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A descriptive and inferential analysis of on-street parking volume in Nigeria –A case study of Ibadan

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Abstract. Urbanization is a term used for capturing the process by which a rural settlement transforms into the urban way of life. It is associated with development and civilization. A multitude of push and pull factors is causing a rapid growth in Nigeria's process of urbanization. Observations from urban centres in Nigeria have outlined various threats faced due to urbanizations such as the risk of environmental hazards, health hazards, and so on. The intense urbanization in Nigeria has further generated urban traffic crises among city dwellers. This traffic exist in different forms but majorly in the road transportation systems. The study analyzes and generate inferences on the stationary vehicular traffic count which was carried out at three areas in the third Africa largest city–Ibadan. Factors such as time point, routes and six (6) categories of vehicles plying the routes were taken into consideration to check whether or not there is a significant difference within each factors. Routes across the study locations with hectic traffic were discovered, such as Efunsetan to MRS and Ososami to Liberty at Challenge, Iwo Road to Abayomi at Gate, First Bank to Ogunpa at Dugbe. Sensitization of road users, strict law enforcement and construction of spaces for stationary vehicles were some of the recommendations made to reduce traffic.

1. Introduction

An increase in the global urban population has been observed right from 1900 till date. The population increased from 13% in 1900 to 29% in 1950; it became 49% in 2005 and it has been forecasted to increase up to 60% by 2030 [1]. This increase has been said to be more intense in the 21st century due to the number of persons moving to cities and the development of rural environs itself. For instance, more than four hundred (400) cities have a population of a million or more and the developing nation is most likely to have develop into urban in character than rural [2]. In the Nigeria society, a multitude of push and pull factors is causing a rapid growth in her process of urbanization [3]. Based on observation from urban centres in Nigeria, threat faced due to urbanizations have been observed to include increase in poverty due to the inability of the local authorities to provide services to all individuals, multiple health hazards caused by factors such as high volume of unorganized wastes [4–7] and concentrated energy use, risk of environmental hazards like flash floods, automobile exhausts producing elevated lead levels in the atmosphere and so on.



The intense urbanization in Nigeria has further generated urban traffic crises among city dwellers. This traffic exist in different forms but majorly in the road transportation system. Many of these road traffics are influenced by the environmental factors, behaviour of the drivers, weather condition, time of the day, road design and majorly high on-street parking [8–12] and this can in turn affect road safety. The development of the transportation system is an infrastructure that generates growth in terms of a nation's socio-economic growth process [13]. Various researchers such as [14–19] have written different articles on traffic flow and its modelling among others. This study involves traffic count of stationary vehicle in three central business district in an urban area. The study seeks to describe the traffic distribution of stationary vehicles in each considered central business districts. The other objective of the study is to determine the existence of significant difference between the traffic distribution in each central business districts with respect to time, type of vehicle and the different routes within each district.

2. Methodology

The research was carried out in Ibadan. Ibadan is the capital city of Oyo State, Nigeria; the city has been said to be the largest and most populous city in Nigeria since independence, and the third largest in Africa. Three central business districts were considered in this study – Challenge, Gate and Dugbe. The on-street parking count was taken for six (6) routes each for Challenge and Gate, and eleven (11) routes for Dugbe (Table 1 – 3). The count was done for four (4) days with about 40 enumerators in each of the central business district. The count was recorded for every fifteen (15) minutes from 7:00 am – 7:00 pm each day. The enumerators were divided into two, such that a group covers 7:00 am – 1:00 pm while the other takes the count from 1:00 pm to 7:00 pm.

Table 1. Roads Considered in the Central Business District –Challenge.

Designation	Routes
CS1	Efunsetan to Tantalizer
CS2	Efunsetan to MRS
CS3	MRS to Iyana Anfaani
CS4	Startimes to Iyana Anfaani
CS5	Iyana Adeoyo to Liberty
CS6	Ososami to Liberty

Table 2. Roads Considered in the Central Business District – Gate.

Designation	Routes
GS1	Iwo Road to Abayomi
GS2	Yidi to Gate Beside Reservoir
GS3	Ibadan North LG to Gate Beside
GS4	Gate Beside Reservoir to Ibadan
GS5	Ibadan North Junction to Oba
GS6	NTA junction to Oba Ogundipe

Table 3. Roads Considered in the Central Business District –Dugbe.

