Evaluation of Movement Priority at Unsignized Intersection

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Abstract: ***The main purposed of this study was to analysis the performance of un - signalized intersection based on gap acceptance study. Un - signalized intersection plays an important role in determining the capacity of road network especially in urban and suburban areas. A poorly operating un - signalized intersection may affect a signalized network or operation of an Intelligent Transport System. The T - junction for this study was controls by stop rule or in other names is two - way stop controlled intersection (TWSC). For a TWSC intersection, the stop controlled approaches are referred to as the minor road approaches. The most important parameters affecting the capacity and performance of un - signalized intersection are the critical gap. Basically, critical gap are establish by Highway Capacity Manual. Therefore, the critical gap is difference between each intersection based on the geometry of the road, numbers of lane, and surrounding area located near the intersection. Critical gap can not be determined directly from field but data of accepted and rejected gaps can be collected and analyzed. Data of gaps were collected using video camera and several equipment's. Raffs method was used in determination of critical gap. In this study, critical gap was divided into three sections which is RT from major road, RT and LT from minor road. The values of critical gap vary from 2 seconds to 7 seconds. Critical gap value that was established by HCM and from field observation was input in Sidra software to analyze the performance of the intersection. Based on analysis of output produced from Sidra software, there is found output were obtained from field observation is more closed with the actual field condition. Therefore, the performance at a TWSC intersection can be determined from this analysis in terms of queue and level of services. This study can be continued in the future in order to improve the value of input parameters and also develop the analysis procedure for four leg intersection and roundabout not only for urban and suburban areas, but also for rural area.***

Keywords: Critical Gap, Sidra software priority

1. Introduction

The rapid development of Bangalore increases the cost of living of the citizen especially in urban area. Transportation is also affected by the development and show the annual increase in the number of vehicle. Because of the increasing of vehicle, road congestion and accidents is occurred especially during peak hour. Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. Intersection plays an important role in the road network, where traffic flows in different direction converge. There is various type of intersection such as at - grade intersection, signalized intersection, un - signalized intersection and roundabout. However, the scope of study is only focused in analysis for the un - signalized intersection. Un - signalized intersection is a common type of intersection to control the movement of the traffic especially in urban area. A poorly operating un - signalized intersection may affect a signalized network or operation of an Intelligent Transport System. Concerning vehicle movement in intersections, there will be a number of conflicts, which influence traffic safety. The most common way to resolve such conflicts is by introducing priority controls such as give way or stop rule at the un - signalized intersection. The rules are implemented at T - intersection or 4 - way junction. In Bangalore majority of the un - signalized intersections is of the T - intersection. Most of the 4way un - signalized intersections are either converted to signalized intersection There are many problem are appeared at the intersection such as congestion, queues, delay and also accident. The evaluation of capacity at un - signalized intersection is practically measured using the gap acceptance approach and used for un - signalized intersection procedure. In this study, the gap acceptance approach was used for un - signalized intersection procedure. The critical gap is a major parameters need to be considered to analysis the un - signalized intersection. In Bangalore, the critical gap for an un - signalized intersection is proposed by Highway Capacity Manual. Therefore, the critical gap is difference between each intersection based on the geometry of the road, numbers of lane, and surrounding area located near the intersection. The efficiency of the performance at un - signalized intersection is become worst if the problem such as delay, queue is always occurred.

2. Problem Statement

This study was conducted to analyze and evaluate the performance of un signalized intersection based on gap acceptance studies. Bangalore is one of the urban areas because the population in the area is above 1000 persons. Study location of' the intersections is located at. Dhodabalapura road which is a major road and Vidyanarayanapura is a minor road of the intcrscction. The un - signalized intersection u as identified as two - way stop controlled un - signalized intersection (TWSC) where the traffic how was controlled by stop rule. For a TWSC intersection, the stop controlled approaches are referred to as the minor road approaches. Two - way stop control requires the vehicle drivers on the minor streets should see that the conflicts are avoided.

