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Study of Drivers' Response Time in Traffic Streams

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Abstract -Reaction times of drivers responding to traffic wardens' signals are important for the design and safe operations of roads. The increased number of road users and pedestrians lead to increasing demands on the facilities and eventual inconvenience and delays. This study evaluated the response time of drivers on the minor leg of Challenge Intersection in Ilorin because of the significance of the minor traffic stream on the capacity analysis or design of traffic merging at the major leg. The method employed was basically manual whereby stopwatches were used to measure the response time of drivers who were unaware of being monitored. The response time of each driver in a traffic stream queue was taken in relation to respective positions in the queue. The average response time for the first and consecutive vehicles in stop and move signal are shown in tables 1.0 and 1.1 respectively. It can be deduced that those far behind do not have to see the warden signals before they respond because the brake light of the preceding vehicle will dictate the signal

Index Term: Traffic Warden, Perception-Reaction Time, Minor Leg, Queue, Intersection.

I. INTRODUCTION

The increase in the number of road users and pedestrians lead to increasing demand on the facilities and eventual distresses or inconveniences and delays. The proper way of studying traffic streams or flows should be adopted at intersections and most especially in areas where stopped delays are more pronounced. This leads to traffic characteristics like poor headways, forced flows, delays and queues [1]. The main aim of this paper was to study the response time of drivers to traffic wardens' signals at Challenge urban intersection. An intersection to a great extent can be used to determine the efficiency, safety, speed, cost of operation and capacity of a highway relative to its design. An intersection could be explained as an area where two or more arteries cross including the roadside and roadway facilities branching out from the intersection, which form the intersection leg [2].

II. DRIVER'S REACTION TIME

Reaction/perception-reaction time means the speed at which a person responds to an action. Reaction time is the key to account for liability. It is classified to be complex in behavior because it is not determined by a single character that applies globally but it is governed by a large number of variables[3].[4]stated the diverse component affecting driver's reaction time as follow:

A. *Mental Process Time*

It is the time taken for the responder to observe that a signal has ensued and to decide upon it a quick response. For instance, the time required for a driver to notice that a pedestrian is crossing the roadway directly ahead especially when the pedestrian crossway is not controlled by traffic light and decide to apply brake to halt the automobile. Mental processing time can further be split into four categories as explained below.

B. *Sensation*

It is the time taken to notice the sensory input from an object, for instance, there is a shape of an object on the road. Reaction time tends to decrease as the signal intensity-brightness, contrast, size and loudness, increases and increased visibility conditions. When comparing the auditory signal to visual signal, the former has best reaction time.

C. *Perception/Recognition*

It can be referred to as the time required to recognize the meaning of sensation, which is aided by the interpretation of information from the memory to the sensory input.

D. *Situational Awareness*

It is the ability in form of time required to notice the seen object and its layout on the road; depict its meaning and relay it to the future. For instance, once a driver recognizes a pedestrian on the road, and perceives his own speed and distance, he must realize what is happening and what will happen next.



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E. Response Selection and Programming

It is the time required to decide the action to be taken whenever an object is spotted and mentally program the movement, steer to left or apply break. Response selection seems to be slow when there are multiple signals and practice decreases the reaction time. Electrophysiological studies explains that most people display preparatory muscles potentials before the actual movement, the decision taken occurs in a way faster than any recordable response can be measured. The aforementioned stages are usually lumped together as perception time (Green, 2000).

III. DATA COLLECTION

The intention is to enumerate the various data and respective method employed in relation to the study. It essentially addresses the driver's response time in traffic streams at Challenge Intersection.