Designation	Routes
DS1	Oando to Union Bank

DS2	Oando to Union Bank
DS3	Salvation Army to Dugbe Junction
DS4	Salvation Army to Dugbe Junction
DS5	Dugbe Junction to Post Office
DS6	J Allen to Oke Bola
DS7	Dugbe Junction to Post Office
DS8	First Bank to Ogunpa
DS9	First Bank to Ogunpa
DS10	Access Bank to UBA
DS11	J Allen to Oke Bola

The collected data was analyzed and presented in tables and charts. The design of the survey was done such that only the main effects were included.

$$x_{ij} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ij} \quad \text{and} \quad i = 1,2, \dots, m, \quad j = 1,2, \dots, n \dots \dots \dots (1)$$

Table 4. Analysis of Variance (ANOVA) Summary Table for Model (1).

Sources	SS	df	MSS	F
Factor A	SSA	1 – 1	MSA = SSA/(m – 1)	MSA/MSE
Factor B	SSB	m – 1	MSB = SSB/(n – 1)	MSB/MSE
Factor C	SSC	n – 1	MSC = SSC/(n – 1)	MSC/MSE
Error	SSE	lmn–1–m–n+2	MSE = SSE/(lmn–1–m–n+2)	
Total	TSS	lmn – 1		

Key: SS – Sum of Squares df – Degree of Freedom MS – Mean of Sum of Squares

Equation (1) is the constructed model for the design and the analysis format for its analysis of variance is summarized in table 4. For simplicity, the probability value popularly refer to as p-value for the f-statistics will be used to draw conclusion for each of the test. Levels of factor that are discovered to have significance difference will be compared in pair using the Duncan pairwise comparison test. All conclusions on significance are drawn on a 5% level of significance, that is, p-value < 0.05. Statistical Package for Social Sciences version 23 (SPSS 23) was used for analysis and Microsoft Excel Package was used for good and clear graphical presentation.

3. Result and Discussions

At Challenge area, CS1 was observed to experience the highest number of private cars parked along the street especially at the later hours of the day with its highest value experienced between the hours of 2:00 pm to 3:00 pm (figure 1a). CS2 and CS3 were observed to experience the highest cab traffic across the day (figure 1b). Bus traffic was observed to be much at CS3 (figure 1c). At the morning hours of the day, CS4 experience the highest motorcycle traffic while CS1 experienced it more any time after noon (figure 1d).

