

Structural Framework for Managing Road Traffic Noise in Jos Metropolis, Nigeria

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ABSTRACT: *The management of road traffic noise largely seeks to maintain low human exposure to high noise levels, such that human health and well-being are protected. The main objective of this study was to evaluate the existing management structures for managing road traffic noise in Jos metropolis, Nigeria. A descriptive and qualitative survey was conducted in all the road traffic-related agencies in Jos, Nigeria. A purposive sample of at least 10 road traffic-related ministries and agencies in Jos voluntarily participated in the study and responded to a set of questions related to their operational codes and conducts, existing laws, statutes, policies and structures, practices and standards, accident violation, penalties fact sheets of operations among others have been put on the ground to reduce traffic volume and noise among other traffic-related challenges in Jos. A reconnaissance survey was carried out to get the agencies' evidences of their operations on the field. The findings of this study revealed that there is no direct organogram at present for managing traffic noise in Jos metropolis, but a series of uncoordinated agencies and standards. This study therefore recommends, a structural framework for managing road traffic noise in Jos metropolis, Nigeria, and also, the establishment of a road traffic management agency to be known as the Plateau State Traffic Management Authority (PLASTMA).*

KEY WORDS: framework, management, road traffic, noise, Jos metropolis.

INTRODUCTION

Noise is conventionally defined as unwanted sound (García *et al.*, 2019). It is an unwanted sound that creates annoyance and interferes with conversation, disturbs sleep and the teaching-learning process, and reduces work efficiency, causing stress and challenges to public health (Paiva *et al.*, 2019). Noise pollution in urban areas is considered the third most hazardous type of pollution right after air and water pollution, much of this noise is road traffic-related (Zerihun *et al.*, 2017). Road traffic noise has over the years become an issue of global debate. For

instance, the first Conference of the Noise Forum, which was held in 2002 in the United Kingdom, was organized with the intent of advising the government on ways forward in monitoring and reducing traffic noise (Czyzewski & Dalka, 2007). Planning appropriately for roads and physical development was considered crucial in the drive towards mainstreaming traffic noise reduction into planning and development in the 19th Annual International Conference on Traffic Noise, which was held in Dresden, Germany, in 2010 (Turner, 2011). Similarly, the Conference on Road Traffic Noise in Hamburg, organized by the Conference of European Directors of Roads (CEDR) (Wiebe & Hans, 2018), identified capacity development as one of the principal means of reducing traffic noise in neighbourhoods. Also, the 6th International Conference on Water, Energy, and Environmental Research (ICWER) (Maina *et al.*, 2019), which held in Abuja-Nigeria, 2019, discussed among others: noise pollution and control, pollution and health issues, pollution control technologies, environmental management, environmental sustainability, and air pollution and treatment.

The World Health Organization report estimates that about 65% of the population in Europe resides in places where they are regularly exposed to unacceptable noise levels (Paiva *et al.*, 2019). Similarly, in Hong Kong, about 80% of the population is affected by road traffic noise to a large extent (Wong *et al.*, 2019). In India, about 60-85% of people opined that vehicular road traffic is a major source of noise pollution and creates annoyance among them (Kumar *et al.*, 2018). According to Bhaven (2011), traffic-related noise pollution accounts for nearly 67% of the total noise pollution in an urban area.

Despite the global concern about the effects of road traffic noise on human health and well-being, the rate of population exposure to road traffic noise has continued to increase in Nigeria and Jos in particular. Several studies have reported that road traffic noise levels in many Nigerian cities exceed standard limits specified by the Federal Environmental Protection Agency (FEPA) and the World Health Organization (WHO). For instance, studies conducted by Adeke *et al.* (2018); Okeke and George (2015); Anomohanran (2013); Oyedepo and Saadu (2010) on road traffic noise levels found that-the noise pollution level in their respective case studies were higher than the safe threshold of 55dB(A) as specified by FEPA and WHO. Similarly, a study conducted by Okokon (2018a) to investigate patterns of travel-mode-specific exposures to road traffic noise and air pollution in three European cities of Rotterdam, Helsinki, and Thessaloniki and a Nigerian city of Lagos, reported that commuter and community exposure to road traffic-related noise and air pollution was higher in Lagos city, Nigeria. Also, Obisung *et al.*, (2016) in a study of five selected cities in eastern Nigeria, found that the majority of the city dwellers suffer serious sleep disturbances due to road traffic noise.

Long exposure to excessive road traffic noise and other noise-generating sources has many adverse effects on human health and well-being (Okokon *et al.*, 2018b). For instance, excessive road traffic noise exposure may cause hearing loss, CVD, mental disorders, high blood pressure, headaches, dizziness, inefficiency, and insomnia (Akinkuade & Fasae, 2015). Similarly, Dasarathy and Thandavamoorthy (2013) reported that even a relatively low level of noise adversely affects human health. For instance, it causes hypertension, disturbs sleep, and hinders cognitive development in children (Ogunseye *et al.*, 2018). The effects of excessive noise exposure could be so severe to the extent that either a permanent loss of memory or a psychiatric disorder might occur (Cai *et al.*, 2017).

