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Evaluating Driver Speeding at Traffic Signal Lights During the Amber Time: With and Without Countdown Timers

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Abstract: At the onset of amber color indication, drivers must decide whether to stop or cross a signalized intersection. In literature, there is enough evidence indicating that a significantly high number of crashes that occur at signalized intersections are of vehicles entering the intersection during amber and red-light indications. However, such findings cannot be stated for Sri Lanka with the lack of details in the crash records. With that gap of knowledge in the local literature, this study investigated how countdown timers (CDTs) impact on the speeding behavior of drivers. With that aim, the objective of this study was to examine driver speeding according to the distance to stop line (DSL) with the presence an absence of countdown timers (CDT). Two intersections with CDTs and one without a CDT in Colombo, Sri Lanka were considered for data collection. The number of vehicles that are speeding at the onset amber, were considered during a peak hour. These values were obtained for the intersections with and without CDTs as well as for Peak and Off-peak conditions. It was found that the dilemma zone was within 15m to 30m from stop line for intersections with CDTs. Results showed that the presence of a CDT showed no significant impact on the number of vehicles that went speeding at the onset of amber, and it was around 22 veh/ 100 cycles. On the other hand, there was a 35% reduction in the number of speeding vehicles per signal cycle during the off-peak hour with the absence of a CDT.

Keywords: Amber time, Dilemma zone, Intersection safety, Countdown timers, Speeding

Introduction

Amber interval plays an important role in signalized intersections while there are two amber intervals on a signal board (See Figure 1). They are green indication changing to amber and red indication changing to amber. There is a risk associated with the amber time at signalized intersections, because the drivers have to make a decision whether to stop or cross the intersection at the onset of the amber.

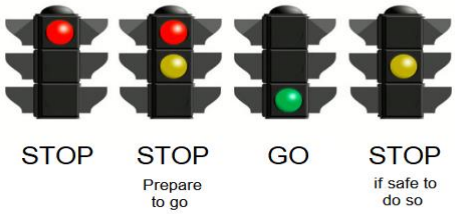

Figure 1. Traffic lights four states
Source:(Petnga and Austin 2016)

The dilemma zone is a zone where drivers may make a decision whether they cross or stop during the amber indication. The dilemma zone associated with problems such as vehicle crashes and red light running results of incorrect driver decisions at amber intervals. Sometimes, drivers decide to stop when they have the ability to drive through an intersection may create unnecessary vehicle traffic and when a driver decides to drive through an intersection when the vehicle should be stopped may create vehicle crashes.

Several studies have been conducted all over the world considering driver behavior at signalized intersections during the amber period considering the factors mentioned. Driver decisions at the onset of amber may vary according to factors such as driver age, driver's gender, vehicle conditions, distance to stop line, speed of the vehicle, road conditions, the presence of countdown timers and etc.

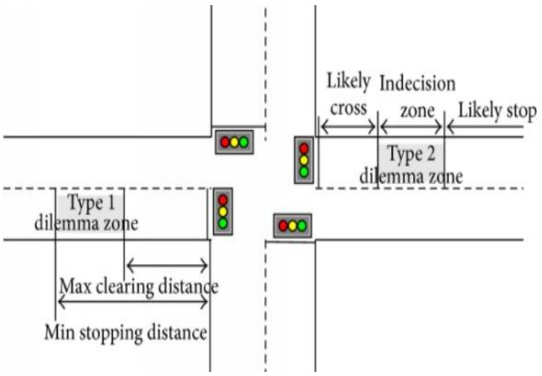

Figure 2. Dilemma zone
Source:(El-shawarby, Amer, and Rakha 2000)

Problem Statement

During the amber light, drivers require a take decision to either stop or go through the intersection. This can lead to unsafe driving conditions deue to confused drivers. When drivers stop their vehicles when the best choice was to cross, it may create and right-angle accidents with side street traffic and red-light running may arise when driver go when it was better to stop (El-shawarby, Amer, and Rakha 2000). According to statistics, out of the all crahses at signalized intersections, crashes in amber light have exceeded half of the entire accidents (Yang et al. 2014). However, Sri Lankan crash reporting system does not capture the data where it says whether the vehicle subjected to crash was running a red-light or had it entered the intersection during the amber time. Hence, a research gap is also identified.

Objectives

To assess driver speeding according with the presence of countdown timers and distance to stop line.

