FEASIBILITY STUDY OF ALTERNATIVE FOR RIGHT TURNING MOVEMENT AT INTERSECTION OF URBAN AREA

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ABSTRACT: *This study evaluates "Indirect right turn treatment" to reduce conflicts and congestion at signalized intersection in urban areas. Traffic agencies and transport planners in Ahmedabad have focused on mitigating congestions through demand managements, and other conventional traffic management measures. From the view point of efficiency and safety, unconventional intersection might be one of the alternatives to be considered for solving traffic problems. The design concept leads to increase safety by reducing conflict points at a major crossing point and operating like a pair of one-way streets which signals independently control from the both directions. In this study delay is measured on selected intersection by field measuring. Various delay models are calculated and evaluate LOS for each approach. Most feasible delay model should be suggested for particular intersection. From the results of LOS by different delay models it increases LOS by implementing the indirect right turn on the intersection which also increases capacity of intersection.*

Keywords*: Indirect Right turn, U-median, U-turn followed by left turn, LOS, Signalized Intersection*

1. Introduction

Urban streets in India convey distinctive sorts of vehicles like fast autos, low speed cycles, cycle rickshaws and creature drawn trucks. This will prompt complex association between the vehicles and investigation of such activity conduct needs extraordinary consideration. The movement employing on streets in western nations is of attributes of various vehicles with peripheral variety as opposed to expansive minor departure from Indian streets. This will bring about expanded collaborations between vehicles; then they tend to move in bunches as opposed to consistently. Further a few wheelers, for example, bikes, cycles, and cycle rickshaws add to this as a result of their simple mobility.

A crossing point is a hub, and more often than not it is a piece of movement stream in expressway system. Limit of crossing point influences the aggregate limit of interstate system because of a wide range of turning developments. For activities of clashing, blending and separating brought on by movement stream, the movement attributes of convergence are more intricate than those of street mid square segment. Activity stream in creating nations includes diverse sorts of mechanized and non-mechanized vehicles prompts blended movement conditions and path evolving designs.

1.1 Need of Study

At an intersection, the turning activity incorporates left-turners and right-turners. Left-turning activity does not generally impede movement streams. Left-turning movement does not ordinarily deter activity moves through the intersections, but rather right-turning movement can bring about genuine loss of limit. Now and again, right-turning movement can bolt the stream and convey the whole stream to a stop. One method for managing overwhelming right-turning activity is to fuse a different right-turning stage in the sign plan, or to present an early cut-off or poor start course of action. These plans have their impediments and result in a long flag cycle. Another arrangement is to give exchange for the turning development by and large.

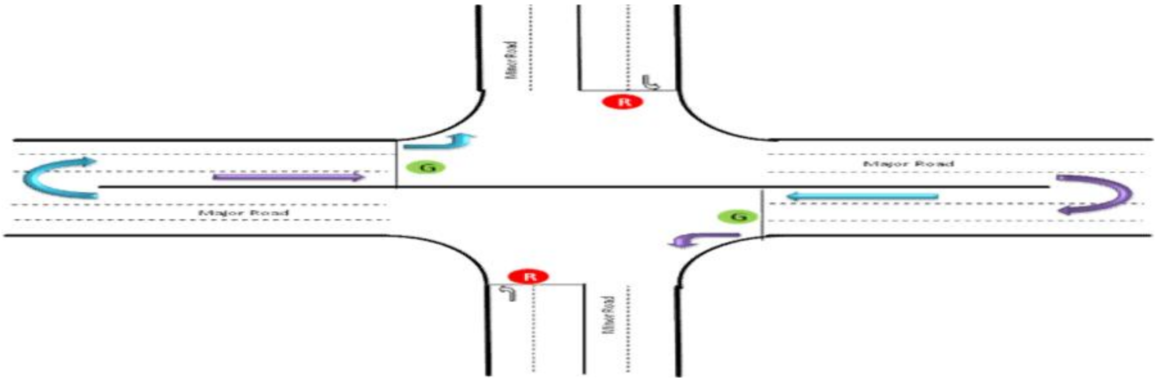
1.2 Objectives of study

Following are the objectives of the present study: -

1. To study the different traffic parameters for the delay at intersection.
2. To identify the traffic conflicts in major & minor streams in intersection of the study area.
3. To study about the volume of different characterized vehicles as per movement wise.
4. To suggest suitable delay model for alternative improvement for right turners at intersection.