Jos being one of the important cities in Nigeria is today a major centre for commercial, transportation, political, administrative, and industrial activities (Aliyu & Amadu, 2017). Jos has in recent times witnessed a high influx of people due to urbanization, economic growth, and its potential for investment opportunities. Most of the land use corridors in Jos metropolis are easily accessed, they attract high traffic volumes by reasons of the activities they accommodate, which lead to a high level of traffic noise that could affect the nearby residents. For instance, a study conducted by Haruna *et al.* (2023), revealed that traffic noise levels in the various land uses of Jos Metropolis were generally high and exceeded the maximum permissible noise levels recommended by WHO and FEPA. This has turned Jos metropolis into a cauldron of noise as being experienced. In spite of the high and intolerable level of road traffic noise in Jos, little attention has been given to road traffic noise management.

Research on noise has primarily focused on the levels of traffic noise and its effects on human health and wellbeing with relatively scarce research in the context of its management. For instance, these studies failed to provide a clear and concise framework for managing traffic noise in their respective case studies. In addition, previous studies have suggested further studies on the introduction of a “smart traffic management” policy with centrally controlled traffic signals (Gilani & Mir, 2021). Rey-Gozalo *et al.* (2022), suggested that greater engagement and control by the authorities is needed for the implementation and efficiency of noise management measures. Therefore, it is against this backdrop that this present study firstly-assessed the existing traffic noise management strategies employed by the relevant traffic-related agencies in controlling urban residents’ exposure to traffic noise pollution and secondly evolved a structural framework for traffic noise reduction in the land uses of Jos metropolis, Nigeria.

METHODOLOGY OF THE STUDY

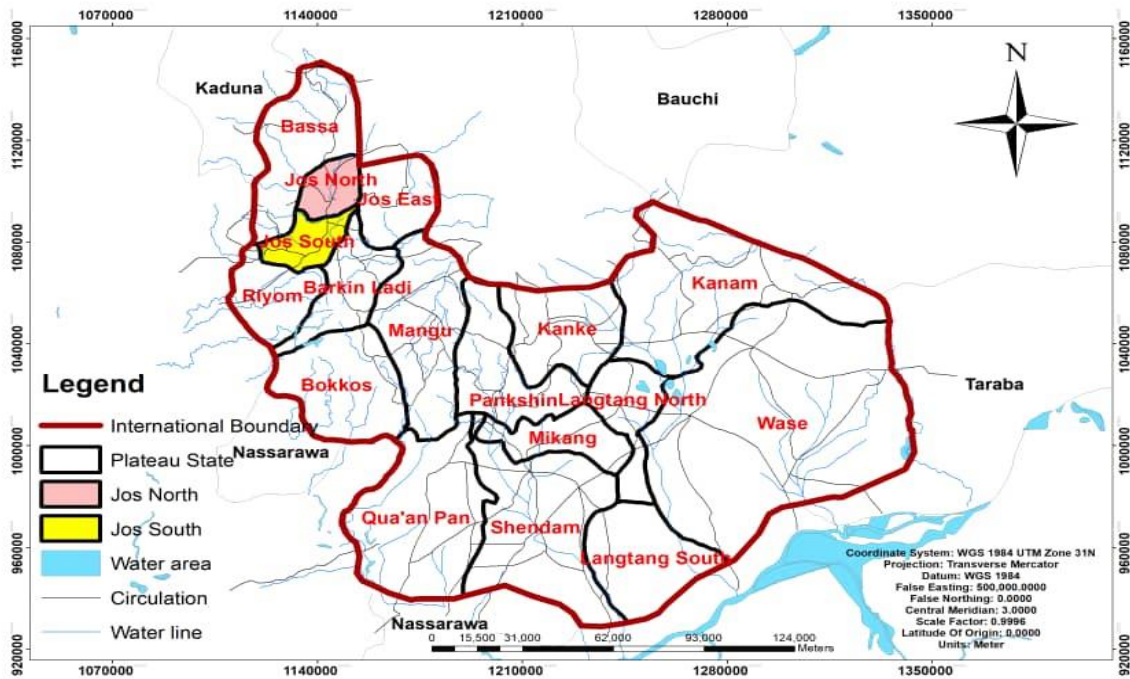
Study Area

This study was conducted in the Jos metropolis, which is located in the Plateau State, Nigeria. It was composed of the Jos South and Jos North local government areas. The study area is regarded as the state capital and serves as a centre for various industries, political, educational, and residential activities. The study area provided a good opportunity to collect information about the volume of road traffic and the residents' opinions about the noise levels generated by road traffic.

Geographically, Jos North is located between latitude 9° 55'N and longitude 8° 54'E. It is a heterogeneous Local Government Area and has a total land mass of 291 km² and a population of 437,217 (NPC, 2006). Jos South is located between Latitude 9° 46'N and Longitude 8° 43'E. Its headquarters is located in Bukuru town, and it has an area of 510 km² with a population of 311,392 as of 2006. The metropolis is a hub for political, economic, industrial, educational, and administrative activities in the state. The present total estimated population of Jos metropolis stands at 1,134,806. As the city continues to increase in size and population, traffic

volume and its associated challenges such as noise and air pollution become a major challenge to the residents and passer by

Figure 1: The Study Area in its Local Settings



Source: Plateau State Ministry of Housing and Urban Development (2019)

METHOD OF DATA COLLECTION

This research adopted a survey research design (Astalin, 2013). A qualitative approach was employed to carry out the study. A descriptive and qualitative survey was conducted in all the road traffic-related agencies in Jos, Nigeria. A purposive sample of at least 10 road traffic-related ministries and agencies in Jos voluntarily participated in the study and responded to a set of questions related to their operational codes and conducts, existing laws, statutes, policies and structures, practices and standards, accident violation, penalties fact sheets of operations among others have been put on the ground to reduce traffic volume and noise among other traffic-related challenges in Jos.

