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MODELLING CRITICAL GAPS FOR U-TURN VEHICLES AT MEDIAN OPENINGS UNDER INDIAN MIXED TRAFFIC CONDITIONS AT HYDERABAD CITY

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ABSTRACT

Recent years have seen an increase in the creation of non-navigable, un-signified middle openings in most of India's major urban centers. To eliminate concerns with illegal U-turns at crossing points and other activity offices in the middle openings on multi-path urban streets, this establishment was conceived in this manner. As a result, this investigation relies on six video-pictures of the middle openings of six U-turns on four and six-path streets in Hyderabad City (i.e. Uppal U-turn near Uppal metro station, Tarnaka U-turn near Railway Nilayam, Kukatpally U-turn near Y-junction, Dilsukhnagar U-turn near RS brothers shopping mall, Nagole U-turn near city bus stop). As a result of the "INAFOGA" technique, a new approach to assessing Gaps at middle openings is presented in this project, which is also compared to the basic Gap esteems obtained by and Macroscopic Probability Equilibrium idea for heterogeneous movement streams in the urban districts in India's urban districts. It has been used to do a combined specimen Hypothesis (t-test) between these two strategies, revealing that the basic Gap esteems obtained by "INAFOGA" are 18-31% higher than those achieved by the Probability Equilibrium strategy.. Radar plots, box-plots, t-measuring, two-followed importance esteem, and greater fundamental Gap esteems for a variety of modes of transportation (aside from Sport Utility Vehicles) support the "INAFOGA" technique's suitability in mixed movement settings.

I. INTRODUCTION

1.1 Contextual

On metropolitan roadways with uncontrolled middle openings and a mixed traffic pattern, the current study provides a system for clearly identifying the conflict zone between a turning vehicle and oncoming cars. Thirteen middle openings on six-path streets and eight middle openings on four-path streets in diverse Indian urban localities were used to collect information on vehicle turning developments. The dimensions of the vehicle and the width of the road have an effect on the basic position (direction of the external wheel) of a vehicle.

1.1.1. Gap Acceptance at Median Openings

Progressively, U-turns at middle are utilized as another option to guide left turns with a specific end goal to decrease clashes and enhance movement operations along blood vessel streets when the volumes on the two bearings are high. Contrasted and other turning developments at convergences (right/left turn), U-turn development at middle openings is exceedingly intricate and dangerous.

Vehicles doing a U-turn must hold up and then turn with unusual alertness because this maneuver is relatively challenging when traffic is flowing at a high speed (main road volume). The basic U-turn gap at middle openings is investigated using Raff's approach and the Log it demonstration in this study. In this investigation, the findings from both approaches were considered and displayed. Ten locations in Tampa, Florida, were selected for field data collection. A PC program created for the Gap acknowledgement contemplates guided the information gathering in the field. Results from this study showed that the basic gap of a U-turn at middle openings increased from 5.8 seconds to 7.4 seconds in relation to shifting geometric and movement conditions at these five locations. Drivers' behavior had a significant impact on the calculation of U-turn Gaps, as indicated by their delivery. Drivers affecting a U-behavior turn's were shown to be greatly affected by the distance between a signalized crossing and a U-turn site. Gap acknowledgment under multi-path conditions is the primary focus of this study (two, three, and four paths toward every path). U-turns at medians, which were not addressed in the Highway Capacity Manual, may benefit from this investigation's findings (HCM 2000).

1.1.2 Importance of “Critical Gap” in traffic flow

Crossing point crashes, particularly those that happen in rustic territories speak to a noteworthy extent of roadway fatalities. The Cooperative Intersection Collision Avoidance System – Stop Sign Assist (i.e., CICAS-SSA) was created with the point of diminishing the quantity of fatalities at rustic convergences. The CICAS-SSA was produced as a roadside-based framework, which helps drivers on a minor street to choose the proper Gap when crossing a rustic thruway. In this report we exhibit the examination which changes the Roadside-based CICAS-SSA to a framework in which the showcases introducing movement related data are situated inside a vehicle. To altogether look at the practicality of the in-vehicle CICAS-SSA, we directed three examinations, each of which investigated particular issues.

