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Road Traffic Flow in Nigeria: A Review And Extension

L. I. Igbinosun[1] and S. E. Omosigho[2]

[1]Department of Mathematics and Statistics, University of Uyo, Uyo, Nigeria.
[2]Department of Mathematics, University of Benin, Benin City, Nigeria.

Abstract

This paper reviews articles on road traffic flow in Nigeria. We examine data sources for reported studies of road traffic gridlock, the methods and methodology applied in the various study and provides some extension to road traffic congestion management in Nigeria. In this review some road traffic gridlock vectors are identified and strategies for the management of road traffic gridlock are proposed. It is also proposed that authorities in charge of the management of road traffic flow should put in place data gathering infrastructure for effective study and management of road traffic flow. The review opens new frontiers and shows the need for further studies on road traffic flow in Nigeria.

Key words: Road traffic management, road traffic congestion, road traffic flow, road transport management. **2010 Mathematics subject classification**: 60K25, 60K30, 90B06, 90B20

1.0 Introduction

Road traffic grid lock is a common phenomenon in many towns and cities in Nigeria. The Federal, State and LGA agencies are involved in the apparent management of road traffic flow and the enforcement of road transport regulations [1]. However, road traffic grid lock continues to defy measures put in place to tackle the menace. In this paper, we review articles on road traffic flow in Nigeria and examine road traffic management practice. The sources of the articles considered are Google and science direct. Articles recovered included studies of road traffic accidents, plausible causes of road traffic gridlock, management of road traffic gridlocks, and infrastructure for collecting data on road traffic events.

This review is structured and discussed under the following headings: Accident management on roads, traffic congestion (causes and effects), mathematical models for road traffic flow, road transport management, drivers' behaviour, road traffic control strategies, suggestions for further studies and conclusions.

2.0 Accident Management on Roads

No fewer than 100 persons lose their lives daily to road traffic accidents [2]. Some of the causes of these road traffic crashes are: (1) deplorable conditions of the roads, lack of road markings, safety barriers, and signage [3], (2) drivers' deviant behaviour including over speeding, (3) vehicles conditions including overloading, and (4) traffic rules violation [2]. Also, many of the vehicles using Nigerian roads are in a state of disrepair [4].

Adebayo [5] reports that between January and December 2010, no fewer than 322 persons died in road traffic crashes in 417 road accidents in Nigeria according to the statistics from the Federal Road Safety Commission (FRSC).

In an effort to reduce road traffic congestion and increase safety on Nigeria roads, the FRSC embarked on many enlightenment campaigns to increase the level of consciousness to these issues by road users. However, these campaigns are usually carried out during festive periods. However, these campaigns do not address the state of the roads or the state of the vehicles. Also there are no effective ways to handle road traffic offenders. Indeed, it is observed that 30% of road accidents are due to reckless driving behaviour; 22% are due to inexperience, while 21% are due to mechanical fault and bad roads [6]. Other causes of accidents such as pedestrians crossing the road recklessly and unidentified reason account for the remaining 27%. They used data obtained from the Motor Traffic Division of the Nigerian Police. Fatalities were also discussed in[6].

Omidiji in [7] investigates the causes of road traffic crashes on major intersections within Abuja. Using data obtained from a survey, it was proposed that traffic engineering calming measures such as speed warning signs, zebra crossing and speed bumps reduce road traffic crashes. The study identifies the need to have data on road crashes on routine basis so that studies can be carried out on how to reduce crashes on our roads. For example, [8] show the importance of traffic flow data in a study, titled "road accidents and traffic flow: an economic investigation".

Corresponding author: L.I. Igbinosun, E-mail: luckyigbinosun@uniuyo.edu.ng, Tel.: +2348034102548.

Road traffic accidents induce road traffic gridlock and the various road traffic management agencies are ill-equipped to clear effectively the wreckage of road traffic accidents. Special towing vehicles are required for this exercise. Indeed, crashed vehicles are left on the scene of accidents for hours and days on many occasions unattended to, causing more accidents, reduction in the capacity of the road and undue traffic gridlock. Accidents Prevention and Rescue Initiative (APRI), a Non Governmental Organisation (NGO) observe that despite the many lives lost to road traffic accident daily, the Nigeria governments' recognition of its impact has not been explicit [9].