For instance, visitation was made to all the heads and representatives of road traffic-related agencies such as the Plateau State Ministry of Physical Planning and Urban Development, Plateau State Environmental Protection Agency, Plateau State Ministry of Transport, Plateau State Ministry of Lands, Survey and Town Planning, Federal Road Safety Commission, Nigeria Police Force, Plateau State Emergency Management Agency among others to conduct face to

face interviews using an interview guide. Also, a reconnaissance survey was carried out to get the agencies' evidence of their operations on the field.

RESULTS AND DISCUSSION

Assessment of Existing Agencies Managing Traffic Noise in Jos

Federal Road Safety Commission (FRSC)

From the review of the Federal Road Safety Commission (Establishment) Act, of 2007, the Act provided the FRSC with the mandate to ensure the safety of all road users and properties on the country's highways. This is done through the enforcement of the rules and regulations that guide the use of the roads. One of the key functions of the agency is the patrolling of the highways to ensure that the roads are in compliance with the regulations (FRSC, 2019). The FRSC's primary duties include controlling traffic, minimizing accidents, and ensuring the safety of road users. It also monitors the movement of vehicles, removes obstructions from roads, educates the public about highway usage, and handles complaints about road conditions. Additionally, they have the authority to enforce the use of seat belts, helmets, and other safety equipment by both drivers and motorcycle riders, as well as to restrict the use of mobile phones by drivers (Gana & Emmanuel, 2014; Oyeyemi, 2003).

Despite the various measures that the government has taken to reduce road transport accidents, the implementation of the rules and regulations that guide the use of the roads has not been able to prevent the deaths and properties of people (Gopalakrishnan, 2012). The management of the road traffic system has also been criticized for its poor performance (Gana & Emmanuel, 2014). Some of the factors that have been identified as contributing to the poor performance of the system include the inadequate level of service provided to the public, the lack of effective vehicle administration, and the pitiable condition of the vehicles (WHO 2004; Agyapong & Ojo, 2018).

Legal Functions of FRSC

The functions of the FRSC are outlined in the 2007 Act. These include making the roads safer for all road users and motorists, identifying and implementing necessary road works and devices, and providing recommendations to the federal and state governments on the locations where these works and devices are most needed. In addition, the agency also educates and informs the public about the importance of highway discipline and the procedures involved in preventing and minimizing accidents on the roads.

Other functions include developing regulations and procedures that will help improve the safety of road users and motorists. It also conducts studies on the causes of road accidents and effective ways to prevent them. It additionally monitors the use of speed limits and other vehicle features. It collaborates with other agencies and groups in road safety to identify and implement effective strategies. Besides being able to issue regulations and procedures that help improve the safety of road users and motorists, the FRSC also provides mobile clinics that are designed to help crash victims get the medical attention they need at no charge. It also prohibits the use of mobile phones by drivers and requires the use of seat belts. It additionally monitors

the use of motorcycles on expressways and issues reminders regarding the validity of driver's licenses (FRSC, 2019).

Table 1: Notice of offense sheet

S/N	Offense	Code	Points	Penalty
1	Ascertainment of Weight Violation	AWV		2000
2	Assaulting Marshal on Duty	AMD	10	10,000
3	Attempting To Corrupt Marshal on Duty	ACS	10	10,000
4	Caution Sign Violation	CSV	3	3,000
5	Child Restraint Violation	CRV	6	3,000
6	Child Sitting Position Violation	CPV	6	3,000
7	Construction Area Speed Limit Violation	CAV	3	3,000
8	Dangerous Driving	DGD	10	50,000
9	Do Not Move Violation	DNM	2	2,000
10	Driver's Licence Violation	DLV	10	10,000
11	Driving Right-Hand Steering Vehicle	DRV	10	3,000
12	Driving With Worn-out Tyres	TVV	3	3,000
13	Driving With an Expired/without Spare Tyre	EWT	2	2,000
14	Excessive Smoke Emission	ESE	5	5,000
15	Failure To Cover Unstable Materials	FCM	5	5,000
16	Failure To Fix Red Flag on Projected Load	FFF	3	3,000
17	Failure To Install Speed Limit Device	SLD	3	3,000
S/N	Offense	Code	Points	Penalty
18	Failure In Move Over	FMO	3	3,000
19	Failure To Report Road Crash	FRC	10	20,000
20	Fire Extinguisher Violation	FEV	3	3,000
21	Fleet Operation Violation	FOV		200,000
22	Inadequate Construction Warning Sign	ICW		50,000
23	Instructor Permit and Training Violation	IPTV	10	2,000
24	Catching and Twist-Locks Violation	LTV	10	5,000
25	Learners Driving Regulation Violation	LDV	10	3,000
26	Number Plate Violation	NPV	2	2,000
27	Light/Sign Violation	LSV	3	3,000
28	Medical Personnel/Hospital Rejection of Road Crash Victim.	RCV		50,000
29	Operating Mechanically Deficient Vehicle.	MDV	5	5,000
30	Obstructing Marshal on Duty.	OMD	3	2,000
31	Operating A Vehicle with Forged Documents	OFD	10	20,000
32	Overloading	OVL	10	10,000
33	Passenger Manifest Violation	PMV	10	10,000
34	Preaching or Hawking in Commercial Vehicle	PHV		50,000
35	Projected Load In Excess of Prescribed Limit	PLE	3	3,000
36	Riding Motorcycle without Using a Crash Helmet.	RMH	2	2,000
37	Road Obstruction	ROB	5	3,000
38	Road Marking Violation	RMV	5	5,000
39	Route Violation	RTV	10	5,000
40	School Bus Violation	SBV	2	2,000
41	Seat Belt Violation	SUV	5	2,000
42	Speed Limit Violation	SLV	5	5,000

