Assessment of Perception Reaction Parameters On Akure- Owo Highway In Ondo State, Nigeria.

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Abstract - This research has been carried out to estimate an average value of perception reaction time (PRT) for single carriageway road in Ondo State, Nigeria. It was deduced from the review that faster drivers have lower reaction time. This implies that PRT value is speed related. Traffic accident being another speed related parameter and Nigeria being on the high side of traffic accident fatality in Africa, the second to South Africa. This shows that low values of PRT are expected for Nigeria. The study was carried out on intercity roads emanating from the city Akure situated in the South –Western part of Nigeria. The road used was Akure-Owo, based on the fact that it is a major road and carry large volumes of traffic. Models relating vehicular spacing to speed (as a variable that affects drivers' PRT'); were developed. Data on Traffic Volume, Concentration and Spot Speed were collected. The developed models were evaluated for overall significance (F-test) at 0.05 level of significance (i.e. 95% level of confidence). The range of value of PRT for the three roads studied span between 1.14 to 1.37seconds and the overall average is 1.26seconds which is still within the average obtained by the various researchers that have conducted similar study. Using these average values with the recommended design speed of 100km/hr for roads in Nigeria (Field Work), the average stopping sight distance (SSD) was estimated to be 117m.This value of SSD is higher than the value of 87m for the highest speed limit of 100km/hr recommended for any road in Nigeria (Nigerian Highway Code). The implication is that drivers in the study area are able to bring their vehicle to a stop upon sighting an obstacle at a distance shorter than the standard required. These no doubt enhances safety on the roads under study and is within permissible limit.

Key words - roads, spacing, speed, perception reaction time, stopping sight distances, drivers.

INTRODUCTION.

One of the problems that face traffic and transportation engineers is accommodating the varying skills and perceptual abilities of drivers on highways. This could be due to the wide range of people's abilities to hear, see, evaluate and react to stimuli and studies show that these abilities may vary in an individual under different conditions such as drugs, fatigue and time of the day. (Garber and Hoel, 1999).

The deplorable conditions of roads in Nigeria contribute to the high level of accidents on the roads. Onwuibiko (2010) stated that Nigerian roads were death traps. Oguara (2010) stated that roads represent the major areas of investment in transportation and are the most dominant travel mode accounting for over 90% of passenger and goods transport in Nigeria. Due to vehicular accident that is very common in the area of study, it is necessary to determine the available perception reaction time (PRT) for a particular driver before one can decide if he had the opportunity to avoid an accident. In some cases, an obstacle appears so quickly that there is no enough time to avoid it, in other cases a driver may be inattentive and not react to the obstacle, even though there was an ample time to avoid the accident. Though there is a wide range of time agreed upon by experts as normal reaction times, the PRT of an operator may vary because he reacts under the stress of an impending accident Okigbo (2012).

In view of the aforementioned findings by various researchers and the fact that work in this area have been sparingly done, there is need to engage in research in the area so as to proffer solution to the problems. This work is therefore intended to estimate Perception reaction time on single carriage roads which originates from Akure in Ondo State, Nigeria.

PERCEPTION REACTION TIME

Perception reaction time is simply the time from when a driver of a vehicle sees an obstacle or object on a roadway to the time when he initiates an action to avoid the object. In other words, this is the time that elapses from the start of perception to the end of the reaction which is usually referred to as (Perception, Identification, Emotion and Volition) PIEV time (Roger *et.al.* 2004).

Driver perception reaction time has important consequences for both the design of safe roads and for the assessment of liability in court. Although, standard organizations have established norms, 2.5seconds in the United States and 2.0 seconds in Europe (Green, 2000). These values have sometimes been criticized, due to the fact that some components for braking responses time, as perception (eye movement, fixation and recognition) and initiating brake application, which is derived from empirical data and is in the 85th percentile were doubted during usage (Hooper and McGee, 1983a and 1983b). This has resulted that 1.5seconds represents an upper limit of a driver PRT which is the estimate of the simplest kind of reaction time with little or no delay. Many researchers have therefore continued to seek a canonical perception reaction time value and investigate the variables that affect it.

Research conducted based on human factors such as observed behavior, abilities, driver's expectancy, distractions, alcohol consumption and sleepiness etc defined perception-reaction times for design as 2.5seconds and operations/control as 1.0seconds. These perception-reactions of 85th percentile of drivers could react in that time or less AASHTO, (2004). Wortman and Mathias (1983) reported both the 'surprise' and alerted 85th percentile perception-reaction times in an urban environment to be 0.9seconds and 1.3seconds respectively.