The identified TWSC intersection was located at commercial area, industrial area, and education area such as yelahanka Bangalore. This is shown in Figure 1.1. These frontages activities in combination lead to busy traffic flow

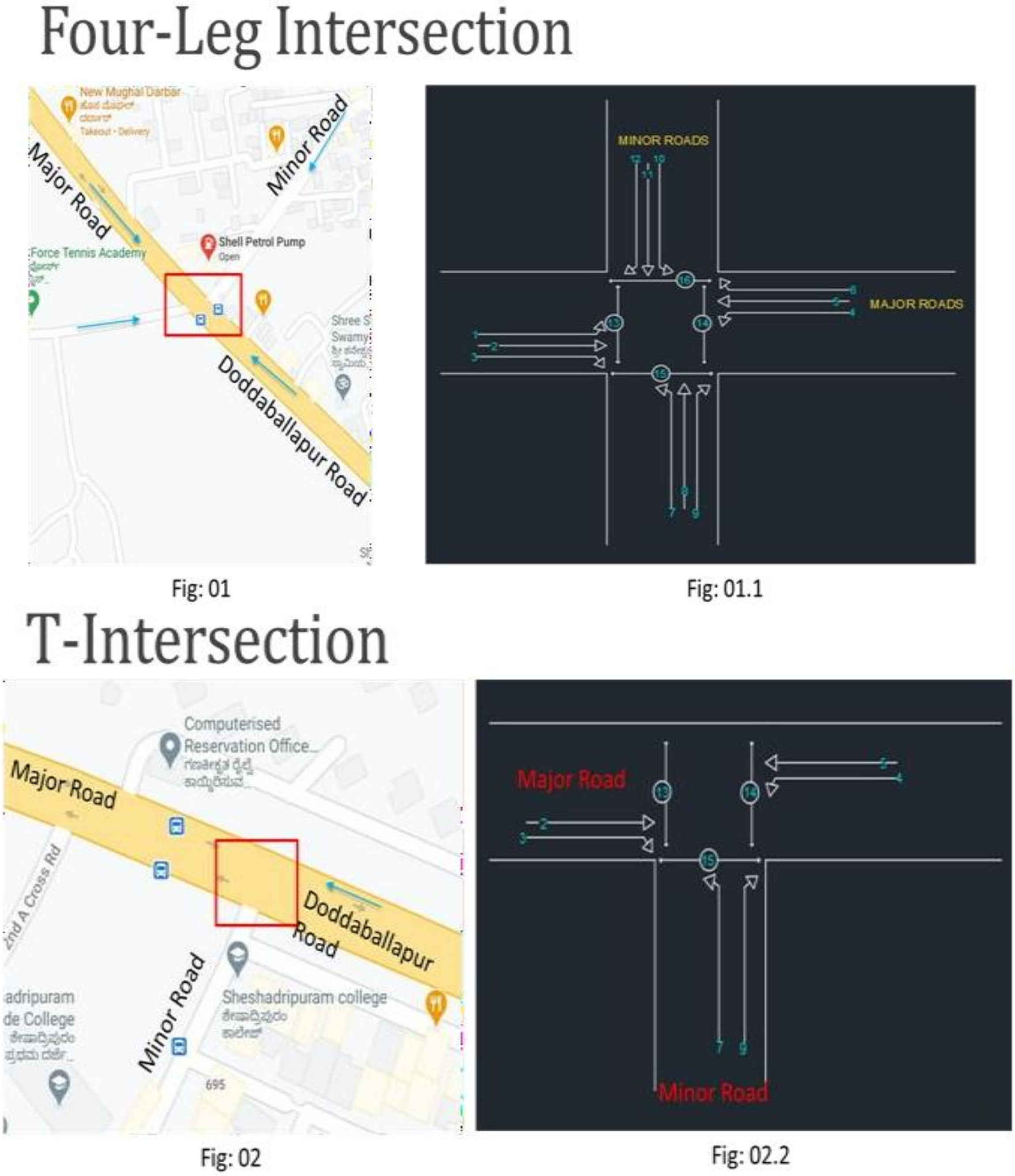


Figure 1: Study Area

3. Data Collection

- I have selected Four - Leg Intersection, T - Intersection.
- Video graphic survey was carried out for data collection. Video recording was done during peak hours (10: 00 am–12: 00 noon). The video camera was so placed that all movements of the vehicles could be recorded. The available modes at those intersections were two - wheelers, auto rickshaws, and four - wheelers. Cycle - rickshaws and heavy vehicles were rarely observed at the minor approaches of those intersections.
- Data will be collected in video survey and used to calculate all the vehicle movements in major street to minor street.
- I have calculated each vehicle movement in 1 minute intervals.
- TWSC intersection if the single minor street approach is controlled by a stop sign. Three - leg intersections
- Video graphic survey was carried out for data collection. Video recording was done during peak hours (10: 00 am–12: 00 noon). The video camera was so placed that all movements of the vehicles could be recorded. The available modes at those intersections were two - wheelers, auto rickshaws, and four - wheelers. Cycle - rickshaws and heavy vehicles were rarely observed at the minor approaches of those intersections.