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43	Unauthorized Removal/Tampering with Road Sign	UTS	5	5,000
44	Underage Driving/Ridding	UDR		2,000
45	Use of Phone While Driving	UPD	4	4,000
46	Use of Sirens Violation	USV	3	2,000
47	Vehicle Licence Violation	VLV	3	3,000
48	Vehicle Identification Tag Violation	VITV	2	3,000
49	Vehicle Mirror Violation	VMV	3	3,000
50	Vehicle Windshield Violation	VWV	2	2,000
51	Wrong Overtaking	WOV	3	3,000
52	Driving Under Alcohol or Drug Influence	DUI	5	5,000
53	Other Offences/Violations (Specify....)	OFV		

Source: FRSC (2019).

The challenges faced by the FRSC in its operations in Jos and in Nigeria by extension are numerous. These include among others constant challenges of the mandates of the corps, poor road conditions, low level of infrastructural development, violation of human rights, low level of technological development in patrol operations, inadequate funding, inadequate database, inadequate command units, and logistics. These challenges have affected the smooth conduct of FRSC operations in Jos.

Plateau state Road Traffic Crash from 2009 to 2022

Table 2 presents the road traffic crash recorded in Jos between 2009 to 2022. A total of 3,467 crashes involving 18,477 people were recorded within the said period. Of the total crashes, 2015 had the highest with 419 which involved 2050 persons, 2020 had 298 (1776 persons) cases, 2013 recorded 297 (1419) cases, and 2022 had 267 (1353) cases among others. This implies that the highest road traffic crash was recorded in 2015 which involved the highest number of people.

On the nature of the road traffic crashes, 645 were fatal, 2417 cases were serious and 616 were considered minor cases. Of the fatal cases that were recorded, most (62) cases were recorded in 2013 and 2016, followed by 2014 with 58, 2009 had 54, and 2020 recorded 53 fatal cases. The majority (330) of serious cases were recorded in 2015, followed by 2013 with 207 cases, 2020 had 200 cases, 2014 had 178, 2016 and 2020 recorded, 176 each and 2009 had 172 respectively. The highest (195) minor cases were recorded in 2010, followed by 2018 with 75 cases. Overall, the majority (2417) cases were serious.

The Table further revealed that about 1,117 people were killed as a result of the accident, while 10,484 people sustained various degrees of injuries. Over speeding was considered the most prevalent cause of the road traffic crash in Plateau state. Speed is one of the factors influencing road traffic noise levels. This could be attributed to a high level of traffic noise recorded in Jos during the study.

Plate 1: A typical accident scene in Jos



Table 2: Road traffic crashes in Jos from 2009 - 2022

Year	No. of RTCS	NO. of people involved	Nature of RTCS			No. injured	No. Killed	Causes of RTC
			Fatal	Serious	Minor			
2009	261	1630	54	172	37	700	95	Over Speeding
2010	117	847	49	134	195	335	25	Wrong Overtaking
2011	164	1030	41	163	37	547	76	Over Speeding
2012	225	1140	33	167	25	728	79	Dangerous Driving
2013	297	1419	62	207	28	861	123	Dangerous Overtaking
2014	250	1174	58	178	15	838	103	Over Speeding
2015	419	2050	46	330	43	1440	75	Use of Phone While Driving
2016	257	1600	62	176	19	764	110	Worn Out Tyre
2017	225	1436	40	163	22	908	88	Over Speeding
2018	256	1394	37	120	75	860	71	Dangerous Driving
2019	173	784	31	96	10	501	11	Drunk Driving
2020	298	1776	53	200	45	923	97	Over Speeding
2021	258	844	35	135	22	464	71	Over Speeding
2022	267	1353	44	176	43	615	93	Dangerous Driving
TOTAL	3467	18477	645	2417	616	10484	1117	

Sources: Plateau State FRSC sector Command, 2023

The Nigerian Police Force

The Nigerian Police Force is charged with the responsibilities of prevention and detection of crime, apprehension of offenders, preservation of law and order, and protection of lives and properties among others. The roles of the Nigerian Police Force in controlling traffic over speeding, rough driving, and apprehension of offenders cannot be overemphasized. For instance, traffic wardens play vital roles in controlling road traffic noise through the enforcement of traffic noise laws, rules and regulations as well as other noise-calming measures. The standardization of highway traffic laws, regular and free care for accident victims given by mobile clinics, and the arrest and punishment of people who are plausibly suspected of committing traffic infractions.

