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Synchronization of Traffic Signals "A Case Study- Mr-10 Road, Indore"

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Abstract: ***During the past decade major cities have under gone haphazard growth of Industrialization, urbanization of country. Consequently the urban population has to travel greater distances within minimum possible time. To manage travel demand the intersections should give least resistance to traffic flow so that the travel time can be minimized. The present requirement of metropolitan cities is to absorb the growing traffic demand but within the same physical dimensions at the intersection. These days all-around the globe efforts are being put forward to protect the environment to save earth. In this paper an attempt has been made to study the various intersections, so as to minimize the delays at these intersections and consequently improve the level of service. Traffic signal can be synchronized so that a vehicle starting at one end of the Street and traveling at Preassigned speed can go to other end without stopping for red light. At each intersection the existing traffic has been estimated and then signal is designed. To improve the level of service at intersections and to minimize delay, optimized signal has been synchronized and benefits are estimated.***

Keywords: Synchronization, Traffic signals, Webster"s Method, Level of Service, Phase Design

1. Introduction

Transportation engineering is the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to provide for the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods. The increasing vehicular traffic on urban road in network demands effective measure of traffic control on road – network, especially at the intersection, where turning movement of vehicle and mixed traffic creates congestion, traffic jam. All the Metropolitan cities in India face this problem in acute form.

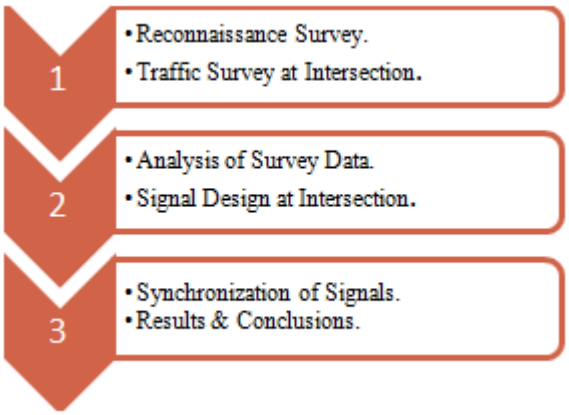
The provision of signal at the intersection is one of the methods to control the traffic, signal permits the leg wise movement of the traffic and synchronization is the coordination between relative signals. In congested parts of the cities, traffic control at road intersection is practical and economical only with the help of traffic signals under the prevailing conditions.

A major objective of Traffic Signal Synchronization at intersection is to clear maximum number of vehicles through the intersection in a given length and time with least number of accidents, at maximum safe speed and with minimum delay

2. Objectives

1. To find out delay for mixed traffic.
2. To develop the synchronization of signals in series.
3. To determine the time saving & increase in journey speed after synchronization.
4. To estimate fuel loss due to delay and low running speed.
5. To estimate loss occurred due to people"s time.
6. To estimate CO2 Emission by Fuel Loss.

3. Methodology



4. Traffic Survey and Data Collection

MR-10 road corridor has twelve intersections between Radisson square to Lavkush square. The traffic growth on this road is increasing rapidly day by day because of development of new colony and township along corridor. With direct connectivity of MR-10 road with Super corridor and Ujjain-Sanwer Road the traffic is expected to increase more. In future with the growth of Information Technology sector in the city i.e. Multinational companies like TCS & Infosys will start their centre near super corridor and hence the traffic growth will increase enormously in the city at this section.

4.1. Detailed information of road.

Name of road: MR-10 Road Corridor
Total length of road: 8.4km
No. of signalized intersections: 12 no.

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4.2. Geometry and Traffic survey at intersection.

Intersection traffic data is collected by the video graphic method. Video is taken for Peak hours i.e. from 8.00a.m. to 11 a.m. in morning & 5p.m. to 8p.m. in evening for seven days at each intersection. Left turning traffic, straight through traffic and right turning traffic is taken from all the approaches and then it is converted into PCU/hr. by using suggested values of PCU for different vehicles.

