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Assessing the Psychological Responses of Drivers to Flashing Amber Lights

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1. Introduction

For accident prevention, as a Traffic Demand Management (TDM) strategy, amber lights are flashed at signalised intersections signalling drivers to drive with caution. Flashing amber light is used mostly during night hours with very a low incidence of traffic or when signal cycle timing is dysfunctional. However, this precautionary action has not eliminated intersection collisions. During off-peak hours, many intersection collisions have been reported. The occurrence of accidents in signalised intersections during off-peak hours is due to incompatibility between the expected and actual reactions of drivers to flashing amber lights or the complete ignorance of drivers. Therefore, this study focuses on how drivers psychologically react to flashing amber lights through an assessment of speed levels of vehicles passing an intersection.

2. Objectives

The main objective of this research is to test the effectiveness of flashing amber lights in lowering the speed of vehicles as a measure to prevent intersection collisions at off-peak hours. The study recommends a proper technique for effective accident prevention in off-peak odd (night) hours, especially if the effectiveness of the flashing amber lights is deemed not to be satisfactory.

3. Literature Review

A Sri Lankan dies every three and half hours in road accidents, and the Western Province continues to be the most unsafe region in this respect (Abeygoonewardena, 2016) [1]. A frequently occurring pattern of accidents is related to drivers with the right of way confronted by misjudgement of another vehicle crossing their path (Sandin, 2009) [2]. Therefore, it is necessary to predict driver behaviour and assist drivers in making correct decisions when they approach intersections, with a view to reducing crashes at signalised intersections (Li, 2016) [3]. A driver assistance system is expected to improve drivers' anticipation of the driving scene. Flashing-green intervals at the end of the green interval do not increase safety at signalized intersections [4]. Results show that, in agreement with literature, Israeli drivers exhibit great variance in their reaction to the flashing green (Rittger, 2012) [5]. Warning beacons are warranted at intersections when no conflicting vehicular approaches are faced. Beacons shall be flashed at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash shall not be less than one-half and not more than two-thirds of the total cycle (U.S.

Federal Highway Administration, 2003) [6]. Response time of the drivers vary to the effect of number of amber lights durations ranging from 0 to 3 seconds (MacDonald, 1978) [7].

During the last decade, there has been a tremendous increase in mobility and motorisation in the country (Abeygoonewardena, 2017) [8], while road deaths reached a startling total of 3,003 in 2017, when compared to 2,816 deaths in 2016. There were 39,086 accidents reported in 2016, while 18,980 accidents occurred in the first six months of 2017 [9].

4. Methodology

The methodology used for the study is speed variation measurement. Five location-based speed levels of vehicles approaching an intersection were measured when amber lights were flashing. The measurements were taken to determine speed levels at distances of 25m, 50m, 75m and 125m away from the traffic light post. Speed of vehicles passing the junction is measured 50m away from the traffic light. Figure 1 demonstrates the demarcation of survey points at the selected intersection.

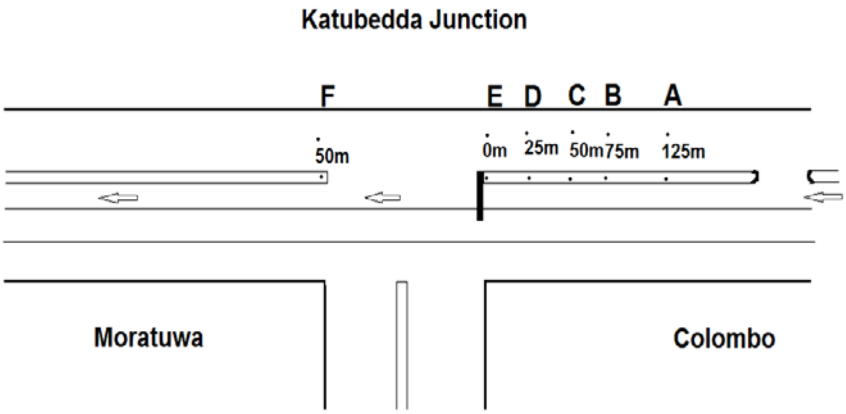

Figure 1: Positions at which the speed levels are measured

The measurements were taken using the Speed Gun technique and Time-Distance technique. The average speed between two points was determined by dividing total distance by elapsed time (Figure 2).

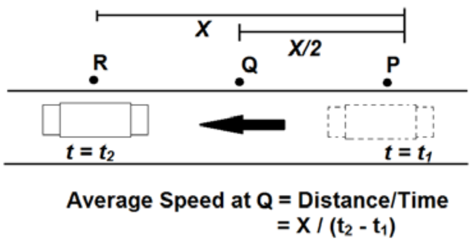

Figure 2: Graphical representation of Time-Distance technique

Hence, to determine a single speed level, time values of two points were needed. Survey for the collection of data was conducted on 22nd March at Katubedda junction. In the survey, vehicles moving towards Moratuwa direction in the 3rd lane (lane nearest to centre-median) in A2 road (Galle road) were considered. Speed variation measurement was implemented as the methodology in the study as it acts as a proxy to the psychological response of the drivers. Thus, psychological response of drivers to flashing amber lights could be assessed.