3.0 Road Traffic Congestion (Causes and Effects).

A number of studies have been carried out to identify causes of road traffic congestion. Most of the studies obtained their data using questionnaire and personal observation. The towns and cities covered include Abuja [7], Akure [10],Benin City [11-13], Lagos [14-16], Enugu City [17], Ilorin [18], Warri [19]**.** Some of the causes identified by these authors include: street trading, inadequate public mass transit buses, poor road traffic control, poor road maintenance, traffic light failure, absence of traffic wardens, too many cars on the roads, poorly maintained vehicles, poor road design, disregard for road traffic rules, flooding, poor drainage system, poor waste management, bad drivers behaviour, and absence of parking lots, [12, 14, 17, 20].

Ukpata and Etika [21] argued that previous studies on road traffic congestion in Nigeria have only concentrated on just a few cities. To get a broader perspective on congestion in Nigeria, the authors used questionnaire in obtaining information on possible causes of congestion from members of the Nigerian Society of Engineers (NSE) during their annual general meeting in 2011. Using simple percentages, they concluded that about 87% of the respondents agree that road traffic congestion is experienced in major cities in Nigeria. The authors presented a list of possible causes of road traffic congestion and asserted that poor driving habit ranked highest (approximately 82%). Table 1 shows the possible causes of road traffic congestion identified in[21].

Table 1: Some Causes of Road Traffic Congestion (Source: [21]).

Rank	Causes of congestion	No	Percentage
1	poor driving habits	161	82.1
2	poor parking habits	155	79.1
3	Poor road network	151	77.0
4	inadequate road capacity	147	75.0
5	lack of parking facilities	139	70.9
6	poor traffic control management	128	65.3
7	Poor drainage	124	63.3
8	presence of heavy vehicles	112	57.1
9	poorly designed junction/roundabout	102	52.0
10	lack of efficient mass transit	98	50.0
11	lack of pedestrian facility	79	40.3
12	malfunctioning vehicles	74	37.8
13	poor road pavement	68	34.7
14	presence of construction activities	68	34.7
15	lack of road furniture	59	30.1
16	too many taxis	46	23.5
17	excessive speeding	42	21.4
18	frequent use of sirens	33	16.8
19	poor weather	10	5.1

Results from the study also show that Lagos, Port Harcourt, Abuja, Ibadan, and Onitsha were cities with the highest level of congestion in Nigeria. The authors recommend good road network, proper traffic management, among others to reduce the congestion level in our cities. Some of the management measures recommended include among others: (1) the provision of bye-passes. The author submits that the "construction of bye-passes has been one of the effective devices for redressing road traffic congestion". However, we argue that enlarging the roads or building of bye-passes will lead to a situation where road users will only shift to the apparent better roads and therefore congesting these roads over time. (2) Managing traffic by providing traffic lights at intersections by recommending the use of generators to power the lights. Experience in Nigeria has however shown that installation of small generators at every traffic light junction is unrealistic. Solar power can be used instead.

Aworemi [15] examined the causes and effects of road traffic congestion in some selected areas of Lagos State, Nigeria. The authors used a structured questionnaire and personal interviews to obtain their data. Poor road condition, accidents and drivers' behaviour were identified as some of the factors responsible for traffic congestion.

Ogunbodede [10] assesses traffic congestion in Akure (south-west of Nigeria) using the Geographic Information System (GIS) approach and concludes that the tool is critical for decision making in the management of traffic congestion. Nigeria is faced with the challenge of increasing traffic congestion in major cities. Factors responsible are numerous and controlling traffic has become essential hence the need for Information Transportation System, ITS ([22]). The impact of socio-economic characteristics of formal and informal public transport has been consideredand it suggests that government must totally support both sectors by providing working policies to improve the performance of operations and services[23]. Spontaneous measures to congestion problems, poor implementation of policies (wherever they exist), road users' 'irrational' behaviour and non compliance to existing traffic rules have not yielded the desired reduction in road traffic congestion in Nigeria [12, 15, 23-29]. The strategy to reduce congestion includes the reactivation and integration of the various elements and modes of transport[30]. These studies did not include the use of mathematical models.

