ALTERNATIVE ROAD TRAFFIC MANAGEMENT FOR PEAK HOUR PERIOD USING MICRO SIMULATION SOFTWARE

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Abstract:

In this research paper, we try to utilize a parallel network of in roads and divert some of the traffic from the major arterial road link to these links in order to compare the resulting delays and queue lengths with the originally normal traffic flow and find out if the peak hour travel times, delays and queue lengths can be reduced along the major road links by reassigning the traffic along the parallel routes. In this paper, we show that by diverting around 10 percent of traffic during peak hour, we can reduce the burden on the major road sections by a larger amount, and the parameters like vehicle travel times, delays and queue lengths see significant reduction along the major road links. For this, we use micro simulation software PTV VISSIM, and simulate the site conditions obtained through traffic volume survey, route choice survey etc. and compare the results of the simulation with and without redirection of traffic volume along the in roads. The section of road network considered is a part of AB Road, between LIG Square and Nawlakha Square with first traffic signal being at Palasiya Square and the last being GPO Square. The alternate in road sections run parallel to more than 3 quarters in length of this section, from Geeta Bhawan Square to GPO Square.

I Introduction

Indore is the largest city of Madhya Pradesh with a population of over 3 million and a metropolitan area of approx. 1200 sq km. It has the highest number of registered personal and commercial vehicles state-wide. As such a need for traffic management is very high, especially during peak hour period. This work is being carried out to find out whether it is feasible to reduce the vehicle travel times, delays and queue lengths at intersections during peak hour traffic period if some traffic volume is alternatively redirected to available less congested in roads.

II Objective

- To study traffic flow pattern on selected network during peak hour period.
- To conduct vehicle count and record turning instances, to derive route choice behaviour of user.
- To use simulation software to calculate travel time, delay time, queuing length, average speed, vehicular occupancy rate on a traffic signal controlled road section.
- To suggest an alternate route for a major arterial road and recalculate travel times, delay times, queuing lengths, average speed and occupancy rate data.
- 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 such that a major section of the network has a set of in roads running parallel to one of the major roads. The original traffic on the in-roads should be significantly lesser then the major road. The in-road should be accessible to major road via multiple access points. Based on above criteria, a section of AB Road (NH-3) from Palasiya Square to GPO was selected. The section length is 2.33 km, with 4 signalized intersections on main route and 1 on alternate route. There are 4 unsignalized intersections on the alternate route. The main route is 2-lane road in each direction while the alternate route is a single lane for most of the route.

The section of road is located between coordinates 22.724313442696857, 75.88691387642193 and 22.707046174254266, 75.87885074843888

Figure 1- Site Location

b) Data Collection:

- Traffic volume survey by videography:-

  Field data of weekdays during 8a.m. to 8p.m. was taken to determine traffic volume, speed of different type of vehicles for free flow and other conditions, peak hour period was arrived at and peak hour volumes for buses, 3 wheelers, cars, bicycles and motorcycles are derived separately. The volume count of the same for each of signalled intersections is shown in table 1 to table 5.

- User Route Choice Survey:

  An online survey was conducted wherein users were provided with two alternate routes and asked questions regarding their preferred route of travel which was then be segregated for different vehicle types, gender, and age group. It was observed that approximately 85% of the users preferred to use the main road irrespective of traffic conditions.

c) Input in PTV VISSIM:

This data was then given to PTV VISSIM as input along with all the signal cycle timings and simulation was carried out. The results for Vehicle travel time, vehicle delay time and queue lengths at various intersections was recorded. Afterwards, 10 percent of the traffic volume is redirected to alternate route and the simulation was carried out again.

GPO Leg		Left (MY)	Straight (Geeta Bhaawan)	Right1 (Police Line)	Right2 (Piplihana)	Total Count
	2W	204	964	52	356	1576
	Bicycle	16	96	20	28	160
	Car	100	328	20	96	544
	3W	12	148	36	48	244
	Bus	0	16	0	8	24
Police Line LEG		Left (GPO)	Straight (MY)	Right1 (piplihana)	Right2 (Geeta Bhawan)	Total Count
	2W	96	512	96	300	1004
	Bicycle	36	52	28	32	148
	Car	56	136	56	92	340
	3W	56	40	20	32	148
	Bus	0	8	0	0	8
Piplihana Leg		Left (Police Line)	Left 2 (GPO)	Straight (MY)	Right1 (Geeta Bhawan)	Total Count
	2W	76	124	944	176	1320
	Bicycle	16	32	60	32	140
	Car	36	36	248	156	476
	3W	20	28	128	28	204
	Bus	0	0	32	8	40
Geeta Bhawan Leg		Left1 (Piplihana)	Left 2 (police line)	Straight (GPO)	Right (MY)	Total Count
	2W	668	100	1128	396	2292
	Bicycle	84	24	96	92	296
	Car	240	48	352	216	856
	3W	16	16	164	136	332
	Bus	8	0	0	0	8
MY Leg		Left (Geeta Bhawan)	Straight (piplihana)	Right 1 (Police Line)	Right 2 (GPO)	Total Count
	2W	388	456	320	140	1304
	Bicycle	68	60	36	48	212
	Car	164	188	132	188	672
	3W	36	88	84	84	292
	Bus	8	8	20	60	96

Table-1: Peak Hour Volume Count Data of White Church Intersection.