Table 1: Summary of Brake Reaction Time Studies.

Name of Authors	85th Percentile	95th Percentile.
Gazis et al. (1960)	1.48	1.75
Wortman et al.(1983)	1.80	2.35
Chang et al. (1985)	1.90	2.50
Sivak et al. (1982)	1.78	2.40

Source: Transportation Research Institute, 1997.

FACTORS THAT DETERMINE THE PERCEPTION REACTION TIME OF A DRIVER.

There are a number of factors that affect and determine the perception-reaction time while driving; the factors are discussed below;

1. SIGHT OF DRIVER

Basic eyesight is one of the most important considerations for perceptions in terms of general vision and a possible need for corrective lenses. Distractions inside or outside of a vehicle can cause drivers to stop looking at the road while driving. A vision test is often required to receive a driver's license in many countries and this is used to ensure that drivers are able to see properly other vehicles and objects while driving Green (2009). Use of corrective lenses is typically necessary for drivers who may have impaired vision, and hearing impairments may also be considered with regard to overall driving perception.

Distractions can have a tremendous impact on someone's perception while driving Green, (2008). If a driver is looking at a passenger or in the mirror, then he or she has reduced perception of the road. Distractions both inside and outside of a vehicle should be considered dangerous, as anything that captures the attention of a driver can be detrimental to his or her general perception. Sleepiness can also have a detrimental impact upon a person's perception while driving. Someone who falls asleep while driving loses a great of perception, since his or her eyes typically close and can no longer see the road even while awake and battling sleepiness, however a driver may have his or her hazard perception reduced. Green, (2008).

2. DRIVER EXPECTANCY

Reaction times are greatly affected by whether the driver is alert to the need to brake. It was useful to divide alertness into three classes;

Expected: the driver is alert and aware of the good possibility that braking will be necessary. This is the absolute best reaction time possible. The best estimate is 0.7 second of this, 0.5 is perception and 0.2 is movement, the time required to release the accelerator and to depress the brake pedal Green, M. (2009)

Unexpected: the driver detects a common road signal such as a brake from the car ahead or from a traffic signal. Reaction time is somewhat slower, about 1.25 seconds. This is due to the increase in perception time to over a second with movement time still about 0.2 second Green, M. (2009)

Surprise: the driver encounters a very unusual circumstance, such as a pedestrian or another car crossing the road in the near distance. There is extra time needed to interpret the event and to decide upon response. Reaction time depends to some extent on the distance to the obstacle and whether it is approaching from the side and is first seen in peripheral vision. The best estimate is 1.5 seconds for side incursions and perhaps a few tenths of a second faster for straight-ahead obstacles. Perception time is 1.2 seconds while movement time lengthens to 0.3 second Green, M. (2009)

3. PAVEMENT COEFFICIENT OF FRICTION.

The coefficient of friction is the ratio of the force necessary to move one body horizontally over another at a constant speed to the weight of the body. The one used for design on arterials or open highways is based on the number of studies that measured the locked-wheel skid resistance on poor wet pavements. Transportation Research Institute, (1997).

The coefficient of friction depends on the speed of the vehicle, the higher the speed the lesser will be the value of coefficient of friction, it also depend on the type and the condition of pavement, the type means whether it is a bituminous pavement, water bound macadam, harden road or a concrete road. It also depend on the condition of pavement whether it is dry or wet. The value of coefficient of friction value is normally much lesser on wet pavement as compared to the pavement which is in dry condition Bhargrab, M.(2007).

The type and condition of tyres also affects the coefficient of friction which also have an effect on the perception reaction time of the driver. Old tyres, worn out tyres which are practically flat and new tyre with very good thread behave in different way and have different break efficiency. The coefficient of friction varies depending on all these factors but for design purpose Indian Roads Congress has recommended a value in the range of 0.35 to 4 depending on the speed of the vehicle Bhargrab, M, (2007)

4. VEHICLE SPEED.

The vehicular speed is the one employed in the analysis of stopping sight distance which is typically the design speed. However in an area where there are wet conditions, the running speed is used AASHTO. (2004). The recent data shown by AASHTO(2004), shows that drivers do not slow appreciably on wet pavements, therefore it recommends that the design speed should be used to determine sight distance criteria. Although, when the design speeds are not known, the operating speed on the roadway is used. Table 2 gives AASHTO design speeds corresponding to the different coefficients of friction.