Plate 2: A typical Traffic Police on Duty in Jos metropolis



Plateau State Ministry of Transport (PSMT)

The Plateau State Ministry of Transport (PSMT) is in charge of devising, developing, and putting into effect state policies and plans for both urban and rural transportation. Other functions include designing highways, building and overseeing state roads, maintaining bridges, repairing and maintaining road construction facilities, and inspecting vehicles.

The VIO of Plateau State is responsible for the inspection and training of drivers and other vehicle operators in the state. It also carries out examinations and tests of applicants for driver's licenses, conducts seminars for the public, and ensures that all roads are roadworthy. Aside from regular inspections, the agency also deploys its officers to enforce traffic laws and regulations and provide accessible emergency services. The state government through the ministries of transport and work carried out various road maintenance projects. Some of these include the dualization of the Polo

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roundabout, the construction of a flyover at the Rukuba junction, and the dualization of the Mararaban Jama'a-Heipang Road.

Plate 3: A newly constructed bridge on British-America Road



Plate 4: VIO operation team on duty in Jos



Plateau State Ministry of Environment (PSME)

The primary function of the Plateau State Ministry of Environment (PSME) is to protect and preserve the environment from both manmade and natural disasters. It is also responsible for maintaining a healthy and clean environment. The PSME is also responsible for ensuring that the environment is safe and clean for human habitation. It coordinates with various agencies and programs to implement policies and regulations related to environmental conservation, sanitation and hygiene, pollution control, wildlife conservation, and research. This ensures conformity with environmental laws and regulations, such as those issued by the Noise Control and Standards Agency.

Jos Wildlife Park is one of Plateau State's topmost tourist attractions and a place in Nigeria where nature has been conserved. The Park attracts a high number of tourists within and outside the state including international tourists on a regular basis who come for various tourism activities and other engagements such as meetings, weddings, seminars, conferences, excursions, field trips, and other social events among others. These activities usually led to high traffic volume along Wildlife Park, Miango, and Tudun Wada Roads. The volume of traffic attracted by these activities can be linked to the high traffic noise levels often recorded along these road corridors in the recreational area.

Ministry of Lands, Survey, and Town Planning (MLSTP)

The Ministry of Lands, Survey, and Town Planning (MLSTP) was established to among others issue certificate of occupancy to deserving citizens. In addition to granting certificates of occupancy to worthy individuals, the government has entrusted the Ministry with the duty of enforcing relevant laws, land administration, allocation, town planning, and land surveys on behalf of the state government (Ali *et al.*, 2019). Land use planning and town planning fall under the purview of the Ministry's Town Planning (TP) department. The importance of land use planning in controlling traffic noise particularly in the areas of general land use allocation and provision of noise barriers such as buffers cannot be overemphasized.

The Ministry of Lands, Survey and Town Planning has faced various challenges. Some of these include the inability of the government to provide relevant land documents to those who purchased them on time, the missing files at the ministry, and the unwillingness of landowners to register their titles. This prevents the government from generating revenue. Also, large parcels of land that are not purchased by the government are not paying ground rent. In addition, the lack of a computer system to meet its staff members' needs has also caused delays in the process.

Despite the challenges above, there have been some remarkable achievements in the areas of revenue generation over the past years, recruitment of ad-hoc staff has hosted the file processing, the process of issuing land titles to the users has been improved, the creation of Plateau Geographical information system (PLAGIS) and the increasing review of fees and rates for acquiring land titles have streamlined the process of obtaining land certificates in Plateau State.

Ministry of Physical Planning and Urban Development (MPPUD)

The Ministry of Physical Planning and Urban Development (MPPUD) is responsible for initiating, formulating, and developing policies and programs in the areas of physical planning, urban development, and urban renewal; creating regional, master, and model city plans; creating action and development plans for excised villages; approving and overseeing layout plans for both public and private estates; and evaluating, relocating, and regularizing urban-based development and activities.

Other functions included formulating policies and managing the various activities related to urbanization and urban development in the state. These include the establishment of a comprehensive transportation infrastructure network for the state, as well as the formulation of a regional and urban planning law. It is responsible for the establishment of comprehensive plans and strategies for the various activities related to urbanization and urban growth in the state. It is also involved in the formulation of policies and programs for the sector. It is also the custodian of all government properties and structures, as well as preparing bills of quantities for the various construction projects.

However, from the discussion above, at present, there seems to be no agency directly responsible for traffic noise control in Jos. However, an indirect structure exists in the agencies controlling traffic speed such as the Police, Road Safety, Ministry of Transport, Ministry of Lands, Survey, and Town Planning, Ministry of Physical Planning and Urban Development, Ministry of Environment and Environmental Impact Assessment procedures of traffic-related developments among others. Thus, there is no direct organogram at present for managing traffic noise in Jos metropolis, but a series of uncoordinated agencies and standards. Nevertheless, from the discussion carried out so far in this study, a framework has been proposed taking cognizance of the agencies indirectly controlling traffic noise through various traffic management measures.

Institutional Framework for Road Traffic Noise Management in the Land Uses of Jos.

Plateau State Ministry of Transport

The Department of Traffic Management in the Ministry of Transport should conduct a road traffic volume and speed survey along the major roads in the various land uses of Jos metropolis in order to ascertain the actual road traffic volume and average speed generated in each land use. The survey should be conducted biannually for a period of one month each in two seasons. This is to determine the road traffic volume and speed variations during the dry and wet seasons. The data generated should be analysed for the purpose of government policy and decision-making. This will serve as the basis for road traffic noise management policies and decisions.