Navlakha Leg	Vehicle type	Left (Chawni)	Straight (Whitechurch)	Right (Residency)	Total Count
	2W	876	1436	256	2568
	Bicycle	36	60	28	124
	Car	92	544	132	768
	3W	208	132	36	376
	Bus	0	40	0	40
Residency Leg		Left (Navlakha)	Straight (Chawni)	Right (Whitechurch)	Total Count
	2W	448	588	280	1316
	Bicycle	76	60	44	180
	Car	104	12	144	260
	3W	44	84	24	152
	Bus	12	0	4	16
Whitechurch Leg		Left (Residency)	Straight (Navlakha)	Right (Chawni)	Total Count
	2W	748	1080	104	1932
	Bicycle	36	124	20	180
	Car	232	480	64	776
	3W	84	112	32	228
	Bus	12	32	0	44
Chawni Leg		Left (whitechurch)	Straight (Residency)	Right (Navlakha)	Total Count
	2W	228	344	144	716
	Bicycle	32	32	24	88
	Car	28	48	48	124
	3W	44	84	64	192
	Bus	0	8	8	16

Table-2: Peak Hour Volume Count Data of GPO Intersection.

Geeta Bhawan Leg		Left (Indraprasth)	Straight (LIG)	Right (Tilak nagar)	Total Count
	2W	720	1052	200	1972
	Bicycle	124	92	24	240
	Car	304	408	80	792
	3W	96	84	44	224
	Bus	0	0	0	0
Tilak Nagar Leg		Left (Geeta bhawan)	Straight (Indraprasth)	Right (LIG)	Total Count
	2W	776	1024	168	1968
	Bicycle	40	68	32	140
	Car	176	228	120	524
	3W	36	72	32	140
	Bus	0	16	0	16
LIG Leg		Left (tilak Nagar)	Straight (Geeta Bhawan)	Right (Indraprasth)	Total Count
	2W	768	1080	956	2804
	Bicycle	136	72	92	300
	Car	216	276	208	700
	3W	124	148	136	408
	Bus	0	8	12	20
Indraprasth Leg		Left (LIG)	Straight (Tilak Nagar)	Right (Geeta Bhawan)	Total Count
	2W	880	972	372	2224
	Bicycle	124	156	92	372
	Car	224	208	244	676
	3W	124	108	88	320
	Bus	0	16	0	16

Table-3: Peak Hour Volume Count Data of Palasiya Intersection.

Whitechurch Leg		Left (Madhumilan)	Straight (Palasiya)	Right (Bengali)	Total Count
	2W	844	1016	296	2156
	Bicycle	104	96	20	220
	Car	232	396	124	752
	3W	76	116	40	232
	Bus	4	20	4	28
Bengali Leg		Left (Whitechurch)	Straight (Madhumilan)	Right (Palasiya)	Total Count
	2W	776	1024	168	1968
	Bicycle	40	68	32	140
	Car	176	232	92	500
	3W	36	72	32	140
	Bus	0	16	0	16
Palasiya Leg		Left (Bengali)	Straight (Whitechurch)	Right (Madhumilan)	Total Count
	2W	720	948	696	2364
	Bicycle	84	120	44	248
	Car	208	404	172	784
	3W	84	128	68	280
	Bus	4	8	0	12
Madhumilan Leg		Left(Palasiya)	Straight (Bengali)	Right (Whitechuch)	Total Count
	2W	728	536	560	1824
	Bicycle	32	52	32	116
	Car	156	72	128	356
	3W	28	36	64	128
	Bus	4	8	8	20

Table-4: Peak Hour Volume Count Data of Geeta Bhawan Intersection.