Table 1: Traffic Volume collection

Time	00: 05	2W	4	3W	4	CARS		BUS	TRUCKS
	00: 05		4						
	00: 05		4						
	00: 08		4						
	00: 08		4						
	00: 14		3						
	00: 14		3						
	00: 19		5		5				
	00: 19		5						
	00: 19		5						
	00: 19		5						
	00: 36		6		9		8		
	00: 36		6						
	00: 36		6						
	00: 36		6						
	00: 36		7						
	00: 46		6		7				
	00: 46		6						
	00: 46		7						
	00: 46		7						
	00: 58		5				6		
	00: 58		5						
	01: 05		5						
	01: 05		5						
	01: 05		5						
	01: 25		5						
	01: 25		5						
	01: 25		5						
	01: 25		5						
	01: 25		5						
	01: 32		4		4		5		
	01: 39				5				
	01: 46 02: 00		4				4		
	02: 05		5						
	02: 00		5						
	02: 55 03: 25				5		6		
	03: 31		3				4		
	03: 51						5		
	04: 01 04: 10		5						
	04: 18		4						
	04: 18		5						
	04: 29		4		5				
	04: 29		4						

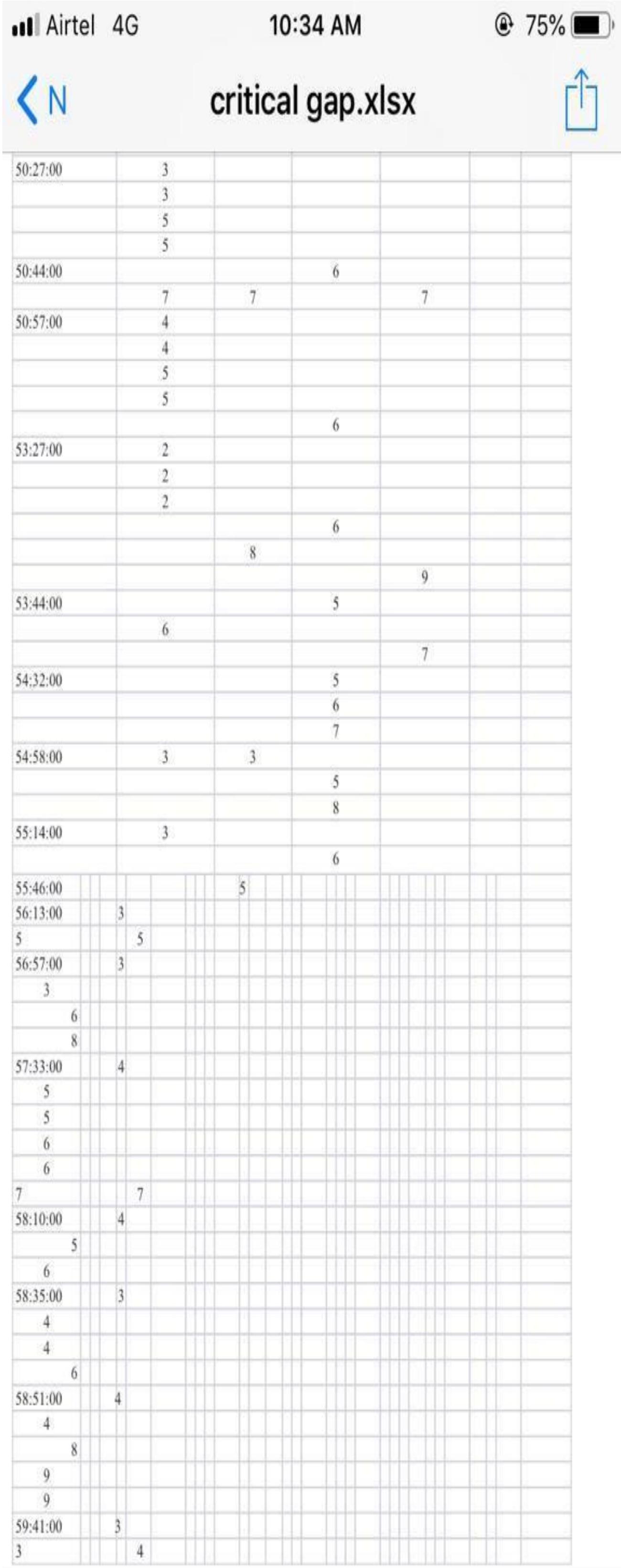


Figure 2: Data on Critical Gap analysis

3.1 Description about topic

Left Turn Lane Evaluation Process

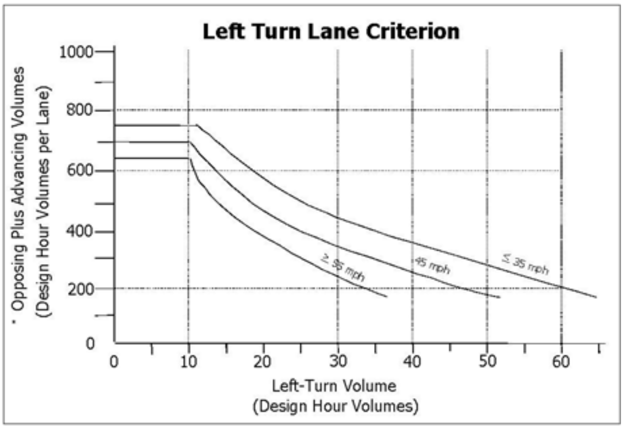
- A left turn lane should be installed, if criterion 1 (Volume) or 2 (Crash) or 3 (Special Cases) are met,

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

unless a subsequent evaluation eliminate it as an option; and
- The Region Traffic Engineer must approve all proposed left turn lanes on state highways, regardless of funding source; and
- Left turn lane complies with Access Management Spacing Standards; and
- Left turn lane conforms to applicable local, regional and state plans.

Vehicular Volume
The vehicular volume criterion is intended for application where the volume of intersecting traffic is the principal reason for considering installation of a left turn lane. The volume criterion is determined by the Texas Transportation Institute (TTI) curves in Exhibit 12 - 1.

The criterion is not met from zero to ten left turn vehicles per hour, but indicates that careful consideration be given to installing a left turn lane due to the increased potential for rear - end collisions in the through lanes. While the turn volumes are low, the adverse safety and operations impacts may require installation of a left turn. The final determination will be based on a field study



