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SURROGATE SAFETY EVALUATION OF UNSIGNALIZED INTERSECTION THROUGH POST ENCROACHMENT TIME

Khushi Patil[1], Rohan Talekar[2], Kenil Bhadesia[3]

[1,2,3] *Final Year B.E. Students, Dept. of Civil Engineering, Universal College of Engineering, Maharashtra, India*

Abstract - *Traffic safety is a crucial aspect of transportation engineering. Most traffic safety evaluation and prediction work now relies on historical accident data, which has obvious flaws in terms of data quality and coverage, particularly in developing nations like India. It is both impractical and unethical to wait for incidents to occur before drawing statistically reliable judgments about the safety impact of roadway remedies in the future. As a result, proactive models based on Surrogate Safety Measures (SSMs) are required for more effective safety evaluation. The main advantage of using safety indicators is that they occur much more frequently than accidents, providing a more efficient and statistically reliable proximate measure of traffic safety. The goal of this study is to assess the level of traffic safety at an uncontrolled intersection under mixed traffic intersections by using a unique technique for monitoring proximal safety indicator, which is Post Encroachment Time (PET).*

Key Words: Traffic safety, Surrogate Safety Measures, Un-signalized Intersection, Post Encroachment Time (PET), Transportation, Roadway

1. INTRODUCTION

Intersections are the most crucial place in terms of traffic safety and performance since they operate as a node where traffic flows either merge or diverge. Intersections present a distinct set of challenges in terms of safety. Because of the dangerous driver's behaviours and manoeuvres, there are worries. Apart from the abrupt changes in vehicle speeds and unexpected lane changes, intersections involve merging, diverging, crossing, and weaving issues. As a result, increases in vehicle speeds and unexpected lane changes constitute a special safety risk implication. According to a study by the Ministry of Transportation and Highways on road accidents, Un-signalized junctions accounted for 20.6 percent of all crashes in 2019, according to MORTH. At the aggregate level, the safety of un-signalized junctions is assessed by linking conflicts with annual traffic flow and intersection-related factors. Because the majority of crashes in India go unreported, crash-based safety diagnostic becomes useless. Recently, there has been an increased interest in using traffic disputes as a proxy for crashes in order to examine traffic safety in a broader context for various highway and traffic conditions. The goal of this research is to look into crossing conflicts. In this study traffic video data from two un-signalized crossings with different route design and intersection control is collected. PET (post encroachment time) was found to be a good surrogate safety measure (SSM) for analysing conflicts. The PET, or Vehicle and Traffic Speed of Conflicting and Offending Vehicles, is a measurement of the speed of conflicting and offending vehicles and traffic. The recorded video was manually analysed for characteristics such as traffic volume and vehicle composition.

2. OBJECTIVES

The study's main aim is to find out the Post Encroachment time manually at un-signalized intersections to assess the safety of the intersection.

3. THEORY BASE

The intersection is the area where the merging and diverging moments of traffic takes place. Before performing analysis, a clear view of terminology and basic concepts of Un-signalized intersections are discussed further

Un-signalized intersections are those that lack traffic signals and are controlled manually. An at-grade junction is an intersection. When two or more transport flows share the same area or cross, they are formed. When two roads intersect, one is designated as a Major road, while the other is designated as a Minor road. When one minor street meets the major street, a three-legged intersection is produced.

4. TERMINOLOGY

Time to Collision (TTC): Expected Time for two vehicles to collide if they remain at their present speed and on the same path.

Gap Time (GT): Time-lapse between completion of encroachment by turning vehicle and the arrival time of crossing vehicle if they continue with same speed and path.

Deceleration rate (DR): Rate at which the crossing vehicle must decelerate to avoid the collision.

Offending Vehicle: Vehicles taking right-turns from all approaches and obstructing in respect to straight movement vehicles are considered as offending vehicles.

Conflicting Vehicle: Vehicles performing a straight movement from all approaches are considered Conflicting vehicles.

Post Encroachment Time (PET): "Time-lapse between the end of encroachment of offending vehicle and time that conflicting vehicle arrives at the potential zone of collision."