Three ideal situations were expected to be representing the results. Speed variation graph with (Figure 3);

- A minimum point of the speed levels at the colour light position; representing the desirable psychological response for flashing amber lights,
- Constant speed throughout the surveyed distance; representing no psychological response for flashing amber lights
- A maximum at the colour light position; representing undesired psychological response.

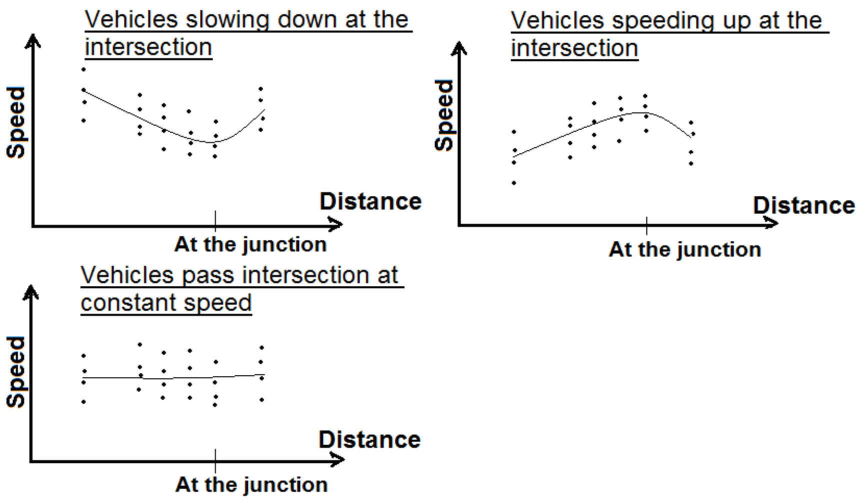

Figure 3: Rough sketches of the possible ideal situations

5. Data

A total of 758 vehicle speeds were calculated from the data collected in 3 samples between 10.50pm to 00.50am which were grouped into 6 speed levels. Table 1 summarises minimum, maximum and average speed levels across all survey points on either side of the intersection.

Table 1: Summary of the processed data

	A (125m)	B (75m)	C (50m)	D (25m)	E (0m)	F (-50m)
Maximum speed	90.0	90.0	88.0	90.0	81.0	120.0
Minimum speed	25.7	20.0	19.0	22.5	19.0	20.0
Mean speed	59.2	36.5	44.8	45.4	43.2	49.1
Standard Deviation	22.5	19.8	11.8	17.1	11.4	21.5
Coefficient of Variation	0.380	0.542	0.264	0.376	0.263	0.437

6. Results

The range of speed level variations from the survey is shown below (Figure 4).

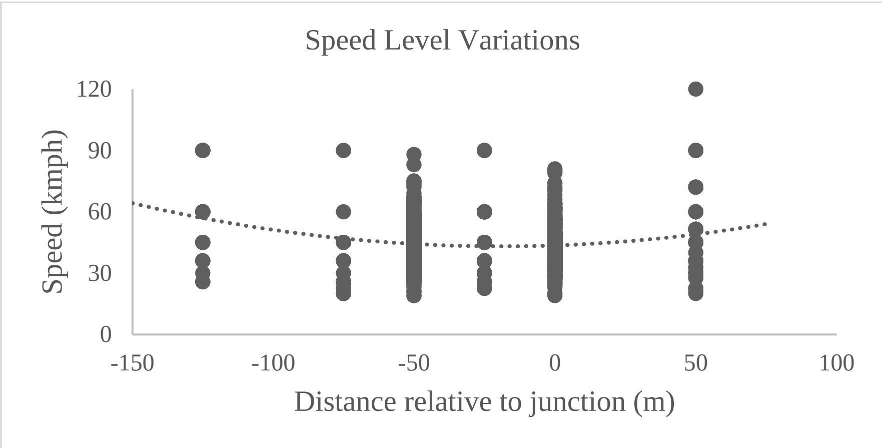

Figure 4: Speed level variations of vehicles passing Katubedda junction

In the above graph, the values of x-axis represent distances from amber light at which speeds were calculated. Negative values denote that vehicles are at the Colombo side when approaching the junction and positive values denote that vehicles are at the Moratuwa side after passing the junction. Turn-off towards by-roads do not affect results because only inner lane traffic is considered in the analysis.