* (Advancing Volume/Number of Advancing through Lanes) + (Opposing Volume/Number of Opposing Through Lanes) Opposing left turns are not counted as opposing volumes)

3.2 Crash Experience

The crash experience criterion is satisfied when:
1) Adequate trial of other remedies with satisfactory observance and enforcement has failed to reduce the accident frequency; and
2) There is a history of crashes of the type susceptible to correction by a left turn lane (such as where a vehicle waiting to make a left turn from a through lane was struck from the rear); and
3) The safety benefits outweigh the associated improvement costs; and 4. The installation of the left turn lane does not adversely impact the operations of the roadway.

3.3 Special Cases

1) Railroad Crossings: If a railroad is parallel to the roadway and adversely affects left turns, a worst case scenario should be used in determining the storage requirements for the left turn lane design. The left turn lane storage length depends on the amount of time the roadway is closed, the expected number of vehicle arrivals and the location of the crossing or other obstruction. The analysis should consider all of the variables influencing the design of the left turn lane and may allow a design for conditions other than the worst case storage requirements, providing safety is not compromised.
2) Passing Lane: Special consideration must be given to installing a left turn lane for those locations where left turns may occur and other mitigation options are not acceptable.
3) Geometric/Safety Concerns: Consider sight distance, alignment, operating speeds, nearby access movements and other safety related concerns.
4) Non - Traversable Median: As required in the Median Policy, a left turn lane must be
5) installed for any break in a non - traversable median (OHP Action 3B.4).
6) Signalized Intersection: Consideration shall be given to installing left turn lanes at a signalized intersection. The State Traffic - Roadway Engineer shall review and approve all proposed left turn lanes at signalized intersection locations on the state highway system.
7) Other Conditions: Other surrounding conditions, such as a drawbridge, could adversely affect left turns and must be treated in a manner similar to that for railroad crossings.