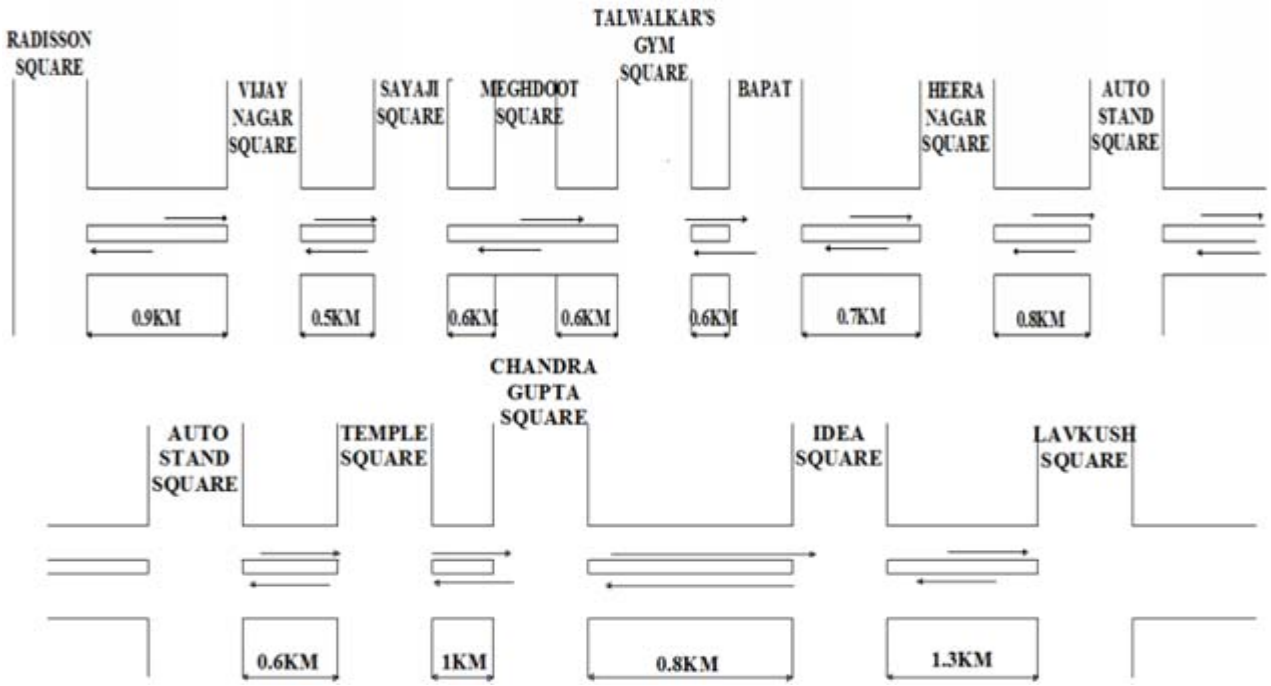


Figure 1: Line diagram of MR-10 Indore

Table 1: Traffic Survey Data at Intersections of MR-10 Road

Sr. No.	Name of Intersection	Distance (m).	From / To	N		E		N	S
				S	W	E	W	N	S
1	Raddisson Square	-		756	391	111	696	254	192
2	Vijay Nagar Square	900		463	573	400	590	497	350
3	Sayaji Square	500		NO LEG			882	0	192
4	Meghdut Square	600		0	592	111	700	893	0
5	Talwalkar"s Square	600		NO LEG			882	0	192
6	Bapat Square	600		596	365	452	852	525	326
7	Heera Nagar Square	700		700	191	111	700	200	192
8	Heera Nagar Auto Stand Square	800		690	190	156	700	200	152
9	Temple Square	600		695	189	189	700	200	259
10	CG Mourya Square	1000		699	256	150	699	356	192
11	Idea Square	800		596	192	152	459	256	192
12	Lavkush Square	1300		759	156	110	685	463	192

5. Results

5.1 All Intersection signal design is based on Webster's Method. Detailed design of one of the signal is given below in Table no.2

Table 2: Signal Design of Radisson Square

Approach	N	E	W	S
Approach width (m)	10.5	10.5	10.5	10.5
Flow V (PCU/hr.)	1147	950	1148	1053
Green phase(g) (sec.)	35	31	36	32
Green time(sec.)	31	26	31	28
Amber time(sec.)	4	5	5	4
Red time(sec.)	97	101	96	99
Delay for each approach(d_a)	49	52	49	50
V/c ratio for each approach(x)	0.89	0.89	0.89	0.89

Optimum cycle time c_o(sec.)	132
Effective green time g_e(sec.)	116
Inter section capacity	4842
Determination of Critical Lane Group	0.78
Critical v/c ratio for intersection x_c	0.90
Average delay for intersection(d_i)	50
Intersection Level of Service	E