Table 2: Design Speed and Coefficients of Friction for Stopping Sight Distance on Poor Pavements.

Design Speed (km/h)	Running Speed (km/h)	AASHTO Coefficient of Friction
30	32	0.40
50	45	0.35
65	58	0.32
80	71	0.30
100	84	0.29
115	93	0.28

Source: AASHTO (2004).

5. BREAK EFFICIENCY.

People brake faster when there is great urgency, when the time to collision is briefer. The driver is travelling faster and/or the obstacle is near when first seen. While brake times generally fall with greater urgency, there are circumstances where reaction time becomes very long when time-to-collision is very short Green, (2008). The most common situation is that the driver has the option of steering into the oncoming lane in order to avoid the obstacle. The driver then must consider alternative responses like braking and steering, weigh the dangers of each response and checking the left lane for traffic etc. When other driving or non driving matters consume the driver's attention, then brake time becomes longer. For example, on a winding road, the driver must attend more to steering the car through the turns. Another major load on attention is the use of in-car displays and cell phones. There is no doubt that both cause delays in reaction times, with estimates ranging from 0.3 to as high a second or more, depending on the circumstance Habeeb (2008).

More complex muscular responses take longer. For example, braking requires lifting the foot from the accelerator, moving laterally to the brake pedal and then depressing. This is far more complex than turning the steering wheel. While there have been relatively few studies of steering reaction time, they find steering to be 0.15 to 0.3 second faster. Perception times are presumably the same, but assuming the hands are on the steering wheel, the movement required to turn a wheel is performed much faster than that required to move the foot from accelerator to break pedal Green (2009).

MATERIALS AND METHODS.

THE ROADS IN FOCUS

Three intercity roads emanating from the city of Akure were selected for the study. These are Akure-Owo, Akure-Ondo, and Akure-Ilesa roads, all of which are single carriageways. Akure-Owo road extends to Edo, Delta and Kogi States. Akure-Ondo road extends to Ogun, Osun, and Lagos States while Akure-Ilesa extends to Osun, Oyo, Lagos, Ekiti and Kwara States

DATA COLLECTION AND REDUCTION.

These types of traffic studies were conducted on each of the roads in the process of data collection. These are;

(i) Road link volume study (to determine peak and off – peak periods)

(ii) Concentration study (to determine average vehicular space headway)

(iii) Spot speed study (to determine time-mean speed)

The field studies were carried out in two phases. The first being the road link volume study and the second phase covered concentration and spot speed studies which were carried out concurrently. Road link volume study was conducted to serve as a preliminary study in order to assess the nature of traffic volumes on the roads and more importantly to determine the peak and off peak periods which will be of importance to the second phase of the data collection.

ROAD LINK VOLUME STUDY

Manual counts were employed for this study. The method involved the use of field observers to record the traffic volumes on prescribed record sheets. Data were collected at a suitable location along each of the roadways for a period of eleven hours (7am to 6pm) per day for seven days. At each of the locations, traffic counts for various classes of vehicles (motorcycles, cars, minibuses, buses, trucks, and trailers) were taken for both directions (an observer per traffic direction) . The hourly observed traffic volumes were reduced from different number of vehicles to their equivalent passenger car units. (pcu), based on the following conversions factors as proposed by Salter (1985).

Table 3: Conversion Factors to Passenger Car Units

Type of Vehicle	Passenger Cars Unit
Motorcycles	0.33
Cars (including minibuses & pickup vans)	1.00
Heavy Vehicles (trucks and goods vehicles)	1.75
Buses and Trailers	2.25

Source: Salter (1985)

Two peak and two off-peak hours for both morning (7am to 12pm) and afternoon (12pm to 6pm) were determined for each road by computing the weekly average hourly volume for each hour (based on pcu). These peak and off-peak traffic periods were used for the concentration and spot speed studies.

Data collections for second phase of the study were conducted for off peak and peak periods for morning and afternoon periods. Data for morning off peak period were collected between 7am – 9am while morning peak period were between 9am – 11am. Data for afternoon off peak period were collected between 12pm – 2pm while the peak period data was collected between 3pm – 5pm.

CONCENTRATION AND SPACING STUDIES.