To assess the differences of driver the above parameter in the peak hours and off-peak hours

Methodology

Intersection A, B and C were the three intersections selected for this study as shown in Figure 3. Locations of the intersections were, Intersection A: Golumadama, Intersection B: Maliban junction, and Intersection C: Bellanthota (Attidiya/ Nugegoda). Out of these intersections, A and B were with CDTs and C was without a CDT.

Figure 3. Selected locations of the intersections

Although there are many factors that may affect the driver's behaviour at the a signalized intersection, this study considered only four major factors. They were, vehicle speed, distance to stop line, presence of countdown timers, and peak and off-peak time.

Data were collected on Mondays and Thursdays. The study was done for DSL and vehicle speed form the video clips taken at the above-mentioned intersections. To

determine the dilemma zones, lines were marked on the road 5 m to 5 m by 30 m. They were used to calculate the speed of each vehicle when they approached the intersection.

The recorded videos were used to calculate the average vehicle speed. Time to travel between marked lines and the stop line were determined. Through the time spent between a marked line and the stop line, and according to the distance between the marked line and the stop line, the average vehicle speed was calculated. To calculate vehicle speed accurately, the time was measured in milliseconds and video was played in slow-motion.

Results and Discussion

The summary of the results obtained by the evaluation of each intersection is shown in Table 1. From the Speed vs no of vehicles graph for peak hours, it was visible that the speed variation of intersections with CDTs was higher than that of the intersection without CDT. Further more, it was additionally observed that the red-light-running (RLR) violations are higher with the presence of a CDT.

Table 1. Summary of the results obtained by evaluation of each intersection

Name of Intersection	Count Down Timer	Peak or Off-peak	Number of Cycle	Number of Speeding Vehicle	Vehicle speed (km/h)	Dilemma Zone
Intersection A	Yes	Peak	18	49	20~55	10m-25m
		Off peak	22	51	13~45	10m-30m
Intersection B	Yes	Peak	27	49	30~60	10m-25m
		Off peak	28	47	13~45	10m-30m
Intersection C	No	Peak	18	40	12~58	15m-30m
		Off peak	20	26	20~45	15m-30m

With the presence of a CDT, vehicle speeds were higher during the peak periods and lower in the off-peak period. The opposite of that was observed without a CDT , where the off peak speeds were comparatively higher than peak period speed. This observation is illustrated in Figure 4. However the off peak speeds in the Intersection C was still not high as that of peak period in A and B. Hence, it was clear that the presence of a CDT has an overall effect on the vehicular speed during amber time.

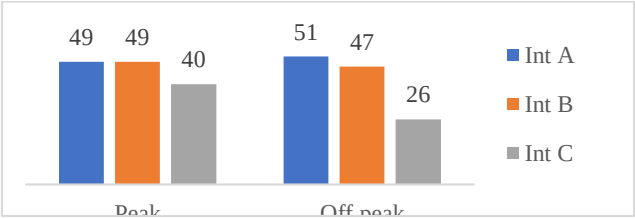

Figure 4. Summary: Number of total speeding vehicles within an hour

While the Figure 4 was developed using the total speeding vehicles within an hour, speeding vehicles per 100 signal cycles was also estimated. During peak period it was 23 and 22 for intersections with CDT and without CDT respectively. During the off-peak period it was 20 and 13 for intersections with CDT and without CDT respectively. The later was a 35% reduction.

Conclusion

This study examined driver speeding at the amber period at signalized intersections considering vehicle speed, countdown timers (CDTs), and distance to stop line (DSL). Three signalized intersections were selected around the Ratmalana area. Two intersections were operating with CDTs and the other intersection without it. Through video surveys and field surveys required data were collected during both peak periods and off peak periods. The study demonstrated that the dilemma zone of these intersections was between 15 m to 30 m from the stop line. It means, the vehicle closer at 0~15m from the stop line decides to proceed to the intersection, whereas the vehilces farther than 30m tend to stop. Further, it was observed that countdown timers could contribute to reducing red-light violations as well.

Moreover, when a CDT is available, during peak hours, vehicles are approaching with high speed during amber light than at off-peak hours. When the DSL was between 0m to 20m more drivers tend to cross the intersection, while they accelerating to higher speeds after the onset of amber. Further results of the study showed if drivers cross an intersection when the DSL was more than 30m, more of those crossings become red-light violations. Hence, it was clear that the presence of a CDT has an overall effect on the vehicular speed during amber time. However, it was debatable whether number of cycles within an hour has an affect on this number of speeding vehicles. It can be studied in future researches by incorperating that factor as well.

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