4.0 Mathematical Models for Road Traffic Flow

Mathematical models for traffic flow are used to predict effect of changes in traffic control policies, obtain description of observed road traffic flow phenomenon, and offer explanations for observed road traffic congestion. Road Traffic assignment and travel demand models play significant roles in traffic flow prediction [28, 31]. Mathematical and simulation models can also be used as platforms for monitoring and controlling road traffic flow by providing real time information on road congestions and expected travel time on affected roads.

Oke, in[32] present an application of Laplace Transform to the quantification of speed control in the modelling of road bumps with hollow rectangular shape. The model simulates the behaviour of a vehicle when passing over a series of bumps. In particular, the model evaluates the effective distance that should be installed between two road bumps. The authors concluded that the application of the model would help in controlling the speed of vehicles, reduce noise pollution due to vehicle movement and sudden break application, and maintain minimum impact on the vehicles. In another work, Oke [33] use a mathematical model based on fluid mechanics to study the congestion problems in the university of Lagos campus. Based on the study in[33], it was concluded that road traffic congestion situation in the university community can be monitored and controlled using equations obtained for pressure in the model, provided certain assumptions are observed. The authors agreed that the work was limited to a university community and that it opens up new areas of research, for example the effect of road traffic obstructions on the general traffic situation.

Omosigho [34] considered a road intersection with a fixed-cycle controlled traffic light and develop a discrete time queuing model to obtain time-dependent measures of performance (expected number of vehicles in the queue) for the system.

$$PG(j) = \sum_{i=0}^{j+s_1} P_G(i) A_G(j + s_1 - i) \tag{1}$$

$$P^{Red}(j) = \begin{cases} \sum_{i=0}^{j} P_R(i) A_R(j - i), & j = i, i+1, \ldots Q_{\max} \\ 0 \qquad otherwise \end{cases} \tag{2}$$

Equations (1) and (2) are the probabilities of having *j* number of vehicles in the queue at the end of the green and red phases respectively.

The discrete time model of traffic flow at signalized intersections of [34] considers the case where the number of cars departing the queue at the turn of the green light is constant at different cycle times. However, the assumption that a fixed number of vehicles can leave the system during the green phase is unlikely in real life situations.

A mathematical model to explain the effect of road traffic frequency of vehicles and speed of vehicles on road traffic congestion was considered in [35]. Data on road traffic flow frequency were collected at two locations in Nigeria, one at kilometer thirty-four (34) on Kaduna-Lokoja Road (the data are for the vehicles going to Abuja.) and the other at kilometer three (3) on Benin-Asaba Road. Both data were collected by manual count. For the Kaduna-Lokoja road, the highest number of vehicles passing through the observation point occurs between 14:00 and 15:00, while the highest number of vehicles passing through the observation point in Benin-Asaba road occurred between 06:00hrs to 10:00hrs and 15:00hrs to 18:00hrs for all days respectively. These periods are known as the 'morning and evening rush hours'. Analysis of the data shows that there is significant difference between the days but no significant difference between the hours at five percent level. Using models for the expected number of vehicles in a queueing system under road traffic conditions they demonstrated that when the frequency of vehicles using a road link is fixed, there is a critical speed for which the level of road traffic congestion is unacceptaable. On the other hand, for each fixed speed, there is a frequency of vehicles using a road segment for which the road traffic congestion will be very high [35].

$$v = L\left(\frac{r+f}{r}\right)F \tag{3}$$

Here, r and f are the rates of occurrence and clearance of incidents respectively. F is the frequency and v is the speed of vehicles on the road.

Thus for each speed of vehicle, there is a frequency of vehicles that will induce road traffic gridlock and whatever will make the speed of the vehicles using a road to drop and approach the critical value is a potential cause of gridlock. This includes road intersection, adverse weather conditions such as flood and failed sections on road segments.