Agri Clg Leg	Vehicle type	Left (Residency)	Straight (Whitechurch)	Right (Geeta Bhawan)	Total Count
	2W	56	248	92	396
	Bicycle	12	24	16	52
	Car	36	184	68	288
	3W	24	48	12	84
	Bus	0	12	0	12
Church Sq Leg		Left (Geeta Bhawan)	Straight (Agri Clg)	Right (Residency)	Total Count
	2W	84	224	44	352
	Bicycle	20	32	12	64
	Car	48	52	28	128
	3W	12	84	24	120
	Bus	0	8	0	8
Residency Leg		Left (Church)	Straight (Geeta Bhawan)	Right (Agri Clg)	Total Count
	2W	48	80	104	232
	Bicycle	12	24	20	56
	Car	32	48	64	144
	3W	12	16	12	40
	Bus	0	0	0	0
Geeta Bhawan Leg		Left (Agriculture College)	Straight (Residency)	Right (Church)	Total Count
	2W	144	104	84	332
	Bicycle	32	32	24	88
	Car	64	24	48	136
	3W	36	12	20	68
	Bus	0	0	0	0

Table-5: Peak Hour Volume Count Data of Alternate Route Intersection.

IV Data Analysis

The data regarding average speed, occupancy rate, average travel time, average delay time, average queue length and maximum queue length were collected through simulations using PTV VISSIM before and after diverting 10 percent of traffic volume. The comparative analysis is tabulated in the following tables:

S. No.	NAME OF APPROACH	Occupancy Rate (%)		Avg speed (m/s)	
		Before	After	Before	After
1	LIG - PALASIYA SQ	69.13%	68.12%	17.65	17.74
2	MG RD - PALASIYA SQ	78.42%	75.88%	17.31	17.19
3	TILAK NGR RD - PALASIYA SQ	58.81%	60.11%	18.39	19.69
4	GEETA BHAWAN - PALASIYA SQ	48.33%	49.75%	15.73	16.69
5	PALASIYA SQ - GEETA BHAWAN	66.10%	64.37%	18.81	19.14
6	CHURCH SQ - GEETA BHAWAN	72.46%	71.88%	19.16	19.80
7	THEATRE RD - GEETA BHAWAN	64.65%	62.88%	20.54	20.30
8	BENGALI SQ- GEETA BHAWAN	86.66%	85.50%	22.95	21.09
9	ALTERNATE RT	28.34%	41.51%	17.24	15.44
10	FROM AGRI CLG	54.47%	52.23%	15.26	16.05
11	TOWARDS AGRI CLG	77.65%	71.86%	15.72	15.32
12	GEETA BHAWAN - CHURCH SQ	75.48%	67.15%	15.26	17.86
13	GPO SQ - CHURCH SQ	75.24%	78.32%	18.67	18.79
14	AGRI CLG - CHURCH SQ	33.51%	30.84%	15.07	15.57
15	MY - CHURCH SQ	76.80%	74.88%	20.79	19.30
16	RESIDENCY - CHURCH SQ	80.57%	82.56%	18.57	18.54
17	RESIDENCY - GPO SQ	4.55%	4.25%	19.47	18.18
18	CHAWNI - GPO SQ	42.42%	41.84%	14.87	14.08
19	NAWLAKHA - GPO SQ	48.69%	48.38%	20.73	20.70
20	CHURCH SQ - GPO SQ	45.02%	39.61%	15.04	16.18

Table-6: Occupancy Rate in % and Average speed in m/s before and after redirecting traffic.

The above table shows the variation in occupancy rate and average speed of vehicles along different sections of the road network before and after redirecting 10 percent of traffic from main route to the alternate route.

S. No.	NAME OF APPROACH	Avg Queue length (m)		Max Queue Length (m)	
		Before	After	Before	After
1	LIG - PALASIYA SQ	9.113	8.895	36.988	36.106
2	MG RD - PALASIYA SQ	14.976	12.173	58.022	47.161
3	TILAK NGR RD - PALASIYA SQ	11.091	11.102	58.583	58.638
4	GEETA BHAWAN - PALASIYA SQ	4.184	4.379	24.120	25.243
5	PALASIYA SQ - GEETA BHAWAN	24.220	21.605	102.648	91.564
6	BENGALI SQ- GEETA BHAWAN	24.322	29.423	66.452	80.387
7	THEATRE RD - GEETA BHAWAN	6.132	6.366	38.053	39.502
8	CHURCH SQ - GEETA BHAWAN	10.107	9.072	62.686	56.267
9	MY - CHURCH SQ	18.996	17.211	67.303	60.977
10	AGRI CLG - CHURCH SQ	21.179	21.223	55.930	56.047
11	GEETA BHAWAN - CHURCH SQ	69.237	55.301	567.779	453.499
12	GPO SQ - CHURCH SQ	25.421	19.117	77.640	58.387
13	RESIDENCY - CHURCH SQ	358.519	350.649	512.336	501.090
14	CHAWNI - GPO SQ	3.187	2.953	32.211	29.847
15	RESIDENCY - GPO SQ	7.590	8.798	63.351	73.434
16	CHURCH SQ - GPO SQ	2.710	1.473	31.720	17.235
17	NAWLAKHA - GPO SQ	3.950	4.237	31.928	34.244
18	ALTERNATE RT	227.091	287.114	397.235	502.229
19	TOWARDS AGRI CLG	38.801	19.380	243.568	121.658
20	FROM AGRI CLG	9.090	7.695	40.202	34.031

Table-7: Average and Maximum Queue Length in m before and after redirecting traffic

The above table shows the variation in average and maximum queue length of vehicles along different signal heads of the road network before and after redirecting 10 percent of traffic from main route to the alternate route.

