908	
3	GPO Square						
		Navlakha Leg	625.82	2503.28	2406	1.96349436	
		Residency Leg	367.8	1471.2	1543	1.84949606	
		Whitechurch Leg	538.8	2155.2	2193	0.81068482	
		Chawni Leg	251.34	1005.36	932	2.35705196	
4	Whitechurch Square						
		Gpo Leg	595.82	2383.28	2344	0.80794317	
		Police line Leg	451.3	1805.2	1619	4.50002693	
		Piplihana Leg	443.9	1775.6	1717	1.40229114	
		Geeta bhawan Leg	568.78	2275.12	1993	6.10703716	
		MY Leg	623.8	2495.2	2410	1.72038732	
5	Geeta Bhawan						
		Whitechurch Leg	593	2372	2543	3.44944597	

		Tilak nagar Leg	486.2	1944.8	1126	20.8961879	
		Palasiya Leg	600.94	2403.76	2469	1.32172602	
		Madhumilan Leg	495.88	1983.52	1845	3.16600809	
6	Palasiya						
		Geeta bhawan Leg	631.6	2526.4	2458	1.37013909	
		Tilak nagar Leg	428.8	1715.2	1810	2.25803908	
		LIG Leg	702.56	2810.24	2748	1.18063576	
		Indraprasth Leg	656.6	2626.4	2601	0.49682775	

Table-2 Average of random seed simulation GEH values

		Volume for peak 15 min	L=2N+R	V (pcu/hr)	PCU/hr/lane	Saturation Flow (S)	Y=V/S	Cycle Time (s)	Green Times (s)
Bhawakuan Square									
	Rajeev gandhi leg	694	36	2776	925.33	5250	0.18	220	44
	It park Leg	635		2540	846.67	4200	0.20		51
	Navlakha Leg	620		2480	826.67	4200	0.20		50
	Tower square	620		2480	826.67	5250	0.16		40
Navlakha Square									
	Bhawarkuan Leg	753	43	3012	1004.00	5250	0.19	276	60
	Neemawar Leg	881.62		3526.48	1175.49	5250	0.22		70
	Azad nagar Leg	290.58		1162.32	387.44	5250	0.07		23
	Gpo Leg	425.8		1703.2	567.73	4725	0.12		37
	Agrasen Leg	549		2196	732.00	5250	0.14		43
Gpo Square									
	Navlakha Leg	625.82	36	2503.28	834.43	4200	0.20	145	36
	Residency Leg	367		1468	489.33	4200	0.12		21
	Whitechurch Leg	538.8		2155.2	718.40	4200	0.17		31
	Chawni Leg	251.34		1005.36	335.12	3150	0.11		20
Whitechurch Square									
	Gpo Leg	595.82	43	2383.28	794.43	5250	0.15	266	46
	police line Leg	451.54		1806.16	602.05	4200	0.14		43

	Piplihana Leg	443.9		1775.6	591.87	4200	0.14		43
	Geeta bhawan Leg	568.78		2275.12	758.37	5250	0.14		44
	My Leg	623.8		2495.2	831.73	5250	0.16		48
Geeta Bhawan									
	whitechurch Leg	593.04	36	2372.16	790.72	4200	0.19	176	40
	Tilak nagar Leg	453		1812	604.00	4725	0.13		27
	Palasiya Leg	600.94		2403.76	801.25	4200	0.19		40
	Madhumilan Leg	498.88		1995.52	665.17	4200	0.16		33
Palasiya									
	Geeta bhawan Leg	631.6	36	2526.4	842.13	4987.5	0.17	169	35
	Tilak nagar Leg	428.2		1712.8	570.93	4200	0.14		28
	LIG Leg	702.56		2810.24	936.75	5250	0.18		37
	Indraprasth Leg	656.86		2627.44	875.81	5250	0.17		35

Table-3 Webster Optimized Signal Plan.

IV Data Analysis

The simulation tool is run for Base Plan and the Optimized Plan following network outputs are shown in Table-4.

Network Result	Base Plan	Optimised Plan
Density (pcu/km/lane)	24.4394	24.5542
VHT (veh-hr)	1902.88	1911.81
VHT-Total (veh-hr)	2499.67	2401.51
VHT-Virtual (veh-hr)	596.79	489.692
VHD (veh-hr)	1240.36	1241.87
VHD-Total (veh-hr)	1837.15	1731.56
VKT (veh-km)	33035.1	33386.3
Speed (km/hr)	17.3606	17.4631

Table-4 Comparison of Base Plan and Optimized Plan Network Result

V Results

After simulations were carried out, the following were the results obtained:

a) *Density:*
It is observed that the Density (PCU/km/lane) has increased by 0.47% in optimised plan simulation.

b) *VHT-Total(veh-hr):*
The total vehicle-hours of travel during the interval has decreased by 3.93% in the optimised plan simulation.

c) *Vehicle hour delay (veh-hr):*

The total VHD of travel during interval has decreased by 5.8% in the optimised plan simulation.

d) Vehicle kilometre travelled (veh-km):

The VKT in the network during interval has increased by 1% in the optimised plan simulation.

e) Average Speed (km/hr):

The average speed of network has increased by 0.05% in the optimised plan simulation.

VI Conclusion

It was observed that all the parameters showed significant results, the percentage of improvement could be less as cycle time length of intersection has increased. This paper suggests that existing corridor network can be improved with the help of mesoscopic simulation.

VII Future Scope

The future scope to this work can be calculation of optimized signal plans by different methods of signal time design and applying the concept of synchronization of traffic signal.

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