Based on the data derived from the survey, the ministry, should come up with urban speed limit regulations and speed bumps and assign them along all the roads in each of the noise-sensitive land uses in order to reduce the level of human exposure to traffic noise. Other traffic calming strategies such as lane narrowing, raised intersections, traffic circles, pavement markings, and

signages among others should be designed and implemented. Again, certain vehicles such as heavy vehicles should be banned from entering the central area of the metropolis or moving on a particular road either the whole day or at night which could bring substantial noise benefits.

For the short-term intervention, the Plateau State Ministry of Transport in collaboration with the state government should provide mass transit that would cater for the daily transportation of the residents of Jos metropolis. The provision of mass transit within the metropolis will reduce motorists, particularly private car users off the roads. For the long-term intervention, the Ministry of Transport in conjunction with the ministries of work (state and federal) would construct an intra-city railway and bye-pass along the Zaria and Bauchi routes axes to decongest the number of vehicles passing within Jos metropolis. This is because commuters who have no business to do in the metropolis can follow through the bye-pass. This can lead to a decrease in the number of vehicles on the roads which would in turn reduce traffic noise levels in the metropolis.

Again, the carrying capacity of some existing roads such as Miango Road, Bauchi Ring Road, Tafawa Balewa Road, Bauchi Road, Murtala Muh'd Way, Ahmadu Bello Way among others should be expanded to accommodate and meet the increasing traffic volume and travel demand within the metropolis. High vehicle speed has been linked to high levels of traffic noise. Therefore, by employing low-noise tires or pavements, the rolling noise can be reduced. The Department of Traffic Management under the Ministry of Transport should assign urban speed limits and construct speed bumps.

The operation of the local and national transportation and land use planning systems should take road traffic noise management into account. Techniques include traffic noise management plans, such as rerouting traffic away from sensitive receptors, restricting heavy vehicles from using specific roads at certain times of day, designing and constructing new roads to provide an alternative route away from noise-sensitive buildings, and enacting urban speed limits directly. The Ministry of Transport should within a reasonable period communicate such data and decisions to the Ministry of Environment and Federal Road Safety Commission (FRSC) respectively for further action.

Federal Road Safety Commission (FRSC)

The Federal Road Safety Commission (FRSC) and other security agencies such as Nigerian police should make use of the transmitted policy document developed by the Ministry of Environment as a guide to enforce traffic control and regulations such as restricting vehicles to certain areas and noise standards regulations and guidelines on all motorists. The FRSC should make sure that all road users, particularly drivers and motorists, adhere to all the established noise standards and guidelines including noise abatement measures, such as low noise emission standards for vehicles, speed limits regulations, a ban on all vehicles—especially heavy vehicles—driving at night, and the indiscriminate use of vehicle horns by drivers, especially at night and in noise-sensitive areas.

This is so because, among other things, the volume of traffic, the type of vehicle, the speed of the vehicle, and the indiscriminate use of horns are some of the key elements generating road traffic noise. A panel codes for violators should be designed and enforced to ensure compliance. Violators of such rules should be penalized based on the principle of polluter pays and prevention. The income generated can serve as a source of revenue to the government. FRSC and other security agencies such as police should ensure that all road users particularly drivers and motorists comply with the acceptable urban speed limits. The construction of speed bumps and enforcement of urban speed limits would significantly reduce the level of traffic noise.

The composition of vehicles plying on the roads within, and outside urban areas has a great influence on the level of traffic noise being produced. For example, buses, lorry and big trucks such as heavy goods vehicles generate more noise than car passenger automobiles (Ece *et al.*, 2018). Okokon (2018a) observed that, if the proportion of heavy vehicles, such as trucks and trailers, is high along the roads within an urban area, there is a tendency to experience high traffic noise levels and air pollution. The FRSC and other relevant security agencies should ban Heavy Goods Vehicles (HGV) such as trucks and trailers from passing through the city centre and around residential areas particularly during night-time. Sign posts and heavy vehicles (trucks and trailers) over height restriction barriers would be provided at the road junction of the entry points into the city centre indicating and directing them toward alternative routes (bye-pass).

Human (driver) behaviour is another factor responsible for high traffic noise. For instance, drivers' behaviours such as over speeding, wrongful over taking, rough driving, drunkenness, blaring of vehicle horns among others have been noted to have high influence on the level of traffic noise. Therefore, law enforcement agencies such as FRSC, and Nigerian Police among others should ensure the enforcement of traffic noise laws, rules, and regulations on all road users, particularly drivers and motorists. To achieve low a traffic noise environment, there would be needed for attitudinal change by all road users. This can be done through public education and awareness by informing them about the health effects of traffic noise. The National Orientation Agency in collaboration with other relevant traffic-related agencies promotes the dissemination of information to road users such as drivers, cyclists, pedestrians, and the general public, on general knowledge about acoustics, noise and its generation, health problems associated with noise, minimization and prevention of noise problems.