S. No.	ORIGIN & DESTINATION	AVG TRAVEL TIME (S)		AVG DELAY TIME (S)	
		BEFORE	AFTER	Before	After
1	PALASIYA SQ - GPO SQ	556.00	503.56	379.33	311.14
2	GPO SQ - PALASIYA SQ	521.56	519.76	282.86	280.91
3	MG RD - GPO SQ	1360.62	1321.27	1083.59	1021.81
4	THEATRE RD - GPO SQ	407.14	370.39	231.00	191.18
5	BENGALI SQ RD - GPO SQ	444.25	425.27	271.84	249.11
6	MY RD - GPO SQ	264.25	282.36	147.18	168.05
7	AGRI CLG RD - GPO SQ	554.04	604.04	328.38	390.33
8	MY RD - PALASIYA SQ	329.92	340.43	152.02	161.86
9	AGRI CLG RD - PALASIYA SQ	587.74	573.93	369.78	352.61
10	CHAWNI RD - PALASIYA SQ	575.21	562.54	196.62	188.05
11	RESIDENCY RD - PALASIYA SQ	433.61	481.11	226.21	278.49
12	THEATRE RD - PALASIYA SQ	103.78	106.22	33.55	35.14
13	BENGALI SQ RD - PALASIYA SQ	229.30	252.35	132.39	160.34
14	PALASIYA SQ - MG RD	67.91	69.96	47.65	50.56
15	PALASIYA SQ - TILAK NGR RD	59.53	56.22	45.24	40.34
16	PALASIYA SQ -THEATRE RD	174.74	191.72	96.20	115.82
17	PALASIYA SQ - BENGALI SQ RD	164.50	155.58	94.87	84.86
18	PALASIYA SQ - AGRI CLG RD	799.57	766.28	434.29	398.89
19	PALASIYA SQ - MY RD	502.08	497.10	276.70	271.24
20	GPO SQ – CHAWNI	50.42	47.68	23.97	21.44
21	GPO SQ - RESIDENCY RD	87.73	92.77	34.22	38.26
22	GPO SQ - AGRI CLG RD	775.91	742.19	478.92	438.20
23	GPO SQ - MY RD	176.79	202.73	79.47	104.50
24	GPO SQ - THEATRE RD	349.57	343.95	169.94	164.52
25	GPO SQ - BENGALI SQ RD	438.56	423.64	231.21	215.75
26	GPO SQ - TILAK NAGAR RD	557.54	536.21	322.28	298.10
27	GPO SQ - MG RD	419.30	430.50	206.57	217.75

Table-8: Average travel time and average delay time between various O-D pairs before and after redirecting traffic

The above table shows the variation in average travel time of vehicles between different pairs of starting and ending locations (can be considered as local OD Pairs) of the road network before and after redirecting 10 percent of traffic from main route to the alternate route.

V Results

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

a) *Average Speed:*
It was observed that the average speed was increased by 17% on the main route while the same was reduced by 10% on the alternate route.

b) *Occupancy Rate:*
It was observed that occupancy rate was reduced by 11% on the main route while the same was increased by 46% on the alternate route.

c) *Travel Time:*
It was observed that average travel time was reduced by 9% on the main route while the same was increased by 9% on the alternate route.

d) *Delay Time:*
It was observed that average delay time was reduced by 18% on the main route while the same was increased by 19% on the alternate route.

e) *Average Queue Length:*
It was observed that average queue length was reduced by 20% on the main route while the same was increased by 26% on the alternate route.

f) *Max. Queue Length:*
It was observed that max queue length was reduced by 20% on the main route while the same was increased by 26% on the alternate route.

VI Conclusion

It was observed that all the parameters were reduced by a somewhat satisfactory faction on the major road network. While the increase on alternate route is high, due to a low initial volume, the same can be considered to be manageable. This paper suggests that utilization of such alternative routes to redirect traffic in peak hour duration can be an effective way to manage peak hour congestion conditions.

VII Future Scope

This work shows that in case traffic is regulated separately during peak hour, the majority of major route congestion issues can be addressed more effectively. We can further add to this work by adding commercial vehicles to the scope of network and increasing the size of this network. Using this work, an alternate peak hour traffic management system can be developed for entire cities. This method can be more cost effective in the long run as it can also consider a periodic increase in traffic volume.

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