1.3 Objective and Organization of the Report

1.3.1 Research Objectives:

Despite the fact that the CICAS-SSA has been appeared to be exceedingly instinctive and simple to

in another language (Creaser et al., 2008) After then, understanding and employing the sign will be second nature. Developing confidence and trust in a framework may necessitate more than just a few loose connections.

?

The more confident a driver is, the more likely he or she is to rely on an emotional support system. Older adults, on the other hand, need more time to get used to a new technology before they can feel confident using it.

II. U-TURN MEDIAN OPENINGS, GAP ACCEPTANCE AND MIXED TRAFFIC CONCEPTS

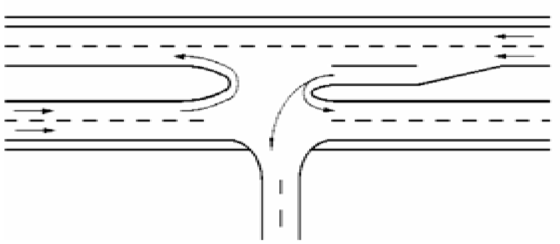
2.1 Introduction

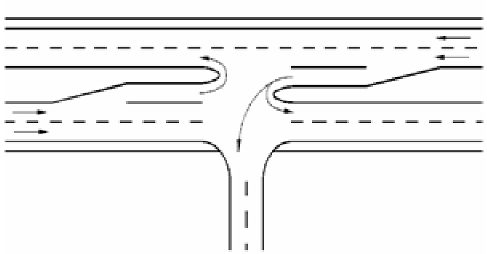
The completion of an investigation technique could be recognized in the transition of study from a lab environment to a verifiable situation. In transportation research, a driving test system is almost always present in the lab setting, as is the case with the investigations presented in this paper. Security considerations necessitate the employment of a test technique in which a driver is diverted, as was the case in Study One. However, it is equally important for scientists to have control over conditions and visual clutter, as was demonstrated in Study Two. A test system can significantly reduce the cost of interface development and ease of use testing.

Field Study topics are investigated by following the principle outlined below:

- Evaluation of the adequacy of the in-vehicle CICAS-SSA on rustic convergence crossing execution at a genuine crossing point
- Driving execution in the Control condition (i.e., no in-vehicle CICAS-SSA sign) was contrasted with the Treatment condition in which drivers were presented to the in vehicle CICAS-SSA.
- Examination of the Age-related impacts on the drivers' utilization of the framework and their driving execution.
- Driving execution of older drivers was contrasted with driving execution of their Younger partners.

2.2 **U-turn Median Openings**





Multilane parkways in many states and neighborhoods now have no-navigable medians installed as a measure to improve safety and travel times while also better monitoring neighboring access. While there are no navigable medians to restrict guide left-swing access to and from neighboring improvements, activities destined for these areas must use alternative routes, some of which may include making U-turns at close-by middle openings-a development commonly referred to as an aberrant left turn.Gap Acceptance and Critical Gap

2.3.1 The concept of Gap acceptance

Gap acceptance is one of the most important components in microscopic traffic characteristic. The gap acceptance theory commonly used in the analysis of uncontrolled intersections based on the concept of defining the extent drivers will be able to utilize a gap of particular size or duration.

Fig: 1.Gap in between the vehicles Basic Terminologies

Gap means the time and space that a subject vehicle needs to merge adequately safely between two vehicles. Gap acceptance is the minimum gap required to finish lane changing safely. Therefore, a

gap acceptance model can help describe how a driver judges whether to accept or not.

Gap acceptance: The process by which a minor stream vehicle accepts an available gap to maneuver. Critical gap: The minimum major-stream headway during which a minor-street vehicle can make a maneuver.

Lag: Time interval between the arrival of a yielding vehicle and the passage of the next priority stream vehicle (Forward waiting time).

Headway: The time interval between the arrivals of two successive vehicles. Headway differs from gap because it is measured from the front bumper of the front vehicle to the front bumper of the next vehicle. Minimum Headway: The minimum gap maintained by a vehicle in the major traffic stream.

III. **REVIEW OF LITERATURES**

3.1 Introduction

The "Gap acknowledgement" topic has generated a great deal of study over the past two decades, however most of it has focused on homogeneous activity streams. Since 1947, a few strategies or models have been used in literary works to estimate the "basic Gap" as accurately as possible. In this regard, works that are clearly articulated about the movement Gap acknowledgement of wonder are rich.