The study was carried out with the aid of Digital-Camera for a period of eight hours (two peak and two off peak hours) for both morning and afternoon on each traffic direction; the data were collected on the day having the highest daily traffic volume (busiest day) determined from the seven days traffic volume count. A suitable straight section 250m long was chosen for the study: Between Benin Motor Park to Federal Government Girls College gate along Akure-Owo highway. In collecting the data a photograph of the chosen roadway segment is taken as the vehicle pass, to capture the image of the moving vehicles within the section. Image of moving vehicles was captured ten times for every hour per traffic direction. The ratio of the number of vehicles appearing to the length of roadway segment (occupied by the vehicles) gives the concentration of the vehicular stream. Concentration, sometimes referred to as density is simply the average per unit length of a roadway at a point in time. It is expressed as vehicles per kilometer (Veh/km) and is defined as,

$$k = n/L \quad (1)$$

where,

n = the number of vehicles on the road

L = the length of the road section

The average spacing is then determined from the relation;

$$H_d = \frac{1}{k} \quad (2)$$

where H_d is the average spacing in meters.

SPOT SPEED STUDY

This study was carried out to measure the instantaneous speed of vehicles at a specified location, between Benin Motor Park to Federal Government Girls College gate along Akure-Owo highway. In collecting the data a photograph of the chosen Data for this study were collected concurrently with that of concentration study. The method used for this study is described as follows, Two parallel lines 30m apart (called trap) were drawn across roadway section and an observer was stationed on each traffic direction to record the time taken by vehicles to cross the section using a stop watch. The time taken by a vehicle is obtained by starting the stopwatch as soon as the front bumper of a vehicle crosses the first line. Immediately the same bumper crosses the second line, the stop watch was then reset to zero and the process repeated as the vehicles cross the marked section. The observation for each hour was made separately by random sampling. The spot speed for every hour is determined from the spot speed data, which is the speed used in the regression model formulation. As mentioned in Transportation Research Board (2005) time mean speed is used in assessing uninterrupted flow, as exists on the road sections in this study.

Time mean speed is the mean of the speed of the vehicles passing a point on the roadway in a particular time interval expressed in kilometer per hour (km/hr) and is defined as;

$$Vt = \frac{1}{n}\sum_{i=1}^{n} Vi \quad (3)$$

Where Vi is the speed of vehicle i at a point on roadway.

REGRESSION MODEL FORMATION

Stopping sight distance (SSD) is the length of the highway visible to driver over which he is required to bring his vehicle to safe stop before reaching an object. It is considered from the perspectives of driver and vehicle characteristics.

With respect to the driver and vehicle characteristics, stopping sight distance is made up of

(a) the distance travelled during perception time,
(b) the distance travelled during the brake reaction

According to AASHTO, 2004, the distance travelled in the (SSD) formula is given by the relation:

$$SSD= PV + V^2/[2g(f\pm i)] \text{ (AASHTO, 2004)} \quad (4)$$

where

V = the speed from which stop is made in meter per second

P = the perception reaction time in seconds

f = the coefficient of friction (for both pavement)

i = the percent of grade (added for upgrade and subtracted for down grade)

The first term (PV) is the distance travelled during the perception reaction time. The usual value for perception and brake reaction times are 1.5 and 1.0 seconds respectively, in most road conditions encountered. The second term is the minimum velocity, V in m/s and g is acceleration due to gravity. The SSD is in meters. Where the SSD is the length of the highway visible to driver over which he is required to bring his vehicle to safe stop before reaching an object. If L is taken as the length of a vehicle, then the headway can be expressed as

$$H_d = L + PV + \frac{V^2}{\{2g(f \pm i)\}} \quad (5)$$

On a level road, one with zero incline ($i.e., i = 0$), *the equation becomes.*

$$H_d = L + PV + V^2/2gf \quad (6)$$

and this can be written as

$$Hd = a + bV + cV^2 \quad (7)$$

where,

$$c = \frac{1}{2gf} \quad (8)$$

where $H = H_d$; a=L; b=P and c= $\frac{1}{2gf}$ respectively.

Thus H_d is the regressed on V with the regression line passing through an intercept ‘a’ on the vertical axis. The intercept ‘a’ represents the length of a vehicle. The value of P (perception reaction time) was obtained from the coefficient of V (i.e. b). The estimation of the model was achieved with the aid of the SPSS package which is illustrated as follows:

(i) The SPSS Software was opened in the computer system.