Percentage of critical Crossing Conflicts (PCCC): "Percentage of conflicts between the offending and conflicting vehicles at an intersection within the range of the threshold value of PET".

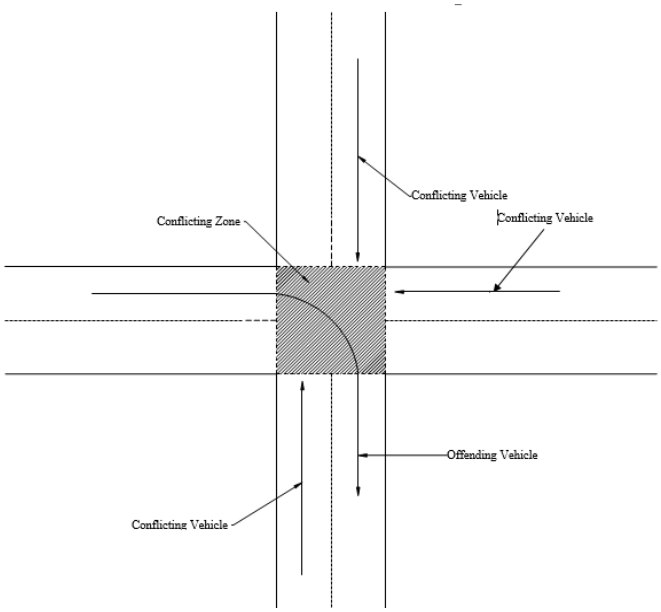

Fig -1: Potential Conflict Zone

5. SITE INFORMATION

For the study purpose an un-signalized intersection named Valinath Circle in the Surat Area was selected.

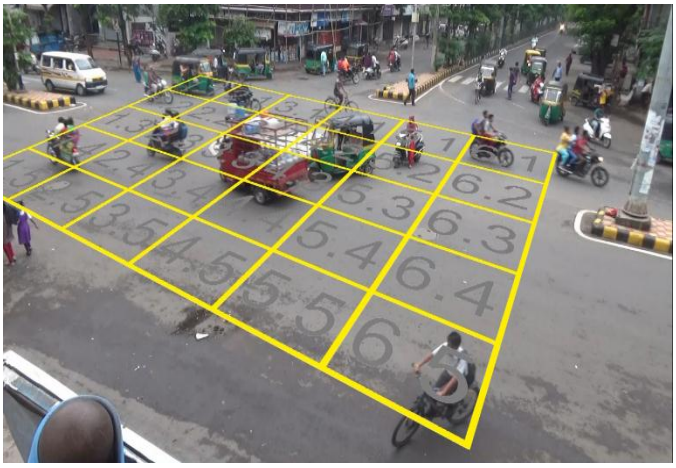

Fig -2: Valinath Circle in the Surat, India

5.1 Experiment setup & data collection

Data is collected for 1hr from morning 10 a.m. to 11 a.m. under fair weather conditions. The data like classified Volume count, running Speed, Road Density, Vehicle-to-Vehicle interaction, speed of the offending and Conflicting vehicle, Gap acceptance/rejection, etc., can be extracted from the video as per our requirement. The video-graphic survey has several advantages as under:

Recording may be reanalyzed at any time,

It provides an account of each traffic event observed,

It required a very low labor force,

It provides a permanent, complete record of the traffic scene at a particular location.

The major disadvantage of the video-graphic technique is a large amount of time and effort are required for data extraction. Traffic data for this study was collected using multiple high-definition (HD) cameras. HD cameras were placed on top of the high-rise buildings in the vicinity of the study intersection as a vantage point to capture the traffic movement. Data collection aimed to record drivers' behavior crossing the major road and the major road vehicles approaching the intersection.

Preliminary Data Analysis the selected Intersections are characterized by four different approaches they are L1, L2, L3, L4, respectively. The L1 approach starts from the leftmost side approach in the video, and characterization continues in the clockwise direction L1 followed by L2, L3, L4. Where these intersections are located in India accounted with Mixed traffic flow conditions. As these Intersections are located in urban areas, in general, the proportion of Two Wheeler (2W), Auto- Rickshaw (3W) and Cars (4W) are more as compare to the other vehicle category.