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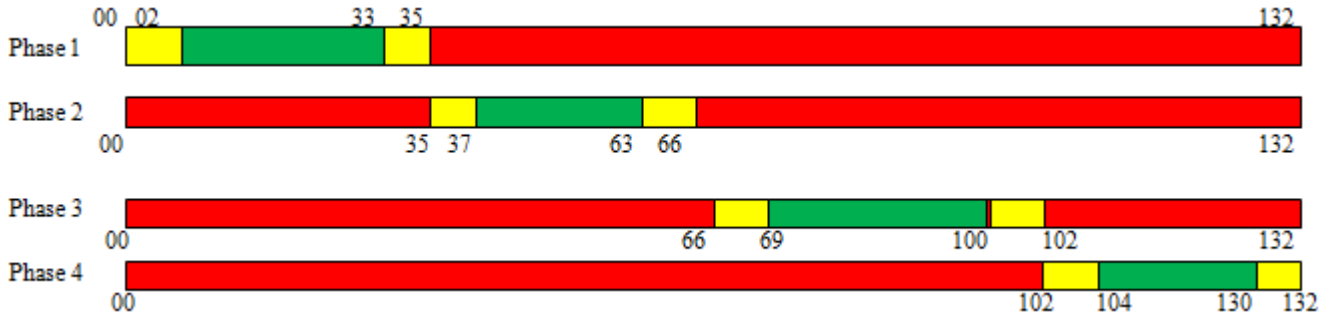


Figure 2: Timing Diagram of Radisson Square

Table 3: Traffic signal design at intersections of MR-10 Road

				Green Phase(sec.)				Red Phase (sec.)			
Sr.No.	**Name of intersection**	**Distance (m.)**	**Cycle Time(C_o)**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
1	Raddisson Square	-	132	35	31	36	32	97	101	96	99
2	Vijay Nagar Square	900	141	46	36	28	34	96	105	113	108
3	Sayaji Square	500	65	-	15	30	14	-	49	35	51
4	Meghdut Square	600	52	16	26	13	-	36	26	39	-
5	Talwalkar"s Square	600	49	-	16	16	19	-	33	33	30
6	Bapat Square	600	211	63	61	47	41	148	149	164	170
7	Heera Nagar Square	700	129	37	33	18	43	92	96	111	86
8	Heera Nagar Auto Stand Square	800	88	28	23	15	25	60	66	73	64
9	Temple Square	600	58	19	21	14	22	54	53	60	52
10	CG Mourya Square	1000	112	26	26	29	32	85	86	83	79
11	Idea Square	800	75	25	17	12	23	50	57	63	52
12	Lavkush Square	1300	124	30	34	32	30	94	89	92	94

Table 4 *Different parameters of Signal Design*

Sr. No.	*Name of intersection*	*Distance (m.)*	*Cycle Time (sec.)*	*V/C Ratio*	*Delay (Sec/Veh.)*	*LOS*
1	Raddisson	-	132	0.89	50	E
2	Vijay Nagar	900	141	0.90	53	E
3	Sayaji	500	65	0.79	20	C
4	Meghdut	600	52	0.72	16	C
5	Talwalkar"s	600	49	0.70	17	C
6	Bapat	600	211	0.93	79	F
7	Heera Nagar	700	129	0.88	47	E
8	Auto Stand	800	88	0.82	33	D
9	Temple	600	58	0.77	28	D
10	CG Mourya	1000	112	0.86	42	E
11	Idea	800	75	0.78	28	D
12	Lavkush	1300	124	0.88	47	E

5.2 Synchronization of Signals

Traffic signal synchronization allows a series of lights along a street to turn green based on synchronized time set and preassigned speed to current traffic patterns and congestion levels.

It is a cost effective way to reduce overall stops and travel delays. Synchronization of traffic Signals has been done and it,,s detail is given in Figure 3 and Figure 4

5.3 Economic Analysis Details

After Applying Synchronization saving time per hour per passenger is 266 sec. and 277 sec. As per Avg. Traffic survey detail Converted into passenger per hour 4217 and 4187. By the report of Advance Estimation of National income 2014-15 estimates at current prices Per Capita income is Rs. 54,527, so per capita per sec. income is Rs 0.00941.