(ii) On the SPSS software two icons at the base were labeled 'Data view and 'Variable view' respectively.

(iii) On the variable icon, the variables which comprises of the dependent and independent variables respectively were labeled.

(iv) After labeling the variables, the data view was used to carry out the analysis.

(v) On the 'Data view' icon, the 'analyze' icon was clicked on.

(vi) Series of prop-up information appeared from 'reports' to 'ROC Curve'.

(vii) Out of these labeled information, 'Regression' icon was clicked on.

(viii) Series of information appears ranging from 'Linear' to 'Optimal Scaling.'

(ix) Since the research analysis was based on polynomial model, the 'Curve Estimation' was clicked on.

(x) A prop-up box appears based on the 'curve estimation' containing series of information like Dependent, independent models (Linear, Quadratic, Compound, Growth, Logarithm etc), display ANOVA table and so on.

(xi) There would be an arrow that will direct the variable(s) to their respective location.

(xii) The 'ok' icon was clicked to analyze the research data and the result of the output finally showed up.

As mentioned earlier, three roads were used for the study and each traffic direction considered separately. As a result, six models (two models per road, i.e., one per traffic direction) were developed. The models are evaluated for overall significance (F-test) at 0.05 level of significance.

RESULTS AND DISCUSSION

TRAFFIC VOLUME.

It was stated earlier that the ultimate aim of the traffic volume study was to establish peak and off peak periods. The data obtained for seven days were reduced to Average Hourly Volume (AHV) in passenger car unit (pcu), and this is as presented in Tables 4, 5 and 6 for Akure - Owo road.

Table: 4 AVERAGE HOURLY VOLUME (pcu) FOR AKURE – OWO ROAD

HOUR		TRAFFIC DIRECTION	
		AKURE-OWO	OWO-AKURE
MORNING	7am -8am	367	327
	8am -9am	455	382
	9am -10am	406	362
	10am-11am	420	422
	11am -12pm	525	445
	12pm -1pm	512	544
AFTERNOON	1pm -2pm	461	551
	2pm -3pm	488	539
	3pm -4pm	454	528
	4pm -5pm	518	549
	5pm -6pm	438	475

AVERAGE SPACING.

Tables 4, 5, and 6 present the data for spacing, H_d (m), for the road studied. The data were derived from the results of concentration (number of vehicles per unit length of road section) study.

TABLE 5: Average Spacing for Akure- Owo Road

Traffic Direction									
AKURE-OWO					OWO-AKURE				
	Morning		Afternoon			Morning		Afternoon	
Hour	H_d (m)	Mean of H_d (m)	H_d (m)	Mean of H_d (m)	Hour	H_d (m)	Mean of H_d (m)	H_d (m)	Mean of H_d (m)
	55.56		32.26			43.48		52.63	
	38.46		66.67			66.67		66.67	
	45.45		55.56			52.63		37.04	
	55.56		45.45			35.71		37.04	
OPK1	33.33		52.63	48.03		32.26	50.02	71.43	
	38.46	48.88	52.63		OPK1	66.67		43.48	47.02
	38.46		37.04			43.48		55.56	
	66.67		45.45			37.04		37.04	
	45.45		37.04			55.56		32.26	
	71.43		55.56			66.67		37.04	
	55.56		43.48			52.63		45.45	
	45.45		52.63			37.04		52.63	
	43.48		43.48			43.48		45.45	
	43.48		55.56			37.04		43.48	
OPK2	37.04		45.45	49.22		66.67	47.40	38.46	48.29
	55.56		45.45		OPK2	55.56		52.63	
	45.45	47.66	38.46			37.04		66.67	
	38.46		45.45			45.45		35.71	
	66.67		66.67			43.48		66.67	
	45.45		55.56			55.56		35.71	
	32.26		31.25			32.26		23.26	
	32.26		27.78			37.04		37.04	
	29.41		28.57			43.48		32.26	
	28.57		32.26			28.57		33.33	
PK1`	32.26		52.63			33.33		43.48	34.32
	25.64	33.96	33.33	35.34	PK1	27.78	32.61	27.78	
	37.04		28.57			37.04		27.78	
	43.48		38.46			26.32		52.13	
	37.04		43.48			23.26		33.33	
	41.67		37.04			37.04		32.26	
	32.26		25			50		28.57	
	52.63		27.78			31.25		43.48	
	37.04		23.26			43.48		23.26	
	32.26		33.33			33.33		37.04	
	27.78	32.07	37.04	36.74	PK2	27.78		25.64	
PK2	31.25		52.63			27.78	37.31	37.04	
	29.41		43.48			35.72		38.46	33.13
	28.57		32.26			52.63		32.26	
	23.81		55.56			25.64		32.26	
	25.64		37.04			45.45		33.33	

LEGEND: OPK1- 1st Off-peak period OPK2- 2nd Off peak period

PK1 – Peak Period PK2 – 2nd Peak Period.