Gaps are **GAMMA DISTRIBUTED.**

IV. A technique devised by Hewitt (1983) measures the possibility of the fundamental Gaps of cars approaching a main street at a need junction who have expelled the underlying latitude granted to them based on the driver's perceptions of the shrinking size of the Gaps. It was then claimed that the unique possibility of absorption of basic Gap by all drivers, including those who acknowledge the underlying slack, may be determined from the example frame for any differential between conveyances of basic slack and Gaps. In 1985, Hewitt re-described his strategy in great detail. Harder had previously presented a system similar to Hewitt's that had become widely recognized in Germany by 1968.

V. METHODOLOGY AND TOOLS

4.1 Estimation of Critical Gaps

It's possible to define the critical gap tc as the least amount of time required between vehicles in the through traffic stream for a U-turning vehicle to perform a merging operation. Depending on the style of driver (some go excessively fast or unsafe, while others go slowly or cautiously), the crucial gap values can vary widely.

4.1.1 Traffic, movement, and the geometry of the median openings are all factors to consider. The essential gaps are considered random variables because of this diversity in the gap acceptance procedure. An attempt is made in the estimation of crucial gaps to identify properties of the variables and the parameters of their distributions that speak to typical driving behavior at the openings under study. The problem is that it is impossible to measure the key gaps directly. The Median Opening can only measure the rejected and accepted gaps of each U-turning vehicle. Some statistical method or procedure can be used to estimate the critical gaps from these data inputs Seven different methods for estimating critical gaps from the field data extracted are described in this chapter of the Report: Ashworth's method (1968), Harder's method (1968), Cumulative gap acceptance method (1970), Ashworth's maximum likelihood method (MLM) of Trout beck (1992), and "INAFOGA" method, which is a combination of the seven methods.

4.1.2 Models/Methods Utilized For Estimation of Critical Gaps

4.1.1 (A) Modified Raff Method

The method of Raff (1950) is based on macroscopic model and it is the earliest method for estimating the critical gap which is used in many countries because of its simplicity. This method involves the empirical distribution functions of accepted gaps Fa (t) and rejected gaps Fr (t). As per Raff method critical gap at un-signalized intersections is defined as “as gap/lag for which no. of accepted gaps shorter than it is equal to the no. of rejected gaps longer than it”. (1950, RAFF & HART)

Two cumulative distribution curves are drawn with no. of gaps as the ordinate & length of gaps in secs in the abscissa. One relates gap lengths t with the number of accepted gaps less than t, while the other one relates t with the number of rejected gaps greater than t. Critical Gap, Tc is obtained by projecting the intersection of these curves on the X-axis corresponding to the no. of gaps.

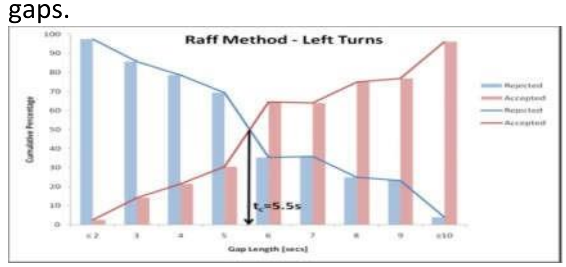
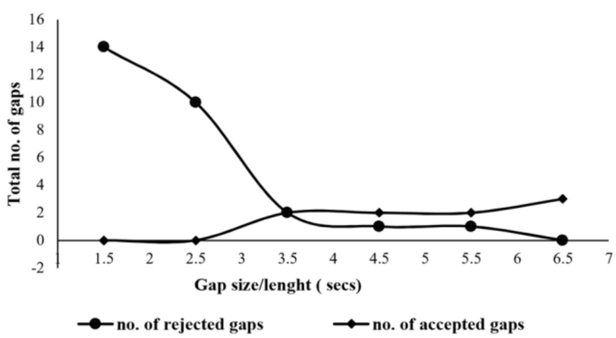