A. Project Area and Description

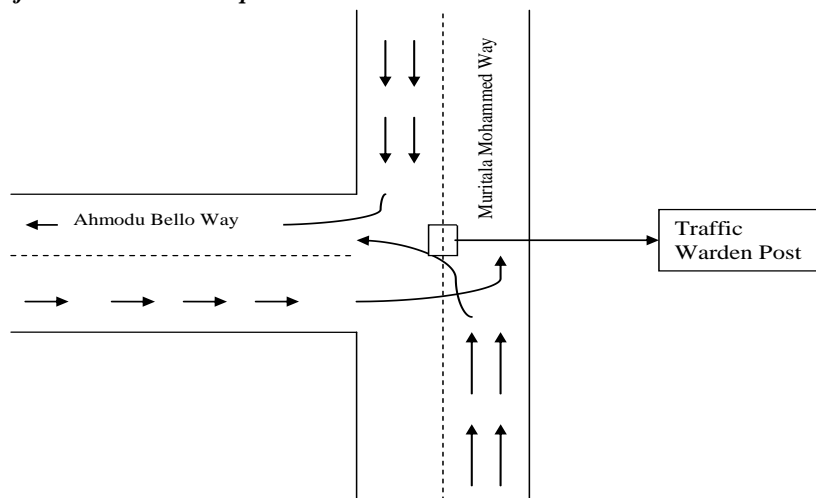


Fig 1 Sketch Location of Challenge Intersection

The study location is at Challenge Intersection in Ilorin, Kwara State, Nigeria. It is a T- intersection consisting of three legs in which only the minor leg was taken into consideration during the driver's perception reaction time measurement. Figure 1 shows the schematic presentation of the studied junction. The main type of traffic control in use is the traffic warden.

IV. METHODOLOGY

The method employed was basically manual whereby stopwatches were used to measure the response time of drivers' who were unaware of being monitored. The typical study recorded the response time to the warden's stop signal and the response time to the warden's move signal. The stopwatches were adopted in this project because of its inexpensiveness. The minor road affects the effective flow of the major road, so the minor road was analyzed in terms of the drivers' response time. The key parameters taken with the stopwatch were:

- (1) Starting time when the traffic warden signals to stop or move.
- (2) Response time that was displayed by the stopwatch when vehicle stops or moves.

A. Procedure

Measurements were made on a manual basis for a period of twelve hours (12hours) beginning from 7.00a.m to 7.00pm at an hourly interval for seven days. Three observers were positioned where they had a clear view of the traffic. The queue lengths for each time sequence of the traffic warden controls were noted during each hour of the study and during each cycle. Several streams were considered; twenty runs during peak hour were analyzed, the tables were graphically presented in order to infer their patterns. Measurements were made in three partitions and only two runs were taken from each partition for analyzing and comparison. Also, the headways for the various vehicles (and indirectly, the drivers) were noted.

V. DATA ANALYSIS

Based on the data collected, the response time of the driver waiting to be served at the intersection and the peak and the lull periods were determined. Also, the mean, standard deviation and graphical representation of response times were used for analysis



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$$\text{Mean } (\bar{X}) = \sum \frac{X}{N} \tag{1}$$

$$\text{Variance } (\sigma^2) = \left(\frac{\sum (X - \bar{X})^2}{N - 1} \right) \text{ and Standard deviation} = \sqrt{\text{Var } (\sigma^2)} \tag{2}$$

Where:

Σ is called Sigma, means sum up

\bar{X} = Mean

X = Response of each vehicle

N = Total number of vehicles per run

A. Graphical representation

Figures 2- 8 and tables 1 and 2 show the graphical relationship of the driver's response time to stop and move and average response times respectively.