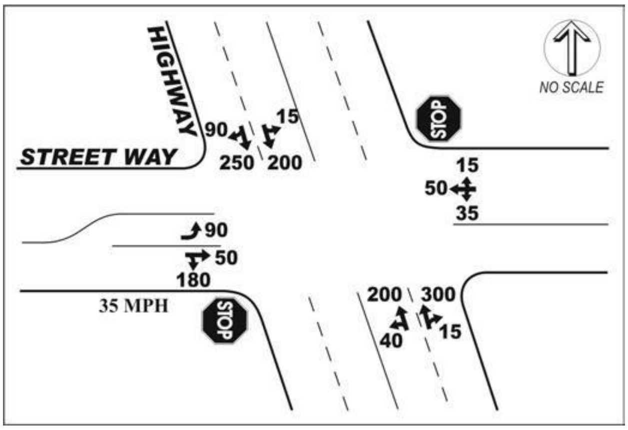
3.4 Evaluation Guidelines

1) The **evaluation** should indicate the installation of a left turn lane will improve the overall safety and/or operation of the intersection and the roadway. If these requirements are not met, the left turn lane should not be installed or, if already in place, not allowed to remain in operation.
2) **Alternatives Considered**: List all alternatives that were considered, including alternative locations. Briefly discuss alternatives to the left turn lane considered to diminish congestion/delays resulting in criteria being met.
3) **Access Management**: Address access management issues such as the long termaccess management strategy for the state roadway, spacing standards, other accesses that may be located nearby, breaks in barrier/curb, etc.
4) **Land Use Concerns**: Include how the proposed left turn lane addresses land use concerns and transportation plans.
5) **Plan**: Include a plan or diagram of proposed location of left turn lane.
6) **Operational Requirements**: Consider storage length requirements, deceleration distance, desired alignment distance, etc. For signalized intersections, installing a left turn lane must be consistent with the requirements in the Traffic Signal Guidelines.

3.5 Left Turn Lane Criterion

Left Turn Volume Criterion
Volume Criterion Example shown below shows an un - signalized intersection with a shared through - right lane and a shared through - left lane on the Highway. The peak hour

volumes and lane configurations are included in the figure. The 85th percentile speed is 45 mph and the intersection is located in a city with a population of 60, 000. Do the NB and SB left turn movements meet the volume criterion?



Volume Criterion Example

Southbound Left: The southbound advancing volume is 90 + 200 + 250 + 15 = 555, and the northbound opposing volume is 515 vehicles (the opposing left turns are not counted as opposing volumes). The volume for the y - axis on Exhibit 12 - 1 is determined using the equation:

y- axis volume = ((Advancing Volume/Number of Advancing Lanes) + (Opposing
Volume/Number of Opposing Lanes)) y - axis
= (555/2 + 515/2) = 535

To determine if the southbound left turn volume criterion is met, use the 45 mph curve in Exhibit 12 - 1, 535 for the y - axis and 15 left - turn for the x - axis. The volume criterion is not met in the southbound direction.

Northbound Left: The northbound advancing volume is 40 + 300 + 200 + 15 = 555, and the southbound opposing volume is 540 vehicles (the opposing left turns are not counted as opposing volumes). The volume for the y - axis on Exhibit 12 - 1 is (555/2+ 540/2) = 548. To determine if the northbound left turn volume criterion is met, use the 45 mph curve in Exhibit 12 - 1, 548 for the y - axis and 40 left - turns for the x - axis. The volume criterion is met in the northbound direction.

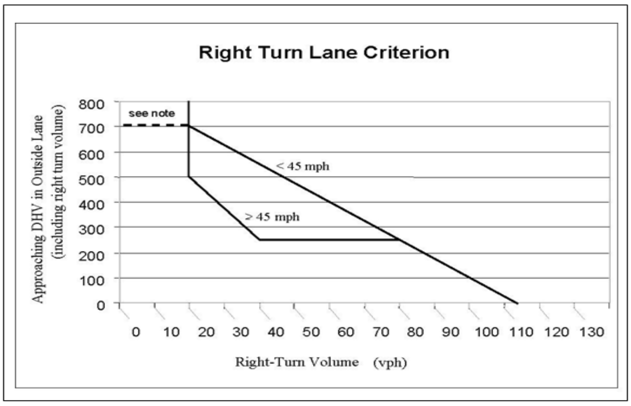
Right Turn Lane Criteria – Un - signalized Intersections

Right Turn Lane Evaluation Process

1) A right turn lane should be installed, if criterion 1 (Volume) or 2 (Crash) or 3 (Special Cases) are met, unless a subsequent evaluation eliminates it as an option; and
2) The Region Traffic Engineer must approve all proposed right turn lanes on state highways, regardless of funding source; and
3) The right turn lane complies with Access Management Spacing Standards; and
4) The right turn lane conforms to applicable local, regional and state plans.