Until recently, there has been lack of mathematical models in literature to explain the dynamics of road traffic flow problems in Nigeria. It is clear that transport systems management (TSM), as a process, has become an indispensable means for efficient urban transport management [19]. Unfortunately, the existing practices in Nigeria are inconsistent with the requirements of TSM. Because of the complexity and dynamism of urban road traffic, the analysis, control and management of road traffic must also be pro-active and scientific.

Ganiyu [36] introduced the concept of Timed Coloured Petri Net (TCPN) to model and simulate a multi-phase traffic light controlled intersection with an associated fixed signal timing plan using T-type junction located in Federal Capital Territory, Abuja, Nigeria, as a case study. A Coloured Petri Net (CPN) modelof a system is an executable model representing the states of the system as well as the events that can cause the system to change state. In a Timed Coloured Petri Net model, a global clock models the passage of time and through this, it is possible to calculate performance measures, such as the speed by which a system operates and throughput. Besides, TCPN models may be investigated by means of simulation and validated by a number of mathematical analysis techniques, such as state graphs and invariants. CPN Tools is an industrial strength computer tool for constructing and analyzing TCPN models.

5.0 Road Transport Management.

There have been several efforts in the management of road traffic congestion in Nigeria. Some road traffic management techniques include: road junction improvement, grade separation using bridges or tunnels, reversible lanes, preferential treatment for Higher Occupancy Vehicles (HOV), separate lanes for specific user groups, traffic calming measures, and improved traffic signs [37]. Other authors including [26-29] have also studied road traffic management in Nigeria. Their findings and recommendations are similar to that in[37].

6.0 Drivers' Behaviour

One of the many factors that have been identified as contributing to traffic congestion is driver's behaviour [15]. Drivers' behaviour is any action taken by a driver while driving his or her vehicle on the road. These actions include; speed, braking action, separation distance between one vehicle and another, etc. Modelling drivers' behaviour and its effects are key aspects of road traffic demand analysis, where collective demand is the accumulation of individuals' decisions [38].

Understanding drivers' behaviour is an important component of road traffic flow analysis and this has been reported in the literature. One problem with many models on drivers' behaviour is that they rely on drivers heeding the advice given to them. Drivers cannot always be expected to do what seem 'rational'. In Nigeria, deviant driving behaviour or "aggressive driving" is not uncommon. Several definitions of deviant driving behaviours have been proposed in the literature. For example, in a testimony before a US Congressional sub-committee, Ricardo Martinez defined "aggressive driving" as the operation of a motor vehicle in a manner which endangers or is likely to endanger people or property". For more definitions of deviant drivers' behaviour, see [39, 40]. Tasca [41] summarises a driving behaviour to be aggressive or deviant "if it is deliberate, likely to increase the risk of collision. It may be motivated by impatience, annoyance, hostility and/or an attempt to save time." Some specific deviant driving behaviour include: Tailgating (driving too closely behind another car), weaving in and out of traffic, passing on the road shoulder, failure to yield the right of way to other road users, road rage, improper lane changes, frequent and abrupt lane changes, blocking of roads by drivers, etc. [41]. The UNECE (United Nations Economic Commission for Europe) in 2004 reported that forms of aggressive behaviour may vary across countries and continents. It has been argued that the level of education of drivers determines their behavioural pattern on the roads [42]. However, it is not uncommon to see uniform personnel disobeying traffic lights restrictions and driving against traffic. Observation has shown that even more literate road users in Nigeria are found to display irresponsible driving behaviour in most of the roads (see Figure 1).

Figure 1: Vehicle driving against traffic. Note the accident caused by the vehicle labelled A.