Figure 2 Example of Modified Raff Method for Left Turns

The critical gap can be determined using the above cumulative distribution curves of accepted and rejected gaps, with the assumption

that the curves are linear between two time instants t1 and t2. Time intervals t1 and t2 = t1 + t, where t1 is the time interval utilized for Gap analysis, are critical.
Now that we're looking at similar triangles,
Here's another gap that has to be addressed:
To calculate tc, multiply the first t1 value by t1's denominator.
Thus, the Modified Raff approach expresses the crucial gap as:

(3.4)



U-turn modification of the Raff method
Figure 3 Example of Modified Raff Method for U-turns
CUMULATIVE GAP ACCEPTANCE METHOD

Both accepted lags and gaps are used in this method to determine critical gaps. Cumulative frequency percentages of lags and gaps are plotted against merging time expressed as frequency distribution. Fig. 5 predicts the critical gap of U- turning 4 wheelers and SUVs using "INAFOGA" method.

VI. **STUDY AREA AND DATA COLLECTION**

5.1 Description of the Study Area

The study area is divided into two cities (Hyderabad and Secunderabad) so that the road networks may provide the necessary input data for studying "Critical Gap" and comparing the same between other means of transportation, such as public transportation. We looked studied median openings on four- and six-lane divided urban roadways. To accommodate a daily traffic volume of at least 500 cars and maintain a maximum speed restriction of 70-80 kmph, median openings are commonplace in Indian cities.

To acquire data, a Sony Handycam was used to record video of the selected median openings at a 30 frames-per-second rate. There were three distinct time periods studied: early morning (8:30-9:30 a.m.), midday (12:30-2:00 pm.), and late afternoon (5:00-6:00 pm.) These data sets were gathered in October and November of 2017. Only on weekdays did the filming take place. Since there is such a huge disagreement in the data sets, it was difficult to accurately estimate the key gaps in U-turning traffic near median openings on the weekends and public holidays.

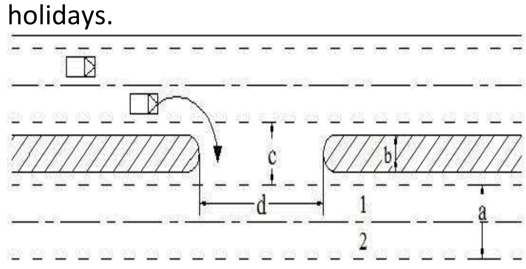


Figure 5. Layout of Median Opening on a 4-lane road

Fig 6 (a): Tarnaka U-turn, near Railway Nilayam, Secunderabad

Fig 6b): Tarnaka U-turn, near Railway Nilayam, Secunderabad

Median Opening Section No.	Location	Median Opening Width(m)		Volume of through traffic (PCU/hr.)	Proportion of U-turn drivers
		d*	c**		
1	Uppal U-turn, near Uppal metro station	14.8	2.4	4100	1184(34%)
2	Tarnaka U-Turn, near Railway Nilayam, Secunderabad	20.1	2.3	4570	715(28%)
3	Kukatpally U-Turn, near Y-junction	20	2.1	4800	670(27%)
4	Dilsukhnagar U-turn, near RS brothers shopping mall	20.3	2.1	1980	828(28%)
5	Nagole U-turn, near city bus stop	20.4	2.0	2490	894(20%)

Fig 6c): Tarnaka U-turn, near Railway Nilayam, Secunderabad

S.no	Vehicle Type	PCU Equivalents
1	Car, LCV, 3W, SUV	1.0
2	HV (i.e. truck, bus, lorry)	3.0
3	2W (i.e. bikes, scooters, Bicycles)	0.5

Fig 7(b): Dilsukhnagar U-turn, near RS brother's shopping mall

Fig 7(c): Dilsukhnagar U-turn, near RS brother's shopping mall

Table 5.2. Traffic Characteristics and Geometry of the Five Median Opening sections Observed

	Value	Standard Error
Waiting Times for SUVs	90.73186	12.31586
	-1.94159	0.12079
Conflicting Traffic flow	8.69222	0.9283
	-2.17058	0.09702

distance between the outer edge of inner lanes and median opening: d* = horizontal width of median opening Passenger Car Unit (PCU)/hr. can be used to graphically show the variance in U-turning flow with respect to through or conflicting traffic flow. Based on Indian Roads Congress (1983) Table 2, the PCU conversion factor for different vehicle classes is -86. (Geometric Design Standards for Urban Roads on Plains). U-turn flow and through traffic flow are shown in PCU/hr on Fig. 1, with the frequency distribution curve for six different sections. This graph shows that the acceptance of U-turn traffic gaps declines exponentially as the percentage of through traffic flow increases