Criterion 1: Vehicular Volume

The vehicular volume criterion is intended for application where the volume of intersecting traffic is the principal reason for considering installation of a right turn lane. The vehicular volume criterion is determined using the curve in Exhibit 12 - 2



Graph 1: Right turn lane criterion

Note: If there is no right turn lane, a shoulder needs to be provided. If this intersection is in a rural area and is a connection to a public street, a right turn lane is needed.

Crash Experience

The crash experience criterion is satisfied when:

1) Adequate trial of other remedies with satisfactory observance and enforcement has failed to reduce the accident frequency; and
2) A history of crashes of the type susceptible to correction by a right turn lane; and
3) The safety benefits outweigh the associated improvements costs; and
4) The installation of the right turn lane minimizes impacts to the safety of vehicles, bicycles or pedestrians along the roadway.

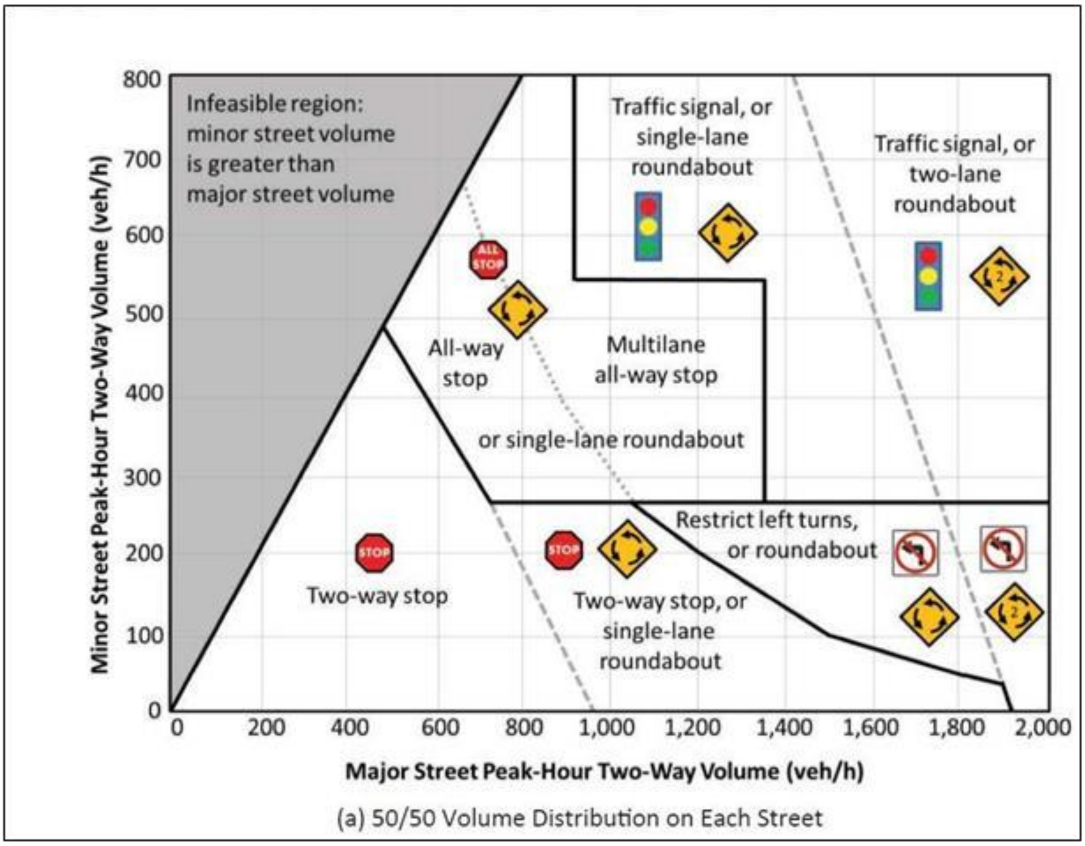


Figure 2: Planning Level Estimate of Traffic Control Needs - 50/50 Directional Volume Distribution