Some observed implications of deviant drivers' behaviour are, blocking of roads in order to gain entrance to another lane. Some mini-bus conductors as well as uniform personnel on their own journey take undue advantage of the chaotic condition and turn themselves to traffic wardens. They ensure that the lane in which their vehicles are moving in the queue is given priority to the detriment of the system. Some motorists do not obey the 'illegal' traffic wardens, thereby causing more confusion. In Nigeria, the Federal Road Safety Commission (FRSC) in an attempt to respond to observed road blocking incidents resulted to the use of aircraft and helicopters to detect road traffic congestion spots [43]. Such phenomenon can be predicted with the availability of data and a good mathematical model. Literature on deviant driving behaviour is mainly descriptive; see for example [15, 24, 26]. They avoid the use of mathematical models. A number of researches have shown that when crossing intersections, drivers display "certain inertia in the regulating actions they take or take time to become aware of conflicts with other drivers" [44], and these are some of the factors that can lead to congestion.
Road traffic education of both drivers and road users will enhance driving behaviour of the people and development of more efficient road utilization, thereby reducing conflict on the roads. Research in literature has shown that publicity campaign by itself has only modest impact on attitudes and behaviour of drivers. In Nigeria, studies of drives' behaviour have been on the causes and effects. There are no mathematical models to describe these effects. Interventions based on practical mathematical modelling will provide scientific basis upon which enforcement of traffic laws and regulations are made, or provision of other safety services and products, or public relations.

7.0 Road Traffic Control Strategies

In this section, we shall discuss road traffic Control strategies. We shall also use mathematical model to explain the need for data collection, and the need for use of real time information for Intelligent Transportation Systems (ITS), and road architecture. Road traffic Control strategies describe those measures which seek to manage traffic flow, which has already made the decision to travel on the road network, through regulatory mechanisms. Whenever there is an increase in the spatial efficiency of the infrastructure, the traffic on the network will have to be assessed and managed. Management decisions depend on the amount of traffic that uses the infrastructure. Since road traffic is dynamic in nature, then there is need for dynamic traffic management (or traffic control). Some measures such as diverters, roundabouts, channelization, speed humps, speed tables, etc. have been applied to ease road traffic congestion [45]. In recent years, efforts have been aimed at taking advantage of the advances in communications, electronics, and Information Technology in order to improve the efficiency and safety of transportation systems. Within the transportation community, this effort is generally referred to as the ITS [46]. ITS (applied to transport infrastructure and vehicles) seeks to improve transport outcomes such as transport safety, transport productivity, informed travel choices, social equity, environmental performance and network operation resilience. The nature of the traffic system is continuously changing, new vehicle and infrastructure technology creates new traffic conditions.
Broadly speaking, traffic control measures can be categorized under a number of headings, namely:

- Intelligent Transport system (ITS), which uses on-road technology to influence traffic flow in response to observed behaviour. Examples include ramp metering, variable speed limits, and incident detection [47];
- Capacity Enhancement, which increases road capacity within the existing boundaries, but supported by a management function. Some examples are Hard Shoulder Running and reversible traffic lanes;
- Priority measures, which dedicate lanes to specific user types, such as public transport, freight, or high occupancy vehicles;

- Information sources provided pre-trip or during a trip which assist users in making appropriate responses to avoid congestion; and
- Network control through the use of national, regional or local control centres. For example, the *Park-and-Ride Facilities* [48].

Improving public transport is also a measure to control road traffic flow by encouraging the use of public vehicles. One of the objectives of the stated control measures is to discourage the use of too many cars on the road.

Work on traffic management techniques and infrastructures for road traffic management is available in literature; see [46, 49-51].

In Nigeria, road traffic control strategies have been put in place in some states. These strategies are in the form of laws, for example, Lagos state government recently enacted the road traffic law titled, '*a law to provide for road traffic administration and make provisions for road traffic and vehicle inspection in Lagos state and other connected purposes'*.

The law seeks to among other things bring some measure of sanity to the roads in Lagos state by imposing restrictions and or penalty. Some of the restrictions include the:

(a) Prohibition or restriction of the use of any specified highway by vehicles of specified class or description;

(*b)* Prohibition of driving or propelling of vehicles on any specified highway otherwise than in a specified direction;

(c) Prohibition of vehicles parking or waiting on any specified highway; (this will increase free flow of vehicles by increasing the frequency and speed. See figure 2).