5.2.1 Extraction of necessary decision variables as per "The Merging Behavior" Concept

After video shooting of the median openings, extraction of necessary decision variables for the estimation of critical gap was done. The video data collected from the field was converted to .AVI format from .MPG file type. All decision variables were extracted by playing the .AVI videos in demurer software named as AVIDEMUX Version 2.6 capable of running videos at a frame rate of 25 frames/second. The time frames chosen for data extraction was based on the new concept on merging time are explained below.

Table.5.3.Statistical and Parametric Details of the Regression Model for SUVs

	Waiting Times for SUVs	Conflicting Traffic flow
Number of Points	35	35
Degrees of Freedom	33	33
Reduced Chi-Square	1.86415	0.00617
Residual Sum of Squares	61.51691	0.20367
Adj. R-Square	0.89749	0.94613
Fit Status	Succeeded(100)	Succeeded(100)

VII. CONCLUSIONS AND DISCUSSIONS

Conclusions regarding the Comparison between Harder's and "INAFOGA" Methods

T The critical gap values were estimated by utilizing a variety of previously published methods. In this study, crucial gaps for U-turns at median openings in mixed traffic situations were estimated using the "INAFOGA" approach for data extraction. Gap acceptance studies have demonstrated that Harder's technique is ineffective when it comes to estimating crucial gap values in mixed traffic situations. This is due to the fact that prior studies only used this strategy in settings with constant traffic flow. Harder's and "INAFOGA" critical gap values were compared using a paired sample t-test to determine the difference in mean values. The values were found to be 28-41% lower than the values obtained using the "INAFOGA" approach by Satish et al.. The critical gap values for each of the four modes examined in this study can be compared using cluster diagrams in each of the study's four sections.Conclusions in General on Estimation of Critical gaps

- For every sections selected for analysis, the critical gap values for a 4wheeler was found to be more than that for a 2 wheeler driver

Values of crucial gaps acquired by "INAFOGA" approach, which are roughly 18-41% greater than the values of critical gaps obtained by existing methods, disputed the above step for the road heading to C.S. Poor.

U-turn drivers' crucial gaps at median openings on multilane roads under mixed traffic flow in India are estimated using a new merging behavior concept introduced in this research endeavor.

U-turn vehicles merging at median openings are given a merging time when they have completed their whole merging maneuver. Drivers' waiting time was also modelled using his critical accepted gap in this study. The study found that the number of significant gaps accepted by the driver decreases exponentially as the wait time for the driver increases. As a result, the critical gap is sometimes referred to as a behavioral factor. It is also necessary to consider how gender influences accepted gaps and merging times while doing behavioral study. Findings from a study of chosen median opening sections show that female drivers are more willing to accept gaps than male drivers. Additionally, female drivers take longer than male drivers to complete U-turn maneuvers at median openings. When merging periods were increased and accepted gaps increased, the power regression decline was observed for both genders. Gap acceptability and crucial gaps at median openings are directly affected by other traffic factors such as competing traffic flow and speed. Experimental regression models are built between these opposing properties of the flow of traffic, and the phenomenon of gap acceptance (i.e. crucial gaps). Models demonstrate a linear relationship between speed and critical gaps, but a power fluctuation between flow and critical gaps, indicating that driver gap acceptance is strongly influenced by vehicle and traffic behavior as well as traffic characteristics.

Future Scope:

This new concept thus used for estimating U-turn critical gaps and evaluating driver gap acceptance have never been used previously and can be unpretentiously used by any traffic engineer/policy makers to address gap acceptance under mixed traffic conditions. Thus, all the aspects introduced through this study will definitely serve as a handy tool to improve traffic operations on unsignalized transportation facilities. However, there is still doubt about the utilization of the new concept of merging behavior to other transportation facilities like roundabouts, interchanges, etc. and thus further research in this field is strongly recommended.

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