6. DATA EXTRACTION METHODOLOGY

Overlaying of Grid to extract the PET values, we primarily collected the conflict area dimensions at the selected intersections during free-flow conditions with the assistance of Traffic police. After that, a grid of size (3.5m *3.5m) equal to the dimensions of the conflict area was drawn in the Auto-cad and exactly overlaid over the collected video by using the Corel Video Studio Pro X11 software. Later onwards, the overlaid video run in the Avidemux 2.6 software with an accuracy of 0.04. The advantage of using this software is that the time for vehicle entry and exit in the conflict zone can be noted precisely. The Video-graphic data is used for the extraction of Post Encroachment Time (PET), and also the number of vehicles involved in the conflict situation along with their categories, direction of the approaching vehicle, the speed of the conflicting vehicles, Speed of the Offending Vehicle,

Traffic volume count is extracted. The same videos were replayed to minimize the human errors and checked for errors in observations if any. The entire process took about 60 person-hours for data cleaning, processing, and proof-checking 1 hour of video data comprising traffic movement from all intersection approaches. PET was processed for all the vehicle categories and segregated in 5- minute intervals. Both positive and negative values were observed due to the formulation used in computing PET. When the Conflicting vehicle enters the Conflict zone first, then we will get negative PET. When the Offending vehicle exit the conflict zone first then it leads to getting a positive PET value.

Table -1: Valinath data extraction details

Grid Number	offending	Vehicle class	Exit Time	conflicting	Vehicle class	Entry time
5.1	1	2W	00:00:39.600	1	4W	00:00:39.440
5.1	1	2W	00:00:39.600	1	2W	00:00:41.320
5.1	1	3W	00:00:43.360	1	4W	00:00:39.440
5.1	1	3W	00:00:43.360	1	2W	00:00:41.320
5.1	1	3W	00:00:43.360	1	3W	00:00:46.240
PET	**value**	**Exit**	**Time**	**Time Sec**	**Distance**	**speed**
-1.852E-06	-0.160	00:00:39.960	6.019E-06	0.520	3.5	24.23076923
1.991E-05	1.720	00:00:41.840	6.019E-06	0.520	3.5	24.23076923
-4.537E-05	-3.920	00:00:39.960	6.019E-06	0.520	3.5	24.23076923
-2.361E-05	-2.040	00:00:41.840	6.019E-06	0.520	3.5	24.23076923
3.333E-05	2.880	00:00:46.680	5.093E-06	0.440	3.5	28.63636364

PET Threshold Value The threshold for PET: It is a challenging task to fix the threshold for SSMs. But there is no standard procedure to estimate the exact threshold value (Mahmud et al., 2017), but (Vogel, 2003), (Paul & Ghosh, 2020), (Mishra et al., 2017) (Shekhar Babu & Vedagiri, 2018) (Goyani et al., 2019) all these studies considered PET as a SSM, for estimating critical conflicts at different locations with threshold range varying from -1 to 1s.

7. CONCLUSION AND FUTURE SCOPE

We have successfully extracted the Pet thresh hold Values from the recorded video. The amount of both conflicting and offending vehicles has a considerable impact on the number of crossing conflicts. The number of critical and non-critical conflicts increases as the volume of offending stream increases. The data we have extracted can be further used to create The generalised Linear Models (GLM). The GLM approach is widely used in the literature to develop conflict and crash prediction models and also to model conflicts. Also the data we have extracted can be used to create critical conflict and non-critical conflict models which will aid to assess the risk and take timely measures for the same.

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BIOGRAPHIES

Khushi Ashish Patil
Pursuing B.E. in Civil Engineering
Universal College of Engineering,
khushipatil1023@gmail.com

Rohan Ramesh Talekar
Pursuing B.E. in Civil Engineering
Universal College of Engineering,
spartankratos.rt@gmail.com

Kenil Girish Bhadesia
Pursuing B.E. in Civil Engineering
Universal College of Engineering,
Kenilbhadesia@gmail.com