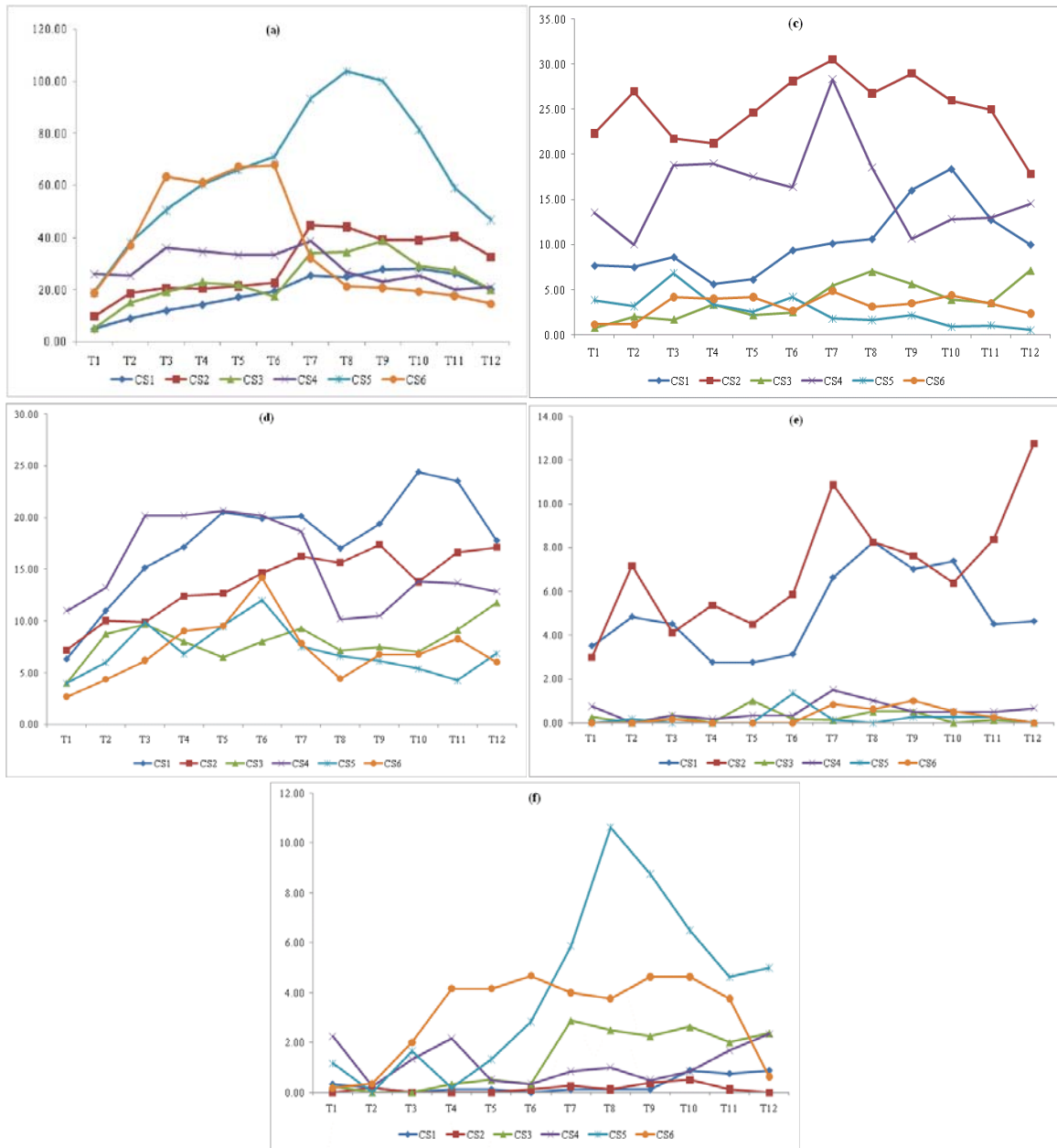


Figure 1. Vehicular On-street Parking at Challenge (a) Private Car (b) Cab (c) Bus (d) Motorcycle (e) Tricycle (f) Truck.

Table 5. Analysis of Variance Result of the Stationary Vehicular Traffic Count.

Area	Time		Routes		Vehicle	
	MSE	P-value	MSE	P-value	MSE	P-value
Challenge	193.761	0.106	856.655	0.000	12266.52	0.000
Gate	4.178	0.000	10.714	0.000	143.457	0.000

Dugbe	1.615	0.090	10.493	0.000	119.772	0.000
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Key: MSE – Mean Square Error P-value – Probability Value

Stationary tricycle traffic is maximally been experienced by CS2 (figure 1e) while stationary truck traffic was been experienced by CS6 at the early hours of the day and by CS5 at any time after 01:00 pm (figure 1f). Overall, the sum of the mean traffic flow was observed to be much at CS2 and less in CS6 between 01:00 pm to 07:00 pm. The traffic was observed to be much at CS2 within 07:00 am – 09:00 am, CS4 within 09:00 am – 12:00 noon and less within 07:00 am – 01:00 pm at CS1 (figure 2).

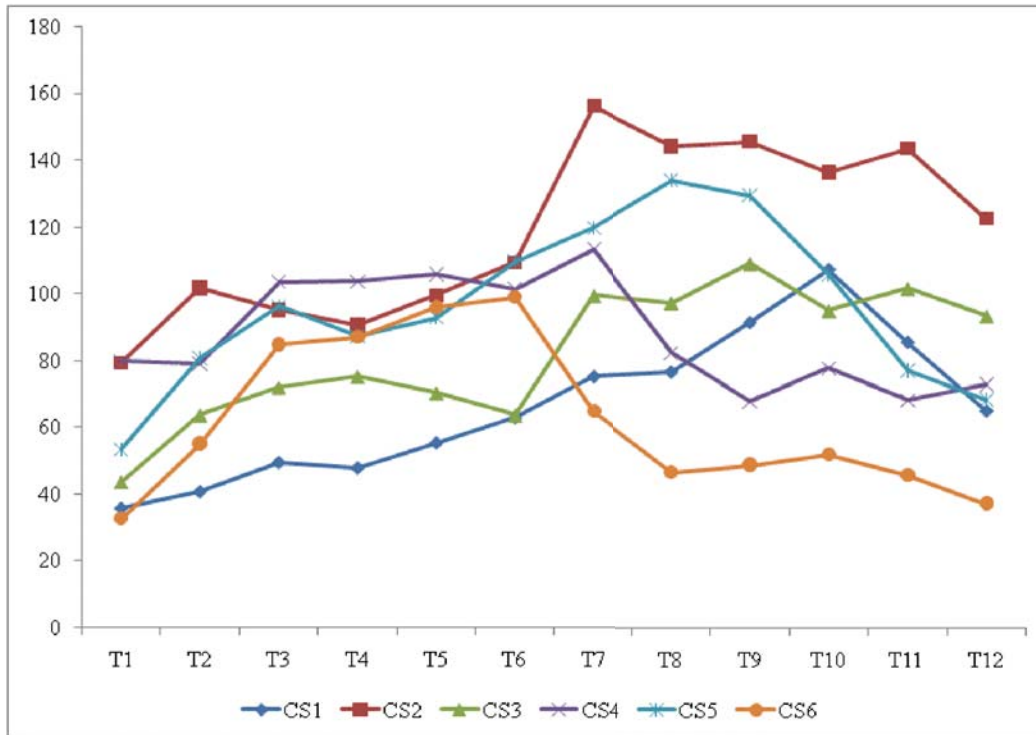


Figure 2. Stationary Vehicular Traffic Flow in Challenge Area.