2. Study of U-Turn followed by Left Turn

A UTLT scheme is an at-grade intersection design which replaces each right turn with a U-turn and a left turn. The design was given the name due to its frequent use along roads and highways in the U.S. state of Michigan since the late 1960. In other contexts, the intersection is called a median U-turn crossover or Michigan left. When traffic clears they complete the U-turn and go back through the intersection. Additionally, the U-turn lane is designed for one-way traffic. Similarly, traffic on the divided highway cannot turn left at an intersection with a cross street. Instead, drivers are instructed to "overshoot" the intersection, go through the U-turn lane, come back to the intersection from the opposite direction, and turn left.



It has been appeared to upgrade wellbeing to people on foot crossing either road at a convergence including the outline, since they just experience through activity and vehicles making right turns. The left-turning development, having been dispensed with, evacuates one wellspring of potential vehicle-passerby struggle. One minor burden of the Michigan left is the additional separation required for the driver to drive. Infrequently the separation to the turnaround is as far away as 1⁄4 mile (400 m) past the convergence. This outline prompts every driver driving an extra 1⁄2 mile (800 m) to make a left turn.

3. Review of Literature

Movement clog at the signalized crossing points in urban territories and procedures to lessen it, is a premier exploration theme in the field of transportation designing. The financing for enhancing transportation frameworks is lessening reliably as a result of worldwide monetary emergency; in this manner transportation architects are searching for minimal effort medications to decrease clog from urban regions.

A study by Xu (2001) inspected unsignalized crossing points on partitioned expressways where a minor road got to the thruway at middle openings. The creator measured the crash lessening because of the end of direct left turns from the minor boulevards by constraining drivers to turn right and make a U-turn. The study results demonstrated that executing this treatment diminished the aggregate accident rate by 26% and the damage/casualty crash rate by 32% for six-path arterials. Concurring the creator u-turns at signalized convergences on major arterials debase level of administration and may bring about genuine clashes with right-turning vehicles. Government Highway Administration (FHWA) distributed the data guide for signalized convergences (2004). The rules are offered identified with the middle openings and giving u-swings to take out left turns. As per this aide, middle u-turns might be given on both the major and minor streets at a convergence.

Reid et.al (1999) contrasted the middle u-turn hybrids and Two-Way Left-Turn Lanes (TWLTL) utilizing minuscule reproduction model. The aftereffects of the study demonstrated that amid top hours travel times lessens by 17 percent and normal rate expanded by 25 percent for middle u-turns. Comparative patterns were found for non crest hours. FHWA (2005) analyzed the security and operational advantages of middle u-turn as crossing point medicines. It was found that diminishment in sign stages build the limit and enhance the level of administration. So also, there was 20 to 50 percent decrease in accidents.

Subsequently, number of studies was done to assess the middle u-turn hybrids. All the studies contrast the middle u-turn hybrids and the signalized or unsignalized crossing points working with diminished number of contentions and confined turning developments. The treatment assessed in this paper is not the same as the past studies as in this treatment the signalized convergence is totally shut and all the turning development are compelled to utilize middle u-turns paying little respect to minor or real street developments. This treatment is known as "Indirect Right Turn". The points of interest and arrangement of this treatment are given in the accompanying area.

4. Study Area

Particular signalized intersection located in fast developing city located in Ahmedabad, India was chosen for the present study. It is four legged isolated type, provided with pre timed signal control operating in four phases with permitted left turns. These study intersection was in such a way that they have fair geometry (level gradient on all the approaches) and there is least interference to traffic by pedestrians, bus stops and parked vehicles etc. Average driving behaviour was assumed and the condition of vehicles was assumed to be moderate. The traffic is highly heterogeneous in nature with poor observance of lane discipline. The composition of traffic consists of a large proportion of motorized two wheelers, a small percentage of auto rickshaws, cars and very smaller proportion of heavy vehicles.

4.1 Site Selection Criteria: Intersection consists major and minor road intersecting on arterial road of Ahmadabad city. At this intersection highly hourly traffic flow causes traffic congestion and traffic congestion causes delay.

