ASSESSMENT OF ROAD FURNITURE ALONG THE MAJOR ROADS IN MINNA METROPOLIS, NIGER STATE

BY

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MEng/SIPET/2018/8347

DEPARTMENT OF CIVIL ENGIEERING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

AUGUST, 2023

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ENGINEERING IN CIVIL ENGINEERING (TRANSPORTATION ENGINEERING)

AUGUST, 2023

DECLARATION

I hereby declare that this thesis titled: **"Assessment of Road Furniture along the major Roads in Minna, Niger State"** is a collection of my original research work and has not been presented for any other qualification anywhere. Information from other sources (published and unpublished) has been duly cited and acknowledged.

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……..
Signature & Date

CERTIFICATION

The thesis titled: **"Assessment of Road Furniture along the major Roads in Minna, Niger State."** by: AZIH, Mercy (MEng./SIPET/2018/8347) meets the regulations governing the award of the degree of MEng. Civil Engineering of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my lovely husband, my daughter and parents.

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I would like say thank you to the Lord Almighty, the King of Kings, the Lords of Lords, the Beginning and the End, for his grace, love, mercy and provision throughout the period of my study. You are indeed a faithful God and I exalt your holy name.

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ABSTRACT

The absence of sufficient safety laws, poor infrastructure and inadequate enforcement in developing countries account for 90% of the world's road traffic fatalities. Road furniture are used to improve safety and control traffic along the roads. The study assessed the road furniture that control traffic along 20km Chanchaga – Mobil – Tudun Fulani Road, 13.5km western by pass and Kpakungu – Gidan Kwano road which are the major highways within Minna, metropolis. The road furniture considered were traffic signals, road signs, speed humps and roundabouts. The research assessed their distribution/ sufficiency, conformity to standards and familiarity/ Compliance of Road Users with the Furniture. This was achieved using data from field, records/standards, ArcGIS technology and questionnaires. The study showed that a total number of 126 furniture have been provided along the major highways. 92 furniture were identified along Chanchaga – Mobil – Tudun Fulani Road, 52 along the western by pass and 7 along Kpakungu – Gidan Kwano road making Chanchaga – Mobil – Tudun Fulani Road the most concentrated. 204 points were identified to be deficient of relevant road furniture. Therefore, only 38% of the required road furniture have been provided and these furniture are randomly distributed having obtained a nearest neighborhood ratio of 1.2. 55% of the existing furniture were observed to conform to conventional standards and though the level of familiarity of 56.1% was obtained, the general compliance level was gotten as 28.4% which is poor. It was therefore recommended that more effort needs to be made in erecting and maintaining road furniture and there is need for more sensitization on the importance of these furniture.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Transportation is the movement of people, goods and services from one place to another and the various means by which such movements are accomplished. An effective transportation system consists of various modes of transportation and the ability to transport goods and people fast and safely has been the index of civilization and technological progress.

The word transport is derived from the Latin words '*portare* and *trans', Portare* means to carry while *trans* which means across (Clement and Jones, 2018). Transportation has been recognized as very essential in the development of any society. It encourages geographical distribution of people and their activities. People travel to primarily earn a living, conduct family businesses, and engage in social and recreational activities (Chengwu *et al.,* 2022).

The various modes of transportation are air, land, water, cable, pipeline, and space. Air transport involves mechanical flight and the aircraft industry. It is the fastest, most expensive and most recent form of transportation (Kolo, 2020). It provides unbroken journey over land and sea. Land transport moves people, goods and animals from one location to another on land. The two main forms of land transport are the rail transport and the road transport. The rail transport transports passengers and goods on wheeled vehicles running on rails which are located on tracks while the road transport runs on a prepared flat surface called roads (Rodrigue *et al.,* 2016). Water or maritime transport is used to move people and goods (cargo) via waterways. It is considered as the cheapest

means of transporting consumable and bulky goods over long distances (Bongdap, 2020). Cable transport makes use of cables to transport goods and people in cable cars. The items are moved by pulling, sliding, sailing or by drives within the object being moved on cable ways. Pipeline transport is used to transport liquid and gas from one location to another in a safe, efficient and reliable manner (Johnstone, 2015).

Road transportation is the most popular form of transportation. It is flexible and plays a vital role in linking communities within a district and communities with other regions. It complements all other forms of transportation (Kolo, 2020). Pavements are constructed to allow for safe and easy movement of vehicles. They are made from strong durable material and laid on a path intended for vehicular or pedestrian movement.

Providing and managing the road transport system is a key issue facing regional and district councils as well as other providers of road transportation. Road furniture are used to improve the safety along the roads, control the traffic, provide utility and aesthetics to the roads (Shude and Shidu, 2022). They are all fixtures (piece of equipment fixed in position) in the road and road reserves. Road furniture that help to control traffic and ensure safety of the road users are traffic signals, road signs, speed humps and roundabouts. In this regard, the major roads in Minna are being investigated to determine the adequacy of road furniture that are available on its major roads.