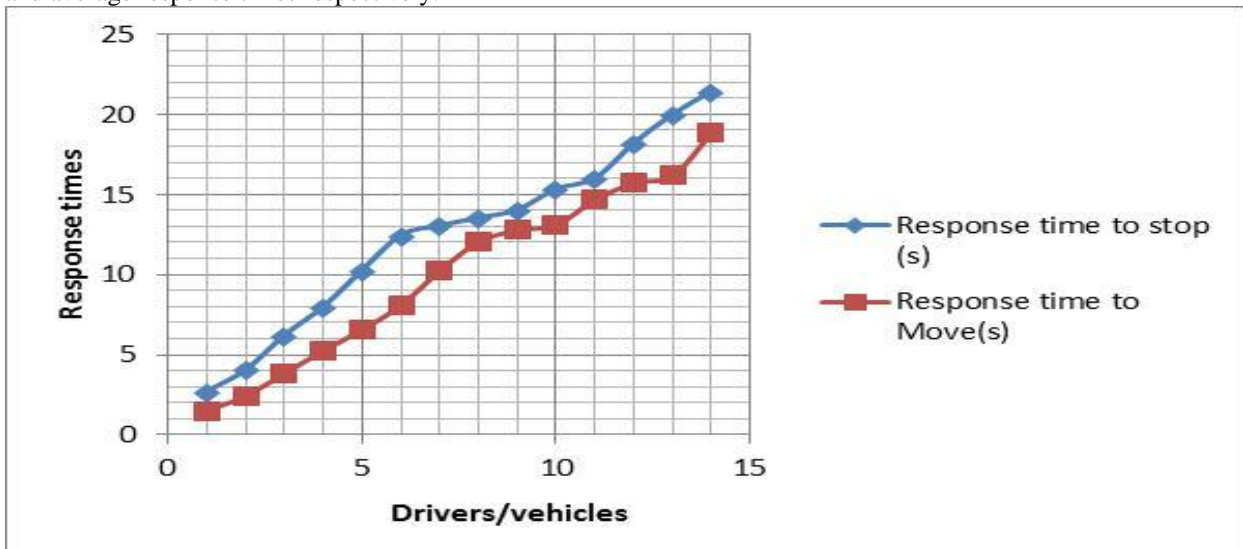


Fig 2 Perception- reaction time for day one

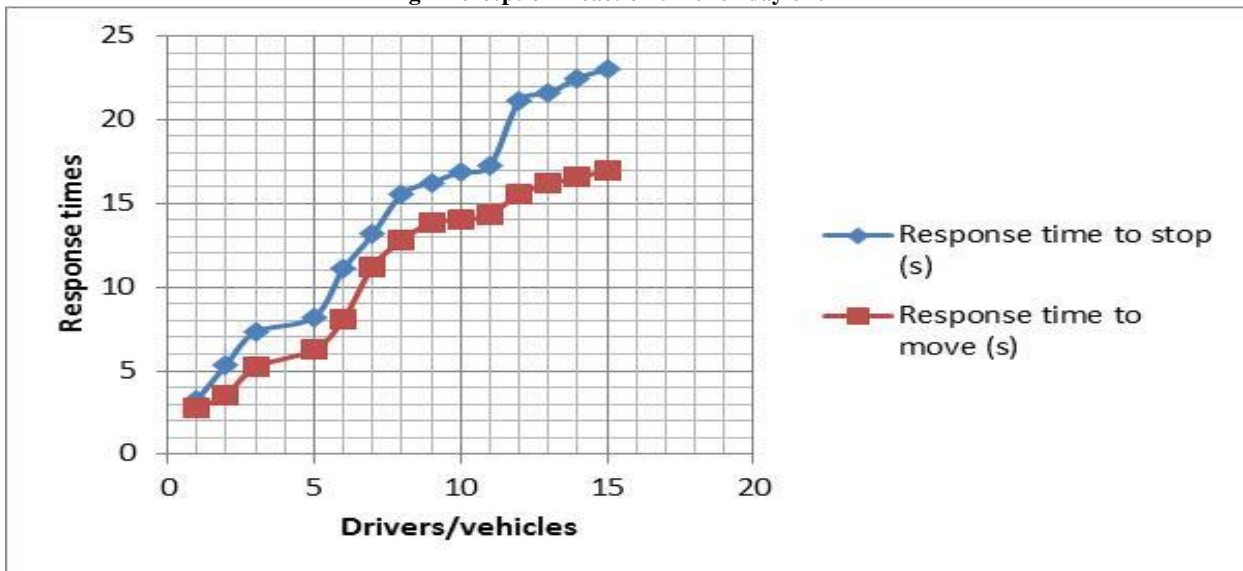


Fig 3 Perception- reaction time for day two



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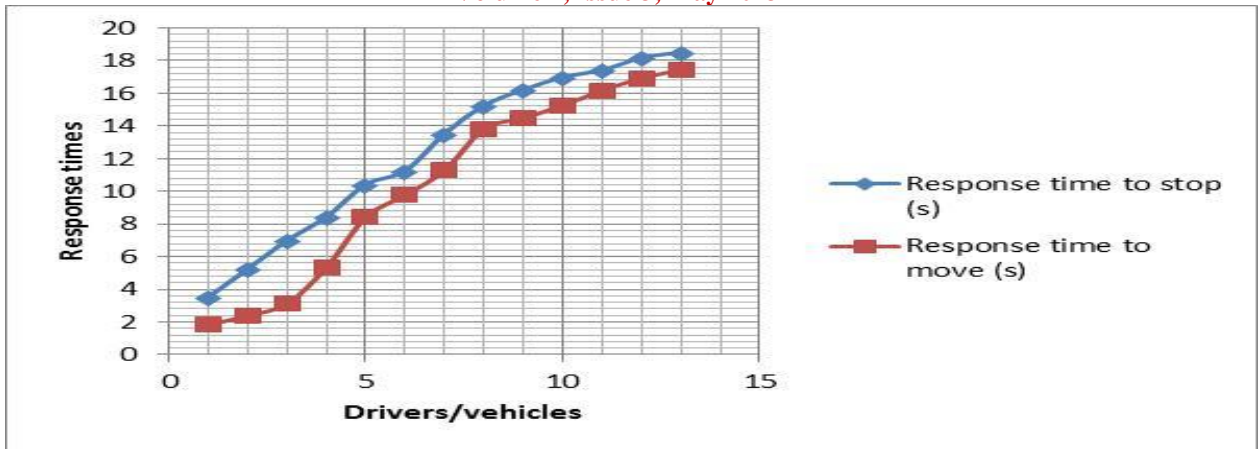