The statistical test conducted for Challenge area inferred a no significant different for the traffic count across time but a significant difference was observed between the different routes in Challenge and vehicles plying the routes at p-value < 0.05 (Table 5). From Table 6, no significant difference was observed between the traffic flow recorded between CS1, CS3 and CS6. There was a significant difference between CS4 and CS6 but not between CS1 and CS3. Traffic flow was observed to be significantly different between CS2 and other routes at p-value < 0.05. Based on numerical mean observation, the flow of traffic at Challenge area was noticed to be much for private car with an overall average of thirty four (34) stationary cars, followed by twenty six (26) cabs, ten (10) buses, twelve (12) motorcycles, two (2) tricycles and two (2) trucks. A significant difference was observed between the six (6) categories of vehicle plying the area except that the differences were not significant between Tricycle and Truck, and also between Bus and Motorcycle at p-value < 0.05.

Table 6. Pairwise Test Result of Time, Route and Vehicle Factor Considered in Challenge Area.

Time	M±S.E	Routes	M±S.E	Vehicle	M±S.E
T1	9.007±1.854 ^a	CS1	11.000±1.311 ^{ab}	Private Car	33.820±1.311 ^d

T2	11.688±1.854 ^a	CS2	19.768±1.311 ^d	Cab	26.155±1.311 ^c
T3	13.908±1.854 ^a	CS3	13.653±1.311 ^{abc}	Bus	10.163±1.311 ^b
T4	13.650±1.854 ^a	CS4	14.669±1.311 ^{bc}	Motorcycle	11.501±1.311 ^b
T5	14.426±1.854 ^a	CS5	16.036±1.311 ^c	Tricycle	2.216±1.311 ^a
T6	15.153±1.854 ^a	CS6	10.408±1.311 ^a	Truck	1.678±1.311 ^a
T7	17.461±1.854 ^a				
T8	16.133±1.854 ^a				
T9	16.450±1.854 ^a				
T10	15.450±1.854 ^a				
T11	14.487±1.854 ^a				
T12	12.763±1.854 ^a				

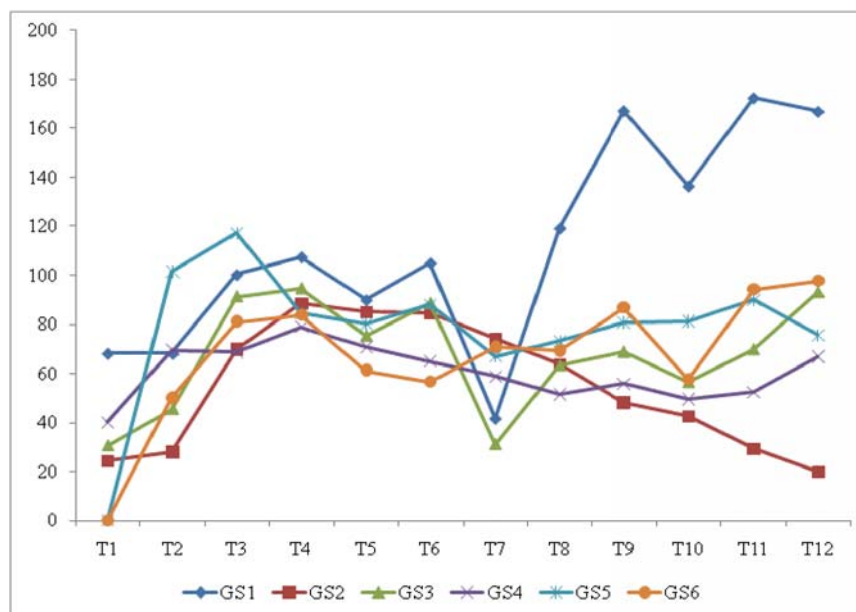


Figure 3. Stationary Vehicular Traffic Flow in Gate Area.