Positions previously denoted by alphabetical letters are related to the values as follows;

-125 $\longrightarrow$ A, -75 $\longrightarrow$ B, -50 $\longrightarrow$ C, -25 $\longrightarrow$ D, 0 $\longrightarrow$ E, 50 $\longrightarrow$ F

The resulting curve from the survey is a quadratic curve with a minimum, which demonstrate that the vehicles slow down while moving through intersections. However, interestingly, the minimum speeds are observed not at the junction (0m location), but 20m before the junction. It is a questionable behaviour from drivers that they glance at oncoming traffic before arriving at the intersection and gradually speed up thereafter if there is no sign of vehicle passing through. Hence, drivers have less ability to react to sudden disturbances at intersections at the time of passing by such intersections. Furthermore, speed and distance to amber light graph (Figure 5) confirms the above results. Higher distance to amber lights indicate higher speed while as vehicle approaches the amber lights, the speed tends to decline indicating drivers have marginal response to flashing amber lights with a higher variance.

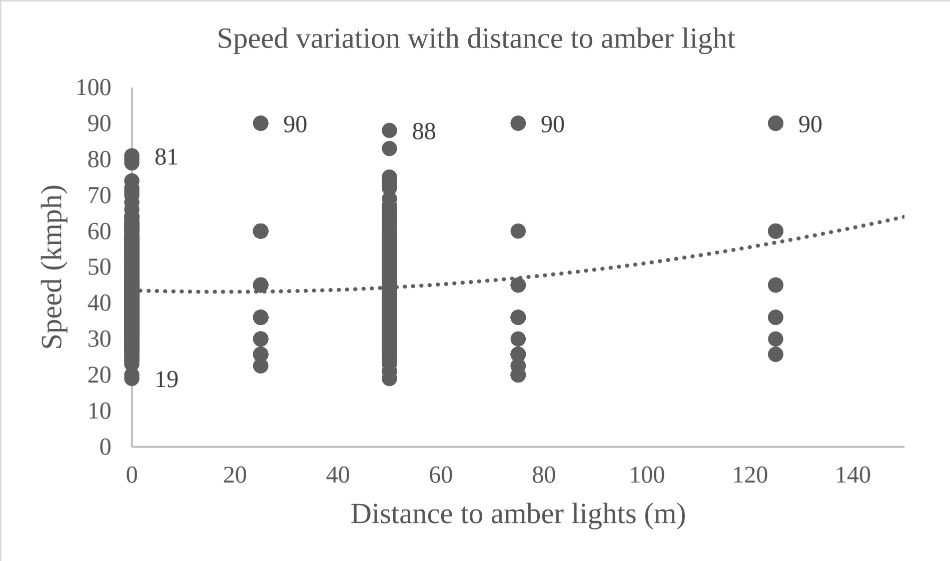

Figure 5: Speed variation with distance to amber light

7. Conclusion and Recommendations

From the study, it can be concluded that expected response of drivers from flashing amber lights is marginally reflected by the speeding behaviour of drivers. Flashing amber lights is implemented to signal drivers to drive with caution. Hence, it is expected that drivers will slow down vehicle speeds at the junction. However, results show that drivers tend to slow their vehicles before arriving at the intersection and accelerate even at the intersection. The contradicting expectation and responses can be a reason for intersection collisions at odd hours. Therefore, the effectiveness of using flashing amber lights as a measure for accident prevention at intersections is questionable. Implementing a real-time image processing traffic light system is recommended as a measure to prevent intersection collisions at odd hours. In this system, the duration of traffic light transitions changes depending on the volume of the traffic passing along each lane, as detected by cameras placed at the junction along each lane.

References

[1] Abeygoonewardena, C.R. (2016). Roads in Sri Lanka - A matter of life & death. The island.

[2] Sandin, J. (2009). An analysis of common patterns in aggregated causation charts from intersection crashes. Accident Analysis & Prevention, 41(3), 624-632.

[3] Li, J., Jia, X., Shao, C. (2016). Predicting Driver Behavior during the Yellow Interval Using Video Surveillance. International Journal of Environmental Research and Public Health, 13, 1213.

[4] Factor, R., Prashker, J.N., Mahalel, D. (2012). The flashing green light paradox. Transport Research Part F, 15, 279-288

[5] Rittger, L., Schmidt, G., Maag, C., Kiesel, A. (2012). Driving behaviour at traffic light intersections. Cognition, Technology & Work, 17, 593-605.

[6] U.S. Federal Highway Administration. (Ed.) (2003). Manual Uniform Traffic Control Devices for Streets and Highways. U.S. Dept. of Transportation, Federal Highway Administration.

[7] MacDonald, W. A. (1978). Effects of Varying Periods of Red-Plus-Amber on Drivers' Starting Response Times at a Traffic Signal. Australian Road Research, 8(4), 68-69.

[8] Abeygoonewardena, C.R. (2017, April). Roads in Sri Lanka deadlier by the year. Retrieved 30th March 2018 from http://www.dailynews.lk/

[9] Statistics, T. P. (2017). Road deaths in Sri Lanka are as natural as they are tragic. The Sunday Times.

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