Ministry of Environment

The Ministry of Environment upon receiving the communication of such data from the Ministry of Transport, should within a reasonable period from the date of the receipt of such communication carry out a traffic noise level survey along the major roads of the various land uses as identified and studied by the MoT. The essence is to determine the levels of road traffic noise generated daily along the major roads in each land use zone. It should also involve the identification and mapping of noise sources and exposed communities. Meteorological conditions such as temperature and humidity which contribute to noise levels should also be monitored. Based on the data obtained

and in consideration of both national and international noise standards and guidelines such as those recommended by FEPA and WHO, the Ministry of Environment should develop and assign a maximum equivalent noise levels permissible for each land use zone in Jos metropolis.

The high noise-sensitive areas should be identified and designated as environmental areas in order to restrict the movement of vehicles within those areas. The concept of environmental areas is a vital part of any planning process. These places are designed to protect the inhabitants and their natural resources from exposure to road traffic noise while promoting sustainable development. In addition, the Ministry of Environment should carry out regular environmental auditing of all the land use zones especially those areas with high traffic noise levels to monitor compliance with the existing rules and regulations. The policy document that contains the noise standards and guidelines such as the developed and assigned maximum equivalent noise levels permissible should be gazetted and published in at least two national dailies. Such policy decisions should be communicated to relevant ministries and agencies such as Lands, survey, Town Planning, Physical Planning and Urban Development, and the Plateau State Geographical Information System (PLAGIS) respectively.

Ministry of Lands, Survey, and Town Planning

The Ministry of Lands, Survey, and Town Planning upon the receipt of such policy documents from both the Ministry of Environment and PLAGIS, will review the documents and thereafter mandate the Department of Town Planning to allocate land uses based on their compatibility in terms of traffic volume and noise generation. In line with the road traffic noise map, the allocation of new land uses should be in such a way that new noise-sensitive uses are located so as not to be exposed to excessive noise levels and new noise emitters are located so as not to introduce excessive levels of noise to existing, committed or planned sensitive uses.

Also, the ministry should carry out land use re-orientation and allocation planning in accordance with traffic noise documents to minimize traffic noise in Jos. One of the main tools for traffic noise management is land use planning. This can be done through land use allocation, setting of standards for the minimum noise levels for various land use zones, building types, and building setbacks based on annoyance responses to noise. The Ministry of Lands, Survey, and Town Planning should within a reasonable period transmit such new a policy to the Ministry of Physical Planning and Urban Development.

Ministry of Physical Planning and Urban Development

The Department of Development Control in the Ministry of Physical Planning and Urban Development, will review the transmitted document and thereafter mainstream such policies into the development control guidelines. This document can form part of their physical planning and urban development policies and programs especially in the areas of physical development control such as physical planning, urban development, and urban renewal; creating regional, master, and model city plans; creating action and development plans for excised communities; approving and overseeing layout plans for both public and private estates; and evaluating, relocating, and

regularizing urban-based development and activities. Additionally, the Development Control (DC) department should be in charge of approving building permits and privately generated layout plans, keeping an eye on and overseeing approved building plans, serving contravention notices on unpermitted buildings, and then demolishing any unlawful structures that are found.

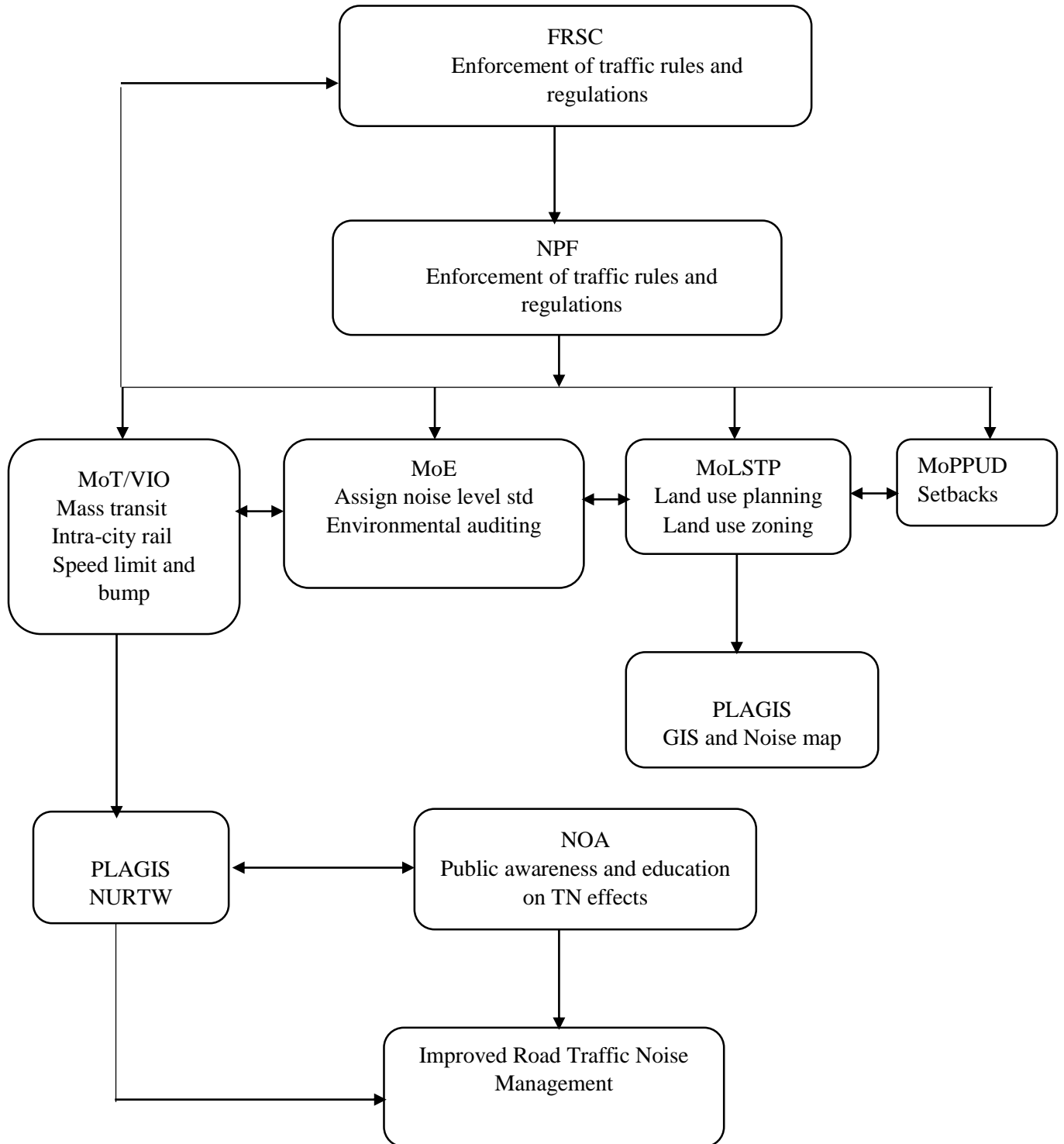
Before granting approval, DC department should ensure that noise mitigation strategies are integrated into building designs in addition, Environment Impact Assessment (EIA) should be attached to the building plans, especially those with traffic-attracting and noise-sensitive uses. In order to improve the environmental quality, traffic noise mitigation strategies should be incorporated into the majority of redevelopment projects from the project planning stage. These precautions may include thoughtful building placement and orientation, the creation of podiums, and building setbacks. The building of a noise barrier or canopy may be taken into consideration in more challenging areas. Therefore, it should be made essential to include noise reduction techniques in the building designs of redevelopment projects.