For Gate area, traffic flow pertaining to private cars was observed to be much experienced at GS1 any time after 02:00 pm (figure 4a) while traffic flow pertaining to cabs was observed to be much around GS1, GS2 and GS3, and mostly at GS1 anytime above 02:00 pm (figure 4b). The traffic flow of buses around Gate could not exactly be generalized except discussed per time point, however, GS5 seems to experience this kind of traffic at a very high rate within 08:00 am to 10:00 am (figure 4c); this same thing pertains to motorcycles (figure 4d). Generally, there is a steady tricycle traffic experience in GS6 (figure 4e) while truck traffic is also been experienced maximally in GS1 anytime above 02:00 pm. Overall, the sum of the mean traffic flow was observed to be high all through the day till evening except within 08:00 am – 10:00 am and 01:00 pm – 02:00 pm in GS1 (figure 3).

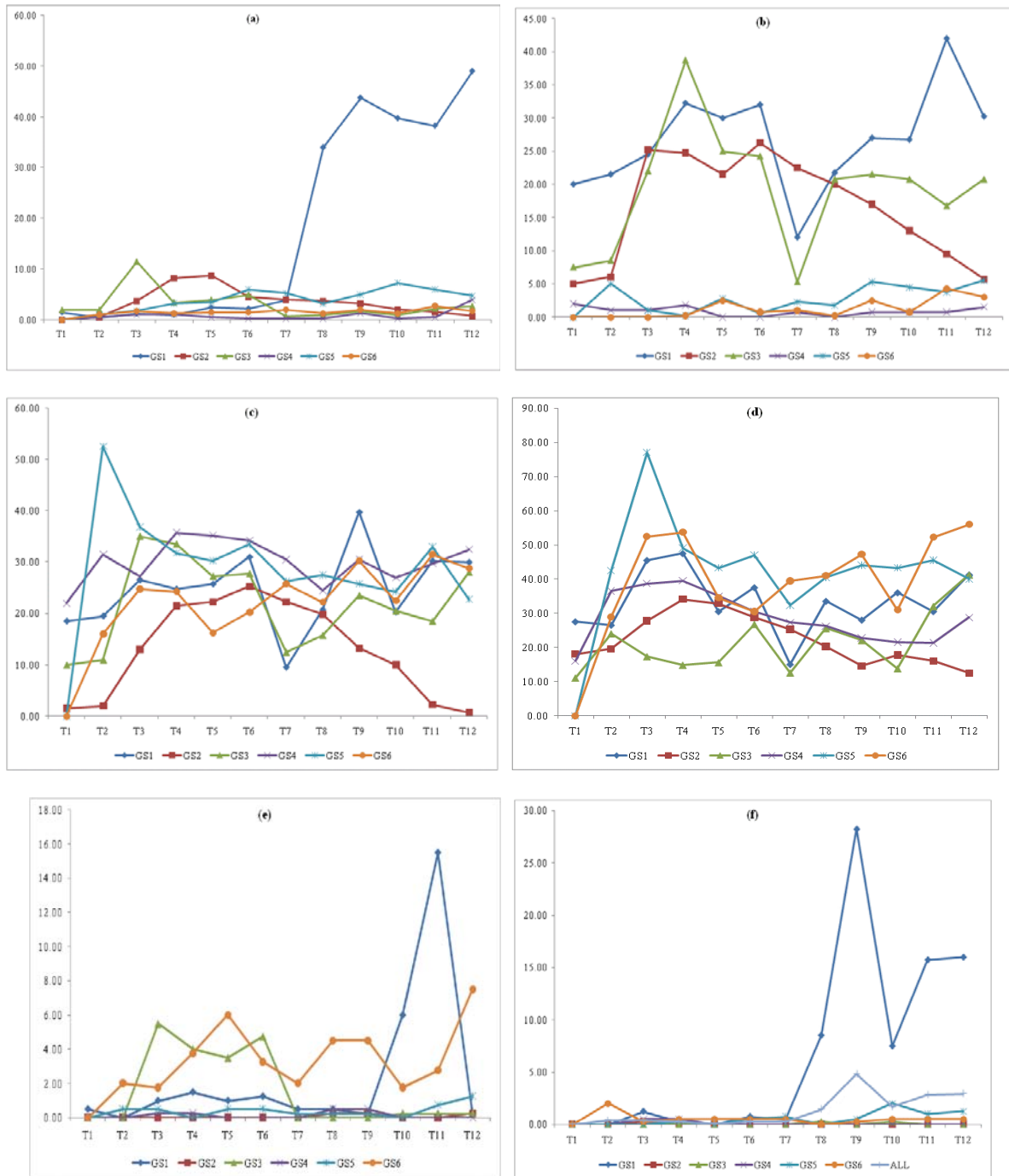


Figure 4. Vehicular Mean Traffic Flow in Gate (a) Private Car (b) Cab (c) Bus (d) Motorcycle (e) Tricycle (f) Truck.