TIME-MEAN SPEED.

Table 6 presents the data for the time-mean speed in both directions for the road studied

TABLE 6: Time –Mean Speed (km/h) For the Road Studied.

Route and Period		PERIOD							
		Morning				Afternoon			
		OPK1	OPK2	PK1	PK2	OPK1	OPK2	PK1	PK2
AKR-OWO	AKR-OWO	64.37	63.25	47.99	45.47	64.01	64.73	49.50	51.16
	OWO-AKR	65.34	62.75	46.12	51.77	62.50	63.83	48.20	46.94

LEGEND: OPK1- 1st Off-peak period OPK2- 2nd Off peak period

PK1 – 1st Peak Period PK2 – 2nd Peak Period.

DATA ANALYSIS.

The variables considered in the analysis are; the average space headway, H_d (as the dependent variable) and time-mean speed, V (as the independent variable). The resulting models from this analysis were evaluated for overall significance F-Test at 0.05 level of significance (i.e. 95% level of confidence)

Level of confidence is the level that is usually considered as the middle-of-the road in research. At this level, there is only 5% chance that a conclusion drawn from the analysis of the data available is in error or that the researcher is 95% confident of the inferences made (Osula and Adebisi. 2001).

The regression was run for the road studied and a model was developed for each traffic direction. The data used for the analysis (i.e. values of H_d and V and are shown in Tables 7)

TABLE 7: Variables Used in the Regression Analysis for Akure – Owo Road for Headway and Time Mean Speed

Period.		Traffic Direction and Variables			
		Akure to Owo		Owo to Akure	
		Hd (m)	V (km/h)	Hd (m)	V (km/h)
Morning	OPK1	48.88	64.37	50.02	65.34
	OPK2	47.66	63.25	47.40	62.75
	PK1	33.96	47.99	32.61	46.12
	PK2	32.07	45.47	37.31	51.77
Afternoon	OPK1	48.03	64.01	47.02	62.50
	OPK2	49.22	64.73	48.29	63.83
	PK1	35.34	49.50	34.32	48.20
	PK2	36.74	51.16	33.13	46.94

DISCUSSION

As stated earlier in equation (vi), a polynomial regression (quadratic) was carried out relating spacing, H_d,(as the dependent variable) and time-mean speed V (as the independent variable) the values of H_d and V in Tables 4 is used for the regression analysis and the values are shown in the table below:

Table 8: Regression Analysis for Headway and Spacing for Akure to Owo Road.

Model	Variables Entered	Variables Removed	Method
1	V_{square} V^a	H_d	Enter

Variables Entered/Removed

a. All requested variables entered.
b. Dependent Variable. H_d

Table 8a Model Summary for Headway and Spacing from Akure to Owo Road.

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Durbin Watson
1	1.000[a]	1.000	0.999	0.18864	2.384

a. Predictors (constant), V_{square}

b. Dependent Variable H_d

Table 8b ANOVA Table for Headway and Spacing from Akure to Owo Road.

Model	Sum of Squares	Df	Mean Square	F	Sig.
1. Regression	400.850	2	200.425	5632.211	0.000[a]
Residual	178	5	0.036		
Total.	401.028	7			

a. Predictors (constant), V_{square}

b. Dependent Variable H_d

Table 8c Coefficients Table for Headway and Spacing from Akure to Owo Road.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	7.008	8.525		0.822	0.448
V	1.140	1.119	0.355	1.019	0.355
V_{square}	0.67	0.36	0.645	1.854	0.123

Table 8d Coefficients Table for Headway and Spacing from Akure to Owo Road.

Model	95% Confidence Interval for B	
	Lower Bound	Upper Bound
1. (Constants)	-14.906	28.922
V	-1.736	4.016
V_{square}	-0.026	0.159

Table 8e Residuals Statistics for Headway and Spacing from Akure to Owo Road.