1.2 Statement of the Research Problem

About 1.3 million people die worldwide each year because of road traffic crashes (World Health Organization, 2013). The absence of sufficient safety laws, poor infrastructure and inadequate enforcement in low and middle income countries account for 90% of the world's road traffic fatalities with an economic cost of almost $100 billion a year to these countries (Khazan, 2013). About 50 million people suffer injuries

due to road traffic crashes globally every year with an overall economic cost ranging from 2-5 percent of the GDP in many countries (Sung and Rios, 2016).

Situation reports conducted by the World Bank Transport Department on the state of roads in Sub Saharan Africa between 1998 and 2008 confirmed a gross inadequacy of road furniture for safety of road users. Specifically, in the West African region, previous credible studies showed that no country except for Ghana took broad steps to install appropriate and near adequate road furniture in 20% of the existing roads. Road furniture are one of the common defects identified to significantly influence safety along the roads (Shude and Shidu, 2022).

Traffic wardens are playing a significant role in the control of traffic especially at intersections in Minna. However, they only operate for 10 hours, hereby leaving a noticeable influence of congestion especially between the hours of 6:00pm – 7:00pm (Ndoke, 2018). Records show that 67% of the accidents recorded in Minna between 2016 – 2020 were because of Speed violations, Traffic Light Violations and Route Violations which are all associated with road furniture. The outcome of data evaluation from analysis of Road Traffic Safety in Minna Niger State, Nigeria showed that the condition of road and general traffic rules are major causes of road accidents in the city (Oyetubo *et al*., 2018). Therefore, it is important to assess the road furniture within Minna metropolis to identify the gaps in general safety of the roads and provide an input to the government particularly the Federal Road Safety Commission, in evolving policies aimed at reducing or possibly eliminating accidents on the roads.

1.3 Research Questions

The research questions for this study are:

i. How have the road furniture been distributed across the major highways in Minna Metropolis?
ii. Do the available road furniture conform with the conventional standards?
iii. What is the level of compliance of road users to the furniture within the metropolis?

1.4 Aim and Objectives

1.4.1 Aim

The aim of this research work was to assess road furniture along the major Highways within Minna Metropolis.

1.4.2 Objectives

The objectives of this research work are to:

i. Determine the distribution and sufficiency of road furniture along major routes in Minna Metropolis.
ii. Assess the conformity of the road furniture to the conventional standards
iii. Determine the compliance level of road users to the road furniture in the town.

1.5 Scope of the Study

This study examined the road furniture within the major highways in Minna metropolis. The roads investigated for this study are Tudun Fulani – Mobil – Chanchaga Road, Western Bypass and Kpakungu – Gidan Kwano Road which are the major highways within the metropolis. The investigation put into consideration all road furniture along the roads, their condition, conformity to standards as well as their adequacy along the roads. Factors affecting the efficiency of these furniture such as commuters understanding of the furniture and compliance with the furniture were also considered. The focus of road furniture for this study were traffic signals, road signs, speed humps and roundabouts.

1.6 Justification of the Study

Road furniture help in ensuring highway safety by providing for the predictable and orderly movement of all traffic (Broxap, 2017). They provide necessary warnings and guidance to ensure the safe and informed operation of every road user on the highway (Chechar, 2017). The major challenge encountered with road furniture is their inadequacy. Most roads are old and do not contain the relevant furniture. They are limited and mostly found only where people live. Therefore, the inconsistency makes drivers fail to pay attention even where they have been provided (Daily Nation, 2019). Another challenge with road furniture is that most of them are either damaged or stolen. People don't fully understand the importance of these furniture (Daily Nation, 2019). They paint on, place posters or even intentionally damage them for no reason. The maintenance culture for the furniture from relevant agencies is very poor. They don't carry out frequent audits to ascertain the conditions of these furniture in order to enable them take relevant

steps to enhance their functionality. Road users are not sensitized on the meanings and importance of these furniture.

The growth of transport and traffic has created several severe problems like congestion which jeopardizes the accessibility of important economic and social centers. The human environment is affected by interferences causing human suffering and social disruptions.

This study will help in identifying the gaps in the erection of road furniture and ways to improve compliance of road users.

1.7 Study Area

Minna the capital of Niger state is situated in the North Central geo-political zone of Nigeria. The city is located at the eastern part of the state and lies between Latitudes 9° 33' - 9° 40'N of the equator and Longitudes 6° 30' - 6° 36'E of the Greenwich Meridian. Minna metropolis comprises two local government areas i.e. Chanchaga and Bosso, spanning from Maikunkele at the north to Chanchaga at the south. Chanchaga LGA is bordered all round by Bosso LGA, while Bosso LGA is bordered at the north by Shiroro LGA, at the East by Paikoro LGA, at the South by Katcha LGA and at the west by Wushishi LGA.

The study focused on the 3 major roads in Minna which include Chanchaga – Mobil – Tudun Fulani, Western Bypass and Kpakungu – Gidan Kwano roads. Chanchaga – Mobil – Tudun Fulani is 20km long, the Western Bypass is 13.5km long and Kpakungu – Gidan Kwano road is 14km long.