Table 7. Pairwise Test Result of Time, Route and Vehicle Factor Considered in Gate Area.

Time	M±S.E	Routes	M±S.E	Vehicle	M±S.E
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T1	4.528±1.465 ^a	GS1	18.618±1.036 ^c	Private Car	5.153±1.036 ^b
T2	10.069±1.465 ^{bc}	GS2	9.156±1.036 ^a	Cab	11.198±1.036 ^c
T3	14.667±1.465 ^{cd}	GS3	11.219±1.036 ^{ab}	Bus	23.347±1.036 ^d
T4	14.924±1.465 ^d	GS4	10.101±1.036 ^{ab}	Motorcycle	31.083±1.036 ^e
T5	12.847±1.465 ^{bcd}	GS5	13.042±1.036 ^b	Tricycle	1.299±1.036 ^a
T6	13.549±1.465 ^{bcd}	GS6	11.233±1.036 ^{ab}	Truck	1.288±1.036 ^a
T7	9.528±1.465 ^b				
T8	12.229±1.465 ^{bcd}				
T9	14.090±1.465 ^{bcd}				
T10	11.778±1.465 ^{bcd}				
T11	14.097±1.465 ^{bcd}				
T12	14.431±1.465 ^{cd}				

The statistical test conducted for Gate area inferred a significant difference for the traffic count across time, the different routes in Gate and vehicles plying the routes at p-value < 0.05 (table 2). The significant difference observed in time can be seen from table 7 to be in four intersecting subsets labelled a – d. No significant difference was observed between the traffic flow recorded between GS2, GS3, GS4 and GS6. There was a significant difference between GS5 and GS2 but not between GS3, GS4 and GS6. The traffic flow in GS1 was observed to be significantly different from other routes at p-value < 0.05. Based on numerical mean observation, the flow of traffic at Gate area was noticed to be much for motorcycles with an overall average of thirty one (31) bikes, followed by twenty three (23) buses, eleven (11) cabs, five (5) private cars, one (1) tricycle and one (1) truck. A significant difference was observed between the six (6) categories of vehicle plying the area except that the difference was not significant between Tricycle and Truck, and also between Cab and Motorcycle at p-value < 0.05.

In the case of Dugbe area, traffic generated by private cars was experienced more at DS9, followed by DS8 and then, DS10 (figure 6a) while that which was generated by cabs was more experienced by DS10 (Figure 6b). Bus traffic was least experienced at DS6 and mostly highly experienced in DS1 from 07:00 am to 02:00 pm, and in DS2 from 02:00 pm to 07:00 pm (figure 6c). Within 09:00 am – 10:00 am and 03:00 pm – 04:00 pm, motorcycle traffic was highly experienced at DS9 while it was least experienced in DS6 anytime from 01:00 pm till evening (Figure 6d). Tricycle and Truck traffic count was much in DS1 (figure 6e – f). Overall, DS9 was observed to experience the highest traffic from 08:00am – 04:00pm (figure 5).