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	32.0496	49.0775	41.4875	7.56732	8
Residual	-0.34220	0.15581	0.00000	0.15943	8
Std. Predicted Value	-1.247	1.003	0.000	1.000	8
Std. Residual	-1.814	0.826	0,000	0.845	8

a: Dependent Variable: H_d

From the regression analysis in Table 7, which was reduced to the values in Table 8a to 8d respectively using the SPSS package, the following values are used for the development of the model proposed for the road studied (i.e. a model per traffic direction).

For Owo-Akure highway, using equation (9):

$$H_d = a + bV + cV^2 \quad (9)$$

where,

H_d = spacing (dependent variable)

V = Velocity (independent variable)

a = Constant which represent the length of the vehicle

b = Coefficient which represents the Perception Reaction Time

c = Coefficient which represents 1/2gf.

(1) <u>Akure- Owo Road:</u>

Akure to Owo Traffic Direction:

$$Hd = 7.008 + 1.14V + 0.671V^2 \quad (10)$$

Owo to Akure Traffic Direction:

$$Hd = 7.292 + 1.225V + 0.701V^2 \quad (11)$$

From the results presented in Table 8a-8e, it can be seen that the values of the perception reaction time estimated are 1.140seconds and 1.225seconds and the average perception reaction time is 1.18seconds. This is the same thing for the lengths of vehicles and the coefficient c (or $\frac{1}{2gf}$). These insignificant differences may be due to number of reasons, which includes the following:

(i) The road studied is a single carriageway in nature and are approximately of the same width.

(ii) The study was carried out in a good field conditions.

(iii) The terrain of the road is relatively flat.

The ranges of the average value of the directional (traffic direction) time-mean speeds and spacing are 12.63m/s(45.47km/hr) to 18.07m/s(65.04km/hr) and 32.07m to 50.02m respectively and the overall average value of the spacing is 41.38m for Akure- Owo Road. For these averages, it can be seen that Akure- Owo Road have a lower speed and the weekly average hourly traffic volume (pcu) of 4975 and a coefficient of friction of 0.75. This value is high because the data collected for this work were for dry condition and more friction is expected in dry condition that the wet one. However, the value of 0.75 for *f*, obtained from this work can be considered in order when compared with the nominal value of 0.65 stipulated by AASHTO for dry pavement condition. The deviation of the value obtained from this work from this AASHTO's value may be due to the difference in the several factors like the sight of the driver, driver expectancy, pavement coefficient of friction, vehicle speed and break efficiency respectively as affecting the PRT values.

The estimated value of PRT is 1.18seconds. The overall average value is low when compared with the value of 2.50seconds recommended by AASHTO and those estimated by other researchers. This is as postulated in the subsidiary hypothesis and gives credence to this research effort especially when the 1.26seconds is within the range of 1.26 to 3.6seconds estimated by Triggs and Harris (1982) from series of studies conducted to assess the response times of drivers to a range of unexpected static stimuli.

Using the overall average values of PRT (1.18seconds) and *f*, (0.75) for the current design speed and highest speed limit of 100km/hr recommended for any type of vehicle on any road in Nigeria, the average stopping sight distance SSD was estimated to be 34.67m

For V = 100km/hr,

$$SSD = \frac{1.18\times1000\times100}{3600}+\frac{100\times1000}{3600} \times \frac{1}{2\times9.81\times0.75} = 34.67m \cong 35m \qquad (12)$$

This value of SSD is lower than the 92m for the same speed in the Nigerian Highway Code

The implication is that drivers in the study area are able to bring their vehicle to a stop upon sighting an obstacle at a distance shorter than the standard required. These no doubt enhances safety on the roads under study and is within permissible limit.

CONCLUSIONS

From the investigations carried out in this work, a relationship exists between driver perception reaction time and vehicular spacing characteristics in Nigerian roads especially in Ondo State. The average value of the PRT estimated was 1.18seconds which is lower than the one recommended by AASHTO of 2.5seconds. Model developed for t he roads will serve as basis for the determination of the perception reaction time for the drivers plying the road.

In view of these findings, Design and construction of roads should take into consideration perception reaction parameters for safety enhancement, The stopping and passing sight distances requirement should be adequately factored into road design and construction. Road safety measures e.g. appropriately textured riding surfacing, roads sign; both regulatory and prohibitory should be introduced. And it can be replicated in other area in Nigeria to compare the perception reaction time.

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