Fig 4 Perception- reaction time for day three

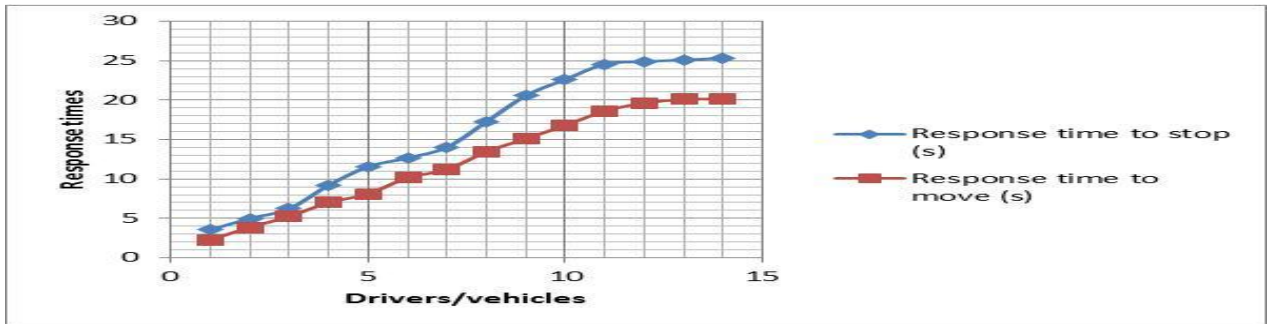


Fig 5 Perception- reaction time for day four

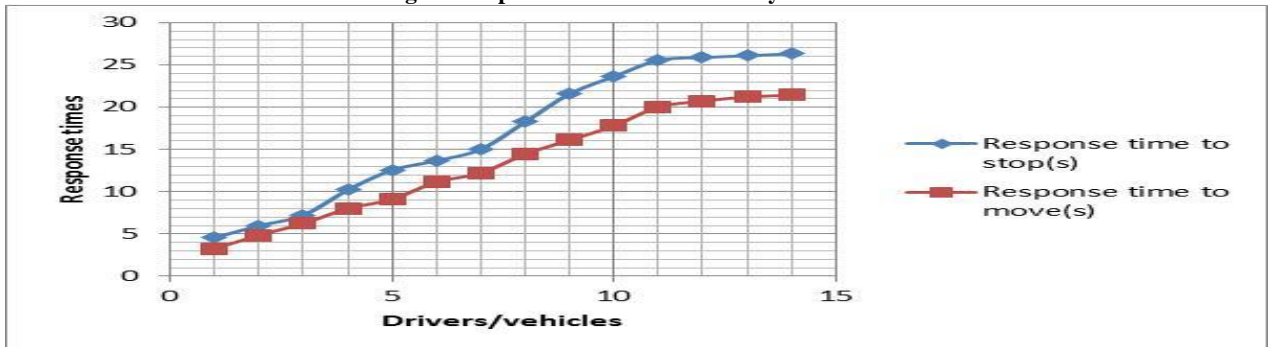


Fig 6 Perception- reaction time for day five

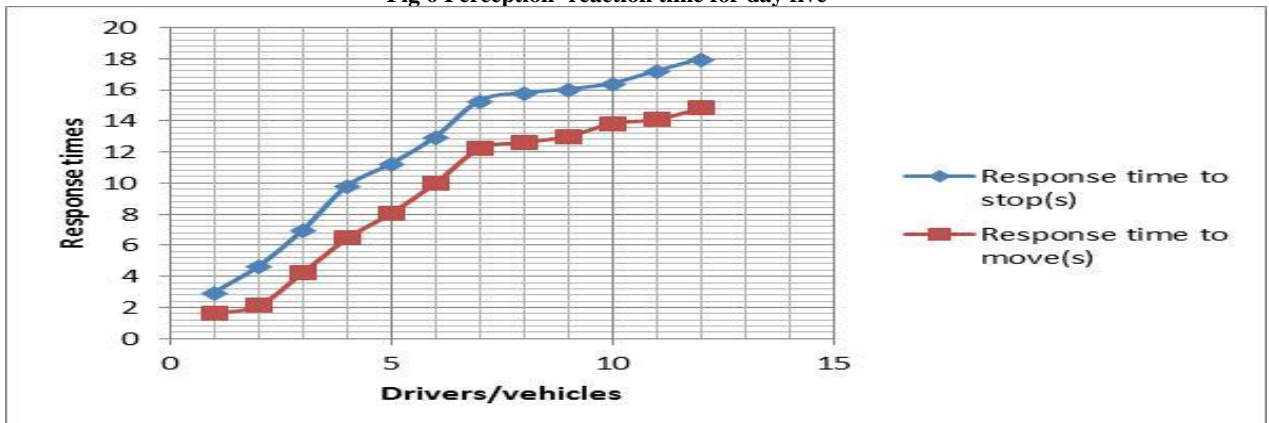


Fig 7 Perception- reaction time for day six



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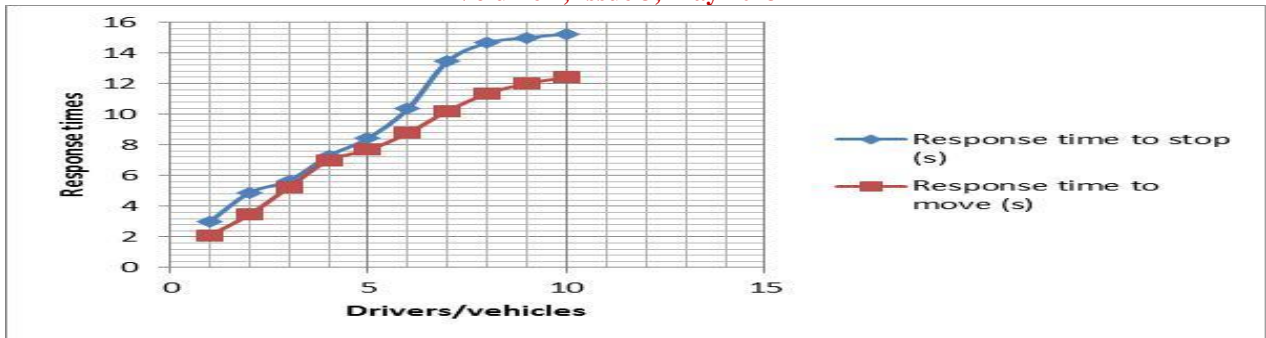


Fig 8 Perception- reaction time for day seven

Table 1. The average response time for each participate (driver) for stop signal.

Driver	1	2	3	4	5	6	7	8	9
Mean	2.72	4.65	5.98	7.99	9.63	11.96	14.53	15.28	15.97
STDEV	0.59	0.72	0.84	1.39	1.45	3.85	2.41	2.32	2.67

Driver	10	11	12	13	14	15
Mean	16.85	17.56	18.67	19.90	21.65	22.08
STDEV	2.45	2.61	2.78	2.80	2.88	3.00

Table 2 The average response time for each participate (driver) for move signal

Driver	1	2	3	4	5	6	7	8	9
Mean	1.63	2.51	3.37	5.31	7.30	8.59	10.02	11.42	12.68
STDEV	0.28	0.58	0.89	1.57	1.25	1.15	1.75	1.81	1.34

Driver	10	11	12	13	14	15
Mean	13.29	14.71	15.20	16.81	17.87	19.10
STDEV	1.99	2.67	1.92	2.21	2.34	2.56

VI. DISCUSSION OF RESULTS

From tables 1.0 and 1.1, the average response time for green signal is faster than the average response time for red signal. Fifteen (15) was the highest number of vehicles served at the intersection in a single queue at any given time for a week and 889 vehicles were served per run in a week. From the graphs of response time against drivers, it was deduced that those far behind do not have to see the warden signals before they response because the brake light of the preceding vehicle will dictate a signal to him. They do not need to see the traffic signal before they stop.

VII. CONCLUSION AND RECOMMENDATION

The morning peak periods vary between 8:00am and 10:00am while the morning lull period is between 11:00am and 12noon. The afternoon peak periods vary between 2:00 pm and 4:00pm and the afternoon lull period is between 6:00pm and 7:00pm. It could be deduced from the tables 1.0 and 1.1 that the average response time to stop is more than the average response to move. The average response times for the first vehicle to stop and move were 2.72secs and 1.63 secs respectively. A comparative analysis can only be done once a signalized intersection is installed and similar study be conducted using the same case study. Hence, one will be able to determine the most efficient and effective mode of traffic control between signalized and unsignalised intersection.

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