Peak traffic hours of the day is 6 hour, then benefits in terms of money is Rs 63,332 per Day and Rs 65,482 per Day. Due to low running Speed of vehicle the extra fuel has been burn, synchronization of signal can save this loss from E-W & W-E, Petrol 1018.61 Lit/Day and Diesel 1385..58 Lit/Day. Cost of this fuel is Rs.1, 57,248. Due to Delay the vehicle burn extra fuel, this fuel loss is ideal fuel consumption of vehicles, it can save loss of fuel Petrol 50.18 Lit/Day and Diesel 31.512 Lit/Day, Cost of fuel Rs.5498.Detail of this data given below in table 5 & table 6.

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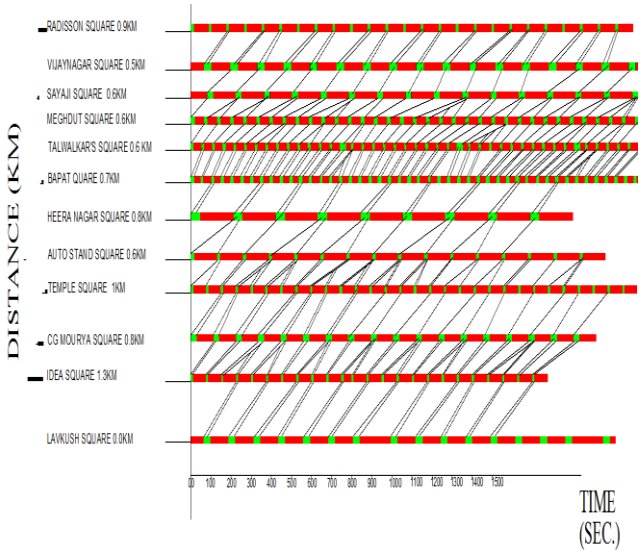


Figure 3: Time and Distance Diagram Radisson Square to Lavkush Square

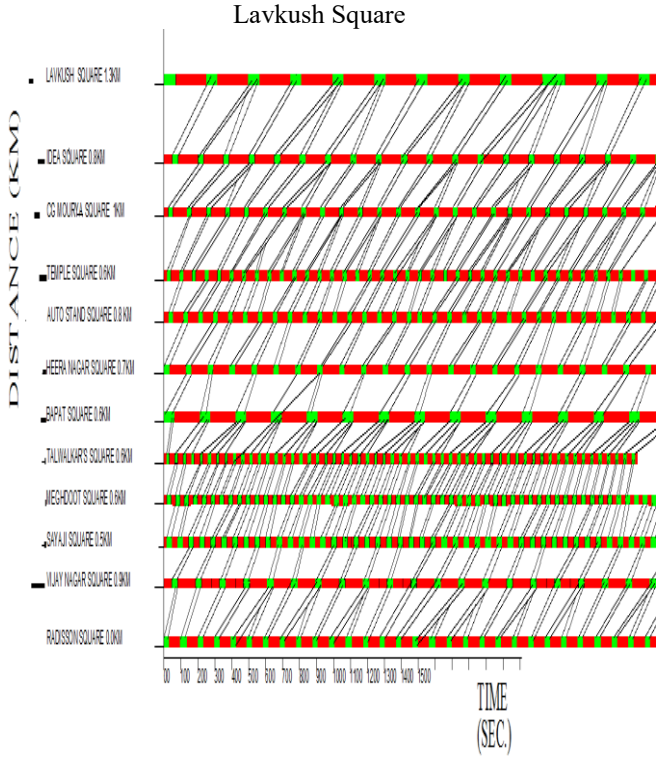


Figure 4: Time and Distance Diagram Lavkush Square to Radisson Square

Table 5: Results of Synchronization

	E to W Time Saving		W to E Time Saving	
	Before	After	Before	After
Journey time (sec)	910	644	962	685
Journey Speed (kmph)	33.23	46.94	31.43	44.14
Delay time (sec)	35	0	45	0
No of Passengers per hr	4217		4187	
Time Saving Sec/hr/pass	266		277	