(d) Prohibition or restriction of the use of sirens, and the sounding of horns or other similar appliances either in general or during specified hours or in respect of specified areas;

(e) Regulation of the conduct of persons driving, propelling, being in charge of or riding any vehicle or animal on a highway;

(f) Application of breath testing, blood and urine specimen testing devices on any driver to detect whether he is driving under the influence of alcohol, or drugs ;

(g) Demand of a psychiatric evaluation of any person who drives against the normal flow of traffic or who fails to comply with any of the provisions of this Law, if in the opinion of any officer of the Authority such an evaluation is necessary for the purpose of determining the person's ability to operate a motor vehicle provided that such shall be at the driver's cost; and

(h) General regulation of traffic on public highways.

The penalty includes imprisonment for a term of not more than three (3) years in any case, or the rendering of community service. For details of the law [52]

A review of the Lagos road traffic law shows that there are provisions to deter deviant behaviours by motorists in Nigeria. However, it is common practice in some urban areas of Nigeria (Benin City for example) to see drivers driving against traffic, driving on the walkways, disobedient to road traffic lights and the exhibition of some other deviant drivers' behaviour. It has also been observed that drivers reduce their speed because traders display wares on walkways and some portions of the road, this reduces the efficiency of the road. It is however an offenceto display wares on walkways or for commercial buses to pick or drop passengers on some designated routes.

Some roads in Benin City have been reconstructed to ease traffic flow and reduce congestion. For example, a segment of Benin-Lagos road from Uselu shell to the University of Benin (Uniben main gate, Ugbowo) now has approximately four (4) turning points (as at 2ndJanuary, 2015) as against making every point of the stretch of the road a turning point. The aim of having very few turning points in the three and half kilometre (3.5km) stretch of road is to restrict drivers' deviant behaviour of making a u-turn at every gap acceptance and to increase free flow of vehicles. However, these turning points may not always provide the expected results. The way the turning areas are constructed makes it difficult for many vehicles to manoeuvre properly without blocking part of or the entire road. It is sometimes difficult for vehicles to make a complete u-turn in a single attempt. Figures 2 shows two different attempts by two drivers to make U-turn along the 3.5km stretch of road. Observe that the two vehicles in the photographs are unable to make a u-turn in a single attempt. This usually leads to road traffic gridlock. Thus, road architecture is very important in the control of road traffic congestion.

Figure 2: The vehicles labelled A and B cannot make a u-turn in one go.

Notice that there is congestion resulting from blocking of the road by the two vehicles attempting to make U-turn.
In Nigeria, the use of motor-bikes has been banned in many states. Reasons for such decisions are two-dimensional: on the one hand, it has been argued that motor-bikes are used by hoodlums to perpetrate criminal activities because of their size and ease of movement. Secondly, they have been used as means of transportation with little or no sense of driving ethics. There have been reported cases of road traffic crashes [2] arising from reckless use of motor-bikes. It is not uncommon to see motor-bikes clogging the front of vehicles at the turn of red phase of traffic light at road intersections. Figure 3 shows a scene where motor-bikes queue in front of vehicles at a road intersection. Such actions normally affect the number of vehicles to use an intersection when they are given the right of way.

Figure 3: Motor-bikes parking in front of vehicles at an intersection.

Shortage of traffic wardens or absence of traffic lights can give rise to unauthorized traffic wardens to take over the control of road traffic. Indeed, we have observed that in some locations where there are no traffic personnel or traffic light or failed traffic lights, some 'bus conductors' including uniform personnel on their own journey take undue advantage of the condition and turn themselves into unauthorised road traffic wardens. They ensure that the lane in which their vehicles are in the queue is giving priority to the detriment of the system. This results in some inefficient polling system. Figure 4 shows a chaotic scene resulting from some unauthorised persons controlling road traffic. Some motorists do not obey these 'illegal' traffic wardens, thereby causing more confusion.