Following criteria were applied during site selection:

1) The selected approach provides a protected right-turn phase and an exclusive right-turn lane for right turn movement. The impact of right-turn lanes and permitted right-turn phase was not considered in this study.
2) The selected sites have large right-turn traffic demand. The average queue length for right-turning vehicles at selected sites should be greater than five vehicles per cycle.
3) Lane widths are at least 3.5 m.
4) There are few pedestrian or cyclists.
5) There is no roadside parking adjacent to a travel lane within 100 m of the stop bar.
6) The approach grade is level.

The intersection is not located in a central business district.

Fig. 1 Arial view of study area

4.2 Data Collection and Reduction

Movement review was completed at the study crossing points. As a major aspect of this, turning development study was directed by photographic technique on run of the mill week days in the wake of posting adequate number of activity enumerators to get the grouped vehicle tally of left turning, straight going and right turning developments and to land at the morning and night top hours. Later information were gathered for the distinguished crest hours utilizing video recording procedure. The camcorder was set at an appropriate vantage indicate close to the crossing point record an unhampered perspective of all methodologies and turning developments. The video tapes were later changed over to VCD and played on extensive screen a few times to concentrate characterized volume of activity, immersion stream, normal control delay per vehicle etc.

5. Data collection and Analysis

Data collection of both scheme Direct Right Turn (DRT) and U-Turn followed by Left Turn (UTLT) at selected signalized intersection on S.G. highway of Ahmedabad was collected. Cross sectional analysis was conducted to compare traffic data collected from four approaches during DRT and UTLT.

5.1Classified volume count data

Table 1: Classified volumes as per turning movement during DRT scenario

Approach	Left Turning					Straight					Right Turning				
	T/W	Auto	Car	B/T	LCV	T/W	Auto	Car	B/T	LCV	T/W	Auto	Car	B/T	LCV
Thaltej	223	36	231	4	9	975	208	975	66	94	148	18	210	9	8
Ringroad	115	25	208	11	10	397	76	365	15	13	190	24	162	7	10
Iscon	123	39	142	6	9	1028	270	1046	53	106	330	53	409	7	16
Vastrapur	131	32	150	6	12	380	59	366	5	16	211	19	164	2	10

Table 2: Classified volumes as per turning movement during UTLT scenario

Approach	Left Turning					Straight				
	T/W	Auto	Car	B/T	LCV	T/W	Auto	Car	B/T	LCV
Thaltej	301	49	358	6	15	1225	416	1423	102	142
Ringroad	346	49	414	17	29	687	118	607	12	22
Vastrapur	218	53	185	8	15	735	128	801	8	21
Iscon	198	53	327	11	15	1573	371	1475	54	153

6. Delay Analysis

- Webster (1958) developed a model for estimating the delay incurred by motorists at under saturated signalized intersections that became the basis for all subsequent delay models. The model developed is presented in Equation given as below,

$$d = \frac{c(1-\lambda)^2}{2(1-\lambda x)} + \frac{x^2}{2q(1-x)} - 0.65\left(\frac{c}{q^2}\right)^{\frac{1}{3}} x^{(2+5\lambda)}$$

Where:
d = average overall delay per vehicle (seconds),
X= v/c ratio,
λ = proportion of the cycle that is effective green (*g/C*),
C = cycle length (seconds),
q = arrival rate (vehicles/hour),
c = capacity for lane group (vehicles/hour),
g = effective green time (seconds).

- Akcelik proposed a delay model and is used in the Australian Road Research Board's signalized intersection. In his delay model, overflow component is given by,

$$OD = \frac{cT}{4}\left[(x-1) + \sqrt{(x-1)^2 + \frac{12(x-x0)}{cT}}\right]$$

where X ≥X0, and if X≤X0 then overflow delay is zero, and

$$xo = 0.67 + \frac{sg}{600}$$

where, T is the analysis period, h, X is the v/c ratio, c is the capacity, veh/hour, s is the saturation flow rate, veh/sg (vehicles per second of green) and g is the effective green time, sec.