Table 6: Benefits in terms of Money

Direction	*Raddisson to Lavkush(E-W)*	*Lavkush to Radisson(W-E)*	*Total*
Due to save time			
Time Saving in Rs.(Per Day)	63,332	65,482	1,28,814
Time Saving in Rs.(Per Annum)	2, 31, 16,334	2, 39, 01,021	4,70,17,355
Due to Low Running Speed			
Loss of fuel in Rs.(Per Day)	81,126	76,122	1,57,248
Loss of fuel in Rs.(Per Annum)	2, 96, 10, 990	2, 47, 84,530	5,43,95,520
Due to Delay			
Loss of fuel in Rs.(Per Day)	2,416	3,082	5,498
Loss of fuel in Rs.(Per Annum)	8, 82,088	11, 25,209	20,07,297
Total Rs.(Per Day)	1,46,874	1,44,686	2,91,560
Total Rs.(Per Annum)	5,36,09,412	4,98,10,760	10,34,20,172

5.4 Carbon Dioxide (CO_2) Emission

Now a day"s Global Warming is a very big problem in front of us. One of the important causes of the Global Warming is Emission of CO_2.After applying Synchronization fuel save up to 390 kl Petrol and 517 kl Diesel per Annum, so emission of CO_2 may be reduced by 2.29 Million Kg per Annum.The estimation of CO_2 is done by using following data:

Table 7: CO_2 Emission per Litre of Fuel[12]

Fuel (Per Litre)	CO_2 Emission(Kg)
Petrol	2.3
Diesel	2.7

6. Conclusions

Based on analysis of data collected from MR-10 Road, following conclusions have been drawn after Synchronization

1) Signal design & synchronization have been done for 12 intersections of MR-10 Road to minimize delay which will also increase the traffic Capacity of MR-10 Road.
2) Journey time 266 seconds is reduced from Raddisson Square to Lavkush Square. & Journey time 225 seconds is reduced from Lavkush Square to Raddisson Square.
3) Journey speed increases from 33.23 kmph to 46.94 kmph i.e. 13.71 kmph increase from Raddisson Square to Lavkush Square & Journey speed increases from 31.43 kmph to 44.14 kmph i.e. 12.71 kmph increase from Lavkush Square to Raddisson Square.
4) 390 kl petrol and 517 kl diesel per annum have been saved & loss occurred of Rs.2.00 million/annum, 54.15 million/annum and 47.01 million/annum due to vehicle delay, low running speed of vehicle and loss of people"s time respectively. CO_2 emission is estimated to reduce by 2.29 Million Kg. per Annum.

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References

[1] Arash M. Roshandeh; Herbert S. Levinson; Zongzhi Li et al "New Methodology for Intersection Signal Timing Optimization to Simultaneously Minimize Vehicle and Pedestrian Delays." ASCE vol.140, No. 5 (2014).
[2] Said M. Easa; and Jianchuan Cheng. "Reliability Analysis of Minimum Pedestrian Green Interval for Traffic Signals." ASCE vol.139, No. 5 (2013)
[3] Ilsoo Yun; and Byungkyu (Brian) Park et al "Stochastic Optimization for Coordinated Actuated Traffic Signal Systems. "ASCE vol.138, No.7 (2012).
[4] H.S.Goliya and Nitin Kumar Jain "Synchronization of Traffic Signals-A Case Study –Eastern Ring Road, Indore". IJATCE vol.1, Issue-2, Pg. No.47-52(2012).
[5] Liang-Tay Lin; Li-Wei Chris Tung and Hsin-Chuan "Synchronized Signal Control Model for Maximizing Progression along an Arterial."ASCE vol. 136: Pg.No.727-735 (2010).
[6] Roberto Leal Pimentel; Moacir Carlos Araújo; Halane Maria Braga Fernandes Brito "Synchronization among Pedestrians in Footbridges due to Crowd Density." ASCE vol. 18, No. 9(2002).
[7] Paul P.-Jovanis and John A. Gregor "Optimization of signal timing."IEEE VOL. 47 No.6 (2000).
[8] Anuj Sharma; Lelitha Vanajakshi; V. Girish et al. "Impact of Signal Timing Information on Safety and Efficiency of Signalized Intersections." ASCE vol. 138:467-478. (1997)
[9] Advance Estimates of National Income (2014-15), Central Statistics Office (CSO), Ministry of Statistics and Programme Implementation. (MOSPI)
[10] Dr.L.R. KADIYALI "TRAFFIC ENGG. AND TRANSPORT PLANNING" KHANNA PUBLISHERS.
[11] WWW.GOOGLE.COM (Google maps).(01/01/2015)
[12] WWW.NEPTEL.COM (01/01/2015)
[13] WWW.GOOGLE.COM (04/04/2015)

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