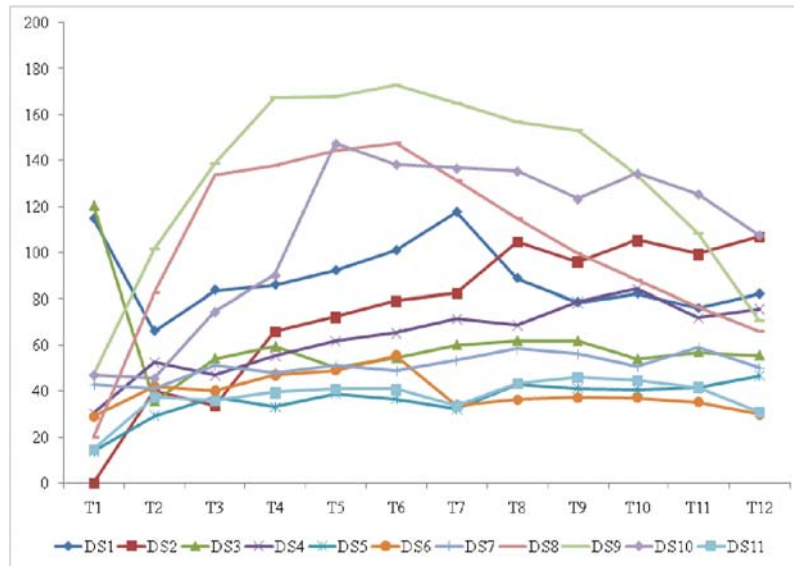
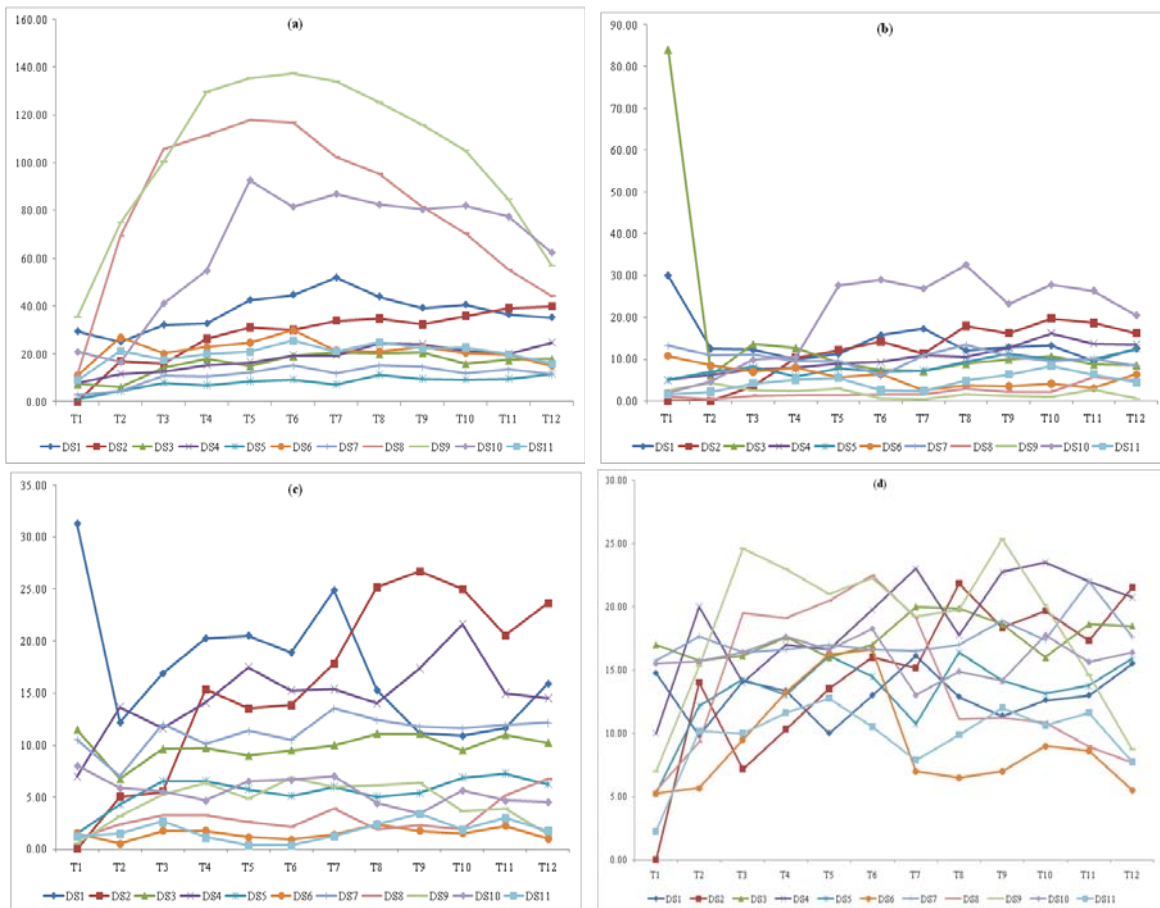


Figure 5. Stationary Vehicular Traffic Flow in Dugbe Area.