The development control department in the Ministry of Physical Planning and Urban Development is to be concerned with the approval of building permits (plan) and privately developed layouts, monitoring and controlling of approved building plans, and serving contravention notices on buildings without the permits and subsequent demolition of illegal structures. This will be done in line with the noise standards or guidelines and maximum permissible noise levels developed by the Ministry of Environment as recommended by FEPA and WHO. This is to ensure that the noise emissions are within the maximum permissible noise equivalent recommended for each land use zone.

National Orientation Agency (NOA)

The relevant ministries and agencies should within a reasonable time communicate the noise abatement policies, rules, regulations, standards and guidelines to the National Orientation Agency (NOA) for dissemination of information to the residents of Jos metropolis. The National Orientation Agency in collaboration with national and local media stations such as National Television Authority, African Independence Television and Plateau Radio and Television Corporation should promote the dissemination of information to road users such as drivers, cyclists, pedestrians, and the general public, general knowledge about acoustics, noise and its generation, health issues related to noise, and the minimization and prevention of noise problems. Consequently, the environmental noise situation of the metropolis can be improved as more people on the road and in general become aware of the sources, effects, and ways to prevent noise. The above processes should be reviewed and amended every two years period with a view to improving the land use management of road traffic noise in Jos metropolis while protecting more people and communities from exposure to high road traffic noise and providing more noise performance information to the public in a more transparent manner. The revision is to explore measures to provide more protection to the residents. For instance, the possible increase in vehicular ownership, and population explosion due to urbanization and industrialization which could lead to rapid urban development are other reasons for the periodic review.

Figure 2: Structural Framework for Managing Road Traffic Noise in Jos Metropolis



CONCLUSION AND FUTURE LINES OF RESEARCH

The aim of this study was twofold: firstly, to assess the existing traffic noise management strategies employed by the relevant traffic-related agencies in controlling urban residents' exposure to traffic noise pollution in Jos metropolis and secondly evolve a structural framework for traffic noise reduction in the land uses of Jos metropolis, Nigeria. Findings revealed that-, there is no agency directly responsible for traffic noise control in Jos. However, an indirect structure exists in the agencies controlling traffic speed such as the Police, Road Safety, Ministry of Transport, Ministry of Lands, Survey, and Town Planning, Ministry of Physical Planning and Urban Development, Ministry of Environment and Environmental Impact Assessment procedures of traffic-related developments among others. Thus, there is no direct organogram at present for managing traffic noise in Jos metropolis, but a series of uncoordinated agencies and standards. These results are particularly interesting for urban planners and other stakeholders in the built environment that are concerned with providing a conducive and friendly environment for urban residents through proper traffic noise management.

The present study focused on the assessment of existing road traffic noise management strategies for traffic noise reduction in Jos. Therefore, future studies on other sources of traffic noise such as railway and airport as well as environmental and community noise should be investigated to ascertain the aggregate noise situation of the study area. Also, there is a need for future collaborative research between urban planners and medical practitioners in the areas of the effects of road traffic noise on human health and the environment. The research could be randomized studies on actual and control populations to establish the effect of traffic noise in Jos metropolis.

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