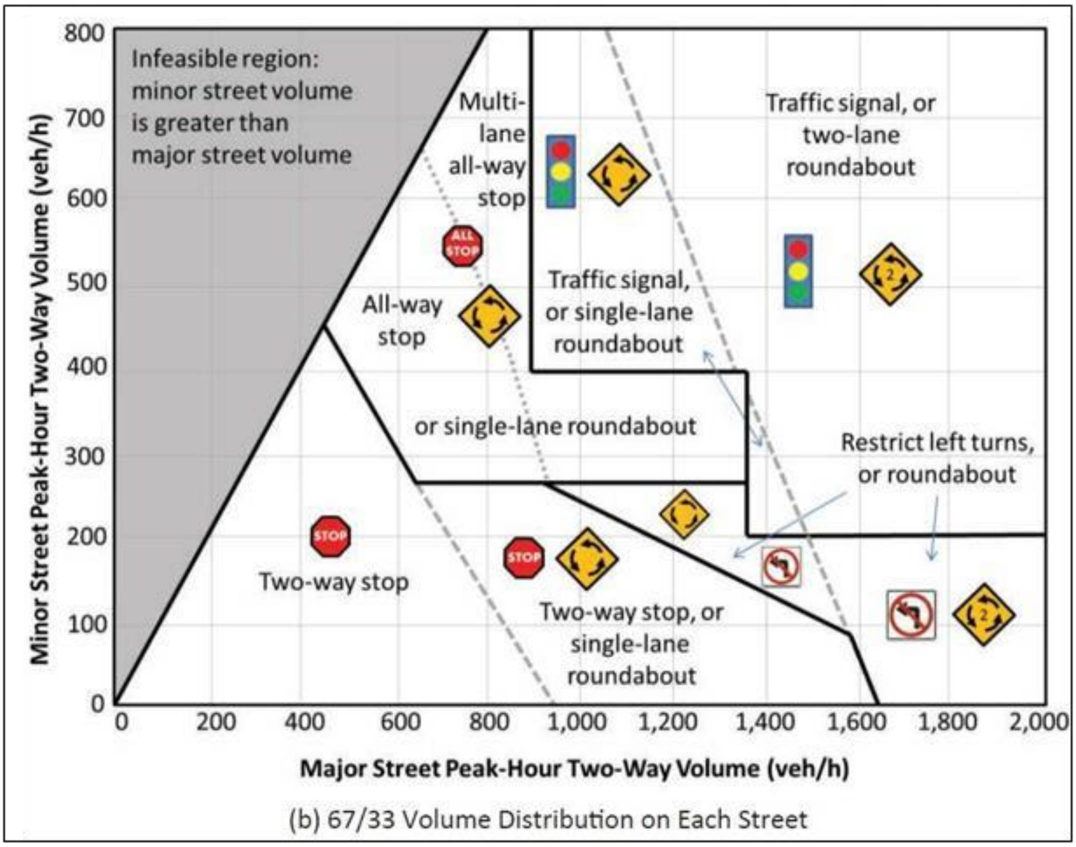


Figure 3: Planning Level Estimate of Traffic Control Needs - 67/33 Volume Distribution

Two - Way Stop Control

For two - way stop control, the HCM employs a procedure for analyzing un - signalized intersections that is primarily based on an established hierarchy of intersection movements (based on assigned ROW) and a gap acceptance model. The major components of the gap acceptance model include the critical gap and follow - up time; where the critical gap is the minimum time interval in the major street traffic stream that allows intersection entry for one minor street vehicle and the follow - up time is the time between the departure of one vehicle from the minor street and the departure of the next vehicle using the same major street gap under a condition of continuous queuing on the minor street. A simplified planning level analysis method is available in the PPEAG, including a simplified spreadsheet tool.

Substitution for the default values of critical gap and follow - up times used in the HCM shall only be permitted after conducting a thorough field investigation and obtaining ODOT approval.