- The delay model incorporated into the HCM 2000 includes the uniform delay model, a version of Akcelik's overflow delay model, and a term covering delay from an existing or residual queue at the beginning of the analysis period. The delay is given as,

$$d = d1 \times PF + d2 + d3$$

$$d1 = \frac{0.5 \times c\left(1-\frac{g}{c}\right)^2}{1-\left[\min(1,x) \times \frac{g}{c}\right]}$$

$$d2 = 900T\left[(x-1) + \sqrt{(x-1)^2 + \frac{8klx}{cT}}\right]$$

d = control delay, s/veh,
d1 = uniform delay component, s/veh,

PF = progression adjustment factor,
d2 = overflow delay component, s/veh,
d3 = delay due to pre-existing queue, s/veh,
T = analysis period, h,
k = incremental delay factor for actuated controller settings; 0.50 for all pre-timed controllers,
l = upstream filtering/metering adjustment factor; 1.0 for all individual intersection analyses,
P = proportion of vehicles arriving during the green interval and
fp = supplemental adjustment factor for platoon arriving during the green

Table 3 Comparison of delays with DRT & UTLT at all approaches

Approach	Webster model		Akcelil model		HCM model	
	DRT	UTLT	DRT	UTLT	DRT	UTLT
Thaltej	88	21	96	27	100	17
Ringroad	98	31	102	36	93	30
Iscon	86	21	90	26	94	16
Vastrapur	96	30	99	37	87	31

7. Analysis of LOS

Table 4 Comparison of LOS by Webster model

Approach	DRT		UTLT	
	Delay(sec)	LOS	Delay(sec)	LOS
Thaltej	88	F	21	C
Ringroad	98	F	31	C
Iscon	86	F	21	C
Vastrapur	96	F	30	C

Table 5 Comparison of LOS by Akcelik model

Approach	DRT		UTLT	
	Delay(sec)	LOS	Delay(sec)	LOS
Thaltej	96	F	27	C
Ringroad	102	F	36	D
Iscon	90	F	26	C
Vastrapur	99	F	37	D

Table 6 Comparison of LOS by HCM model

Approach	DRT		UTLT	
	Delay(sec)	LOS	Delay(sec)	LOS
Thaltej	100	F	17	B
Ringroad	93	F	30	C
Iscon	94	F	16	B
Vastrapur	87	F	31	C

8. Discussion and Conclusions

1. From data analysis of both schemes on four approaches of Pakwan intersection found that LTUT scheme which prohibits direct right turn from approaches increases number of PCU then traditional four leg signalize intersection which allows direct right turn of vehicles from intersection. From Thaltej Intersection 42% increases number of vehicles during LTUT scheme, same as at Ring road approach, Vastrapur approach, and Iscon approach number of PCU increases 36%, 40%, 25% respectively.
2. Study of LOS found out that during DRT scenario Level of Service was Level F at all approaches which increases to Level C at Thaltej, Iscon, and Vastrapur approaches and Level D at Ring road approach after implementing LTUT scheme.
3. Delay calculation by Webster model gives Level F during DRT scenario which increases to Level C at all approaches. Calculation of differences in delay between DRT and UTLT it concluded that average of 66 sec is saving under UTLT scheme.
4. In the case of Akcelik model LOS is increased to Level C at Thaltej and Iscon approach while Level D at Ringroad and vatrapur approach. Calculation of differences between delays of DRT and UTLT, it concluded that average of 65 sec saving in UTLT scenario.

5. Calculation by HCM model it gives better LOS than both Webster and Akcelik model. It shows increase in LOS up to Level B at Thaltej and Iscon approach while Level C at Ring road and vastrapur approaches. Difference calculation of delay between DRT and UTLT it gives average of 70 sec savings at all approaches.
6. By delay calculation and study of LOS and capacity of vehicle approach with different delay models results that UTLT scenario is increase LOS and gives higher savings in seconds of delay at all approaches. It is concluded that UTLT scenario is more feasible as compared to conventional DRT intersection.

9. Scope of Future Work

This study is only limited to evaluation of delay, capacity and Level of Service for selected intersection. This intersection is upgraded with alternative scenario for right turners at each approach. As a future scope of this study more suitable alternative is adopted and evaluated for different parameters. Further related more study is evaluation of accident under different alternative scenario and study for higher safety at intersection. Study of environmental effects like pollution under different situation compared with adopted alternative scheme and conventional intersections.

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