Figure 4: Confusion and possible congestion due to actions of illegal road traffic wardens

8.0 Conclusion

In this paper, we present a review of road traffic flow in Nigeria and some extension. The reviewed literature shows that road traffic congestion is a problem in many Nigerian cities and some level of efforts has been put in place. However, there is no mathematical model to explain the level of congestion. Methods applied in literature have been mainly descriptive. We recommend that there is need for a scientific study of road traffic flow in Nigeria. Also, to help ameliorate the road traffic gridlock on our roads, the under listed recommendations should be considered:

i. Acquire giant car parks, this will remove vehicles that are indiscriminately parked and abandoned on the roads.

ii. The use of Inter-city buses, bus (dedicated) lanes should be encouraged to allow for free flow of vehicles.
iii. Driving on any available space during congestion should be discouraged and fines imposed on law breakers. The road architecture should make it impossible for vehicles to drive against traffic.
iv. All road intersections should be controlled and ITS instruments should be deployed to roads (CCTV cameras, vehicle registration data base should be continuously updated to monitor and ascertain the true number of vehicles in the country). This will help in tracking down erring motorist. Time is wasted when a road junction is not well monitored. Absence of road traffic control can force vehicles to stop in all directions.
v. Mechanism such as controlled motor vehicle registration should be introduced in Nigeria to help check the increase in vehicle ownership. This can be achieved by (1) imposing high vehicle registration fees (2) having a quota vehicle license allocated to states each year and using bidding process to acquire the license (e.g. obtaining authorization before purchasing a vehicle).
vi. Traffic lights should be checked periodically by changing their cycle times to meet current realities of traffic flow and the dynamics of the road junction.
vii. Off-peak vehicle usage should be introduced and enforced to reduce the frequency of vehicles on the roads. This can be enforced by providing special colour tags for off-peak and weekend vehicles. Sanctions in the form of fines should be imposed when such vehicles ply the roads outside their mandatory periods.
viii. We recommend actions such as fee charges to use a road link, restricted use of a road link and the use of other means of transportation (e.g. rail and water system). These have been found to reduce the frequency of vehicles using a road link.

Taking a critical look at the insufficient and poorly managed transport infrastructure and the consequent deviant driving behaviours in cities of Nigeria, chaotic scenes are not uncommon. This is simply because journey times become unnecessarily prolonged, difficult and commuters are repeatedly trapped in poorly ventilated and ramshackle vehicles for hours. More pronounced in the cities of Lagos, Ibadan and Benin among others, is the senseless overtaking and driving on the shoulders of the roads (and opposite traffic) to gain undue advantage over other drivers, especially in a traffic hold-up. Interestingly, notable deviant driving behaviours on Nigerian roads include, changing route and lanes without signals, misuse of the vehicle horn, over-speeding, overloading, stopping or turning at unauthorized locations, etc. It is however shocking to note that, despite the various management agencies of road transport (LASTMA, FRSC, ESTMA, etc.) available in some states of Nigeria, the frequency of occurrence of deviant driving practices still persist. Thus, it is not an over statement to assert that traffic policing is not the definitive measure of curbing this menace. There is need for proper enlightenment of road users about the contents of the Highway Code. More worrisome is that 'knowledgeable' road users are found to exhibit reckless driving pattern in most Nigerian cities. The recommendations above should be considered with a view to reduce the deviant driving behaviour of motorist and the abysmal transport system and poverty in Nigeria. Hence, there is need to emphasize an enduring development plan and rehabilitation of existing transport infrastructure, for improved socio-economic wellbeing, economic vibrancy through a sustained user education policy [53]. The need for data collection techniques and application of mathematical models to solve road traffic congestion in Nigeria should be taken seriously.

Forecasting traffic flow frequency in a road network is a fundamental prerequisite for the management of road traffic congestion. It is also the basis for developing Advanced Traveller Information System (ATIS) and Advanced Traffic Management System (ATMS). These systems require the availability of real time data and a rich data warehouse on both traffic flow and travel time data. There is no database on road utilization in Nigeria. Indeed there is no adequate road traffic data gathering infrastructure in Nigeria. Only available data is on road traffic crashes by the FRSC. There is the urgent need to develop road infrastructure for collecting road traffic data at strategic locations to enhance intelligent management of road traffic flow, mitigate urban gridlock and promote road traffic studies.

The varying problems of transportation across cities and villages call for fundamental research towards providing evidence based and practical solutions to the recurring threat of traffic congestion. Road Traffic agencies should enforce all laws and regulations that will ensure sanity but should respect road users' respective jurisdiction by working in harmony to achieve the desired objectives of road safety for road users.

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