At two - way stop intersections, the controlling movement (usually a minor street left turn) often controls the overall intersection performance. Therefore, the v/c ratio for that movement will typically be the one reported and evaluated against the adopted mobility standard. This is especially important to recognize when analyzing two - way stop - controlled intersections where the very low v/c ratios for the unimpeded, high - volume major street movements will overshadow the higher v/c ratios for the lower - volume minor street movements. In these situations the unimpeded v/c ratio is often very low, even though the minor street movements are near or over capacity. However, as there may be times when the mainline v/c ratio is near the mobility standard, it should always be acknowledged before deferring to minor street movements. For ODOT facilities, the mainline through movement v/c ratio should be reported, as programs generally only report out minor v/c and mainline left.

The analyst should also check for heavy traffic flows that may occur in the opposite direction of peak hour volumes. For example, a high volume right turn movement in the pm peak period can be an indicator of a paired high volume left turn movement in the am peak period.

Conclusion and Results

Based on gap acceptance theory, two new methods are proposed on the assumption of independence between arrival times of minor - stream vehicles and the ones of major - stream vehicles. New models are verified by simulation of headway data and comparison of various critical gap methods.

Both M3 definition method and revised Raff's method use total rejected coefficient. M3 definition method is simple and valid, which can conveniently be substituted into the equations of capacity and delay. Revised Raff's method has more universal application than Raff's method; the calculation value is accurate. Both methods have accordant results, whereas
Raff's method and Ashworth's method have larger fluctuation under different circumstance. Ashworth's method needs to satisfy a rigorous assumption condition. M3 definition method and revised Raff's method are worthy of recommendation.

Methodology of intersection Methodology of four leg intersection Result

- The exclusive line for turning movement is capable to reduce the delay vehicle stream.
- However it still depend on the vehicle speed and the traffic volume
- The promising outcome may expect comparison with the HCM 2000
- The conflict method is verified as capable to assist the gap acceptance approach withdraw calibration better results.

Figure 4: Non-HCM Compatible Intersection with Directions Adjusted for Analysis

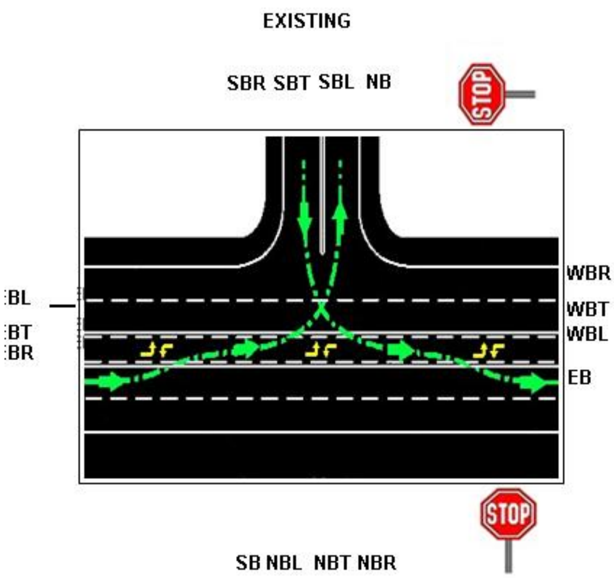


Figure 5: TWLTL 2- Stage

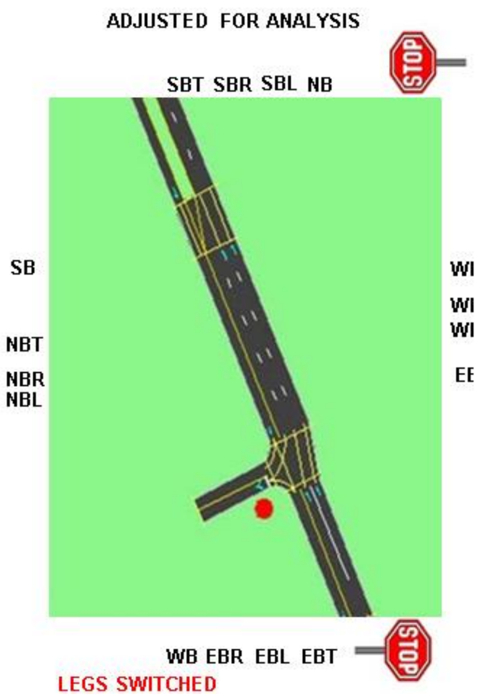


Figure 6: Synchro Median Acceleration Lane

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