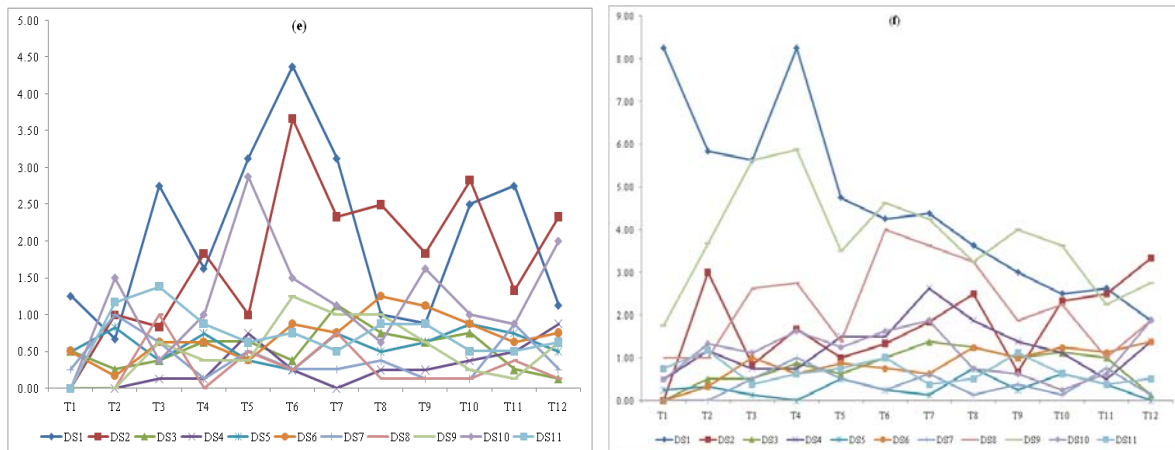


Figure 6. Vehicular Mean Traffic Flow in Dugbe (a) Private Car (b) Cab (c) Bus (d) Motorcycle (e) Tricycle (f) Truck.

The analysis of variance test conducted for Dugbe area inferred a no significant different for the traffic count across time but a significant different was observed between the different routes in Challenge and vehicles plying the routes at p-value < 0.05 (Table 5). The significant difference between the routes was categorized in five (5) different but intersecting subsets. ‘Set a’ contains DS3, DS4, DS5, DS6, DS7 and DS11; ‘Set b’ contains DS2, DS3, DS4 and DS7; ‘Set c’ contains DS1, DS2, DS3 and DS4; ‘Set d’ contains DS1, DS8 and DS10 while ‘Set e’ contain DS8, DS9 and DS10. Significant difference exist between routes that are not captured in the same set at p-value < 0.05.

Based on numerical mean observation, the flow of traffic at Dugbe area was noticed to be much for private car with an overall average of thirty seven (37) stationary cars, followed by fifteen (15) motorcycles, ten (10) cabs, eight (8) buses, one (1) tricycle and one (1) truck as presented in Table 8. A significant difference was observed between the six (6) categories of vehicle plying the area except that the difference was not significant between Tricycle and Truck, and also between Cab and Bus at p-value < 0.05.

Table 8. Pairwise Test Result of Time, Route and Vehicle Factor Considered in Dugbe Area.

Time	M±S.E	Routes	M±S.E	Vehicle	M±S.E
T1	7.277±1.736a	DS1	14.878±1.662cd	Private Car	37.342±1.227d
T2	8.696±1.736a	DS2	12.293±1.662bc	Cab	9.514±1.227b
T3	11.076±1.736a	DS3	10.079±1.662abc	Bus	8.297±1.227b
T4	12.579±1.736a	DS4	10.599±1.662abc	Motorcycle	14.729±1.227c
T5	13.893±1.736a	DS5	6.052±1.662a	Tricycle	0.833±1.227a
T6	14.252±1.736a	DS6	6.563±1.662a	Truck	1.608±1.227a
T7	13.913±1.736a	DS7	8.490±1.662ab		
T8	13.826±1.736a	DS8	17.235±1.662de		
T9	13.217±1.736a	DS9	22.011±1.662e		
T10	12.964±1.736a	DS10	18.149±1.662de		

T11	12.005±1.736a	DS11	6.243±1.662a
T12	10.949±1.736a		

4. Conclusion

Results from this guide demonstrates the flow of traffic by stationary vehicle in Challenge, Gate and Dugbe area of Ibadan, Nigeria. Factors such as time point, routes and six (6) categories of vehicles plying the routes were taken into consideration to check whether or not there is a significant difference within each factors. It was observed from the study that traffic flow is always high from Efunsetan to MRS and Ososami to Liberty between the hours of 01:00 pm to 07:00 pm in Challenge. This traffic was observed to be caused mainly by private cars and cabs plying the area. Traffic at Gate area was observed to be high from Iwo Road to Abayomi due to a lot of motorcycles and buses plying the area. Dugbe area was observed to experience hectic traffic more along First Bank to Ogunpa road due to private cars plying the route. Based on the observations from this study, the following recommendations are suggested to easy traffic along the routes. These suggestions may also apply to other areas in Nigeria.

- i. Sensitization and educational campaign both on formal and informal level should be encouraged for road users.
- ii. Stationary vehicles on routes can be a hindrance to efficient and effective movement. Thus, improved road infrastructure including traffic control devices would provide all road users with efficient and effective motion.
- iii. Stricter road regulations and laws should also be introduced to control unruly behaviour by users both in motion and stationary.
- iv. To further ease motion, construction or designation of spaces for stationary vehicles should be employed. Other forms of road transportations such as the use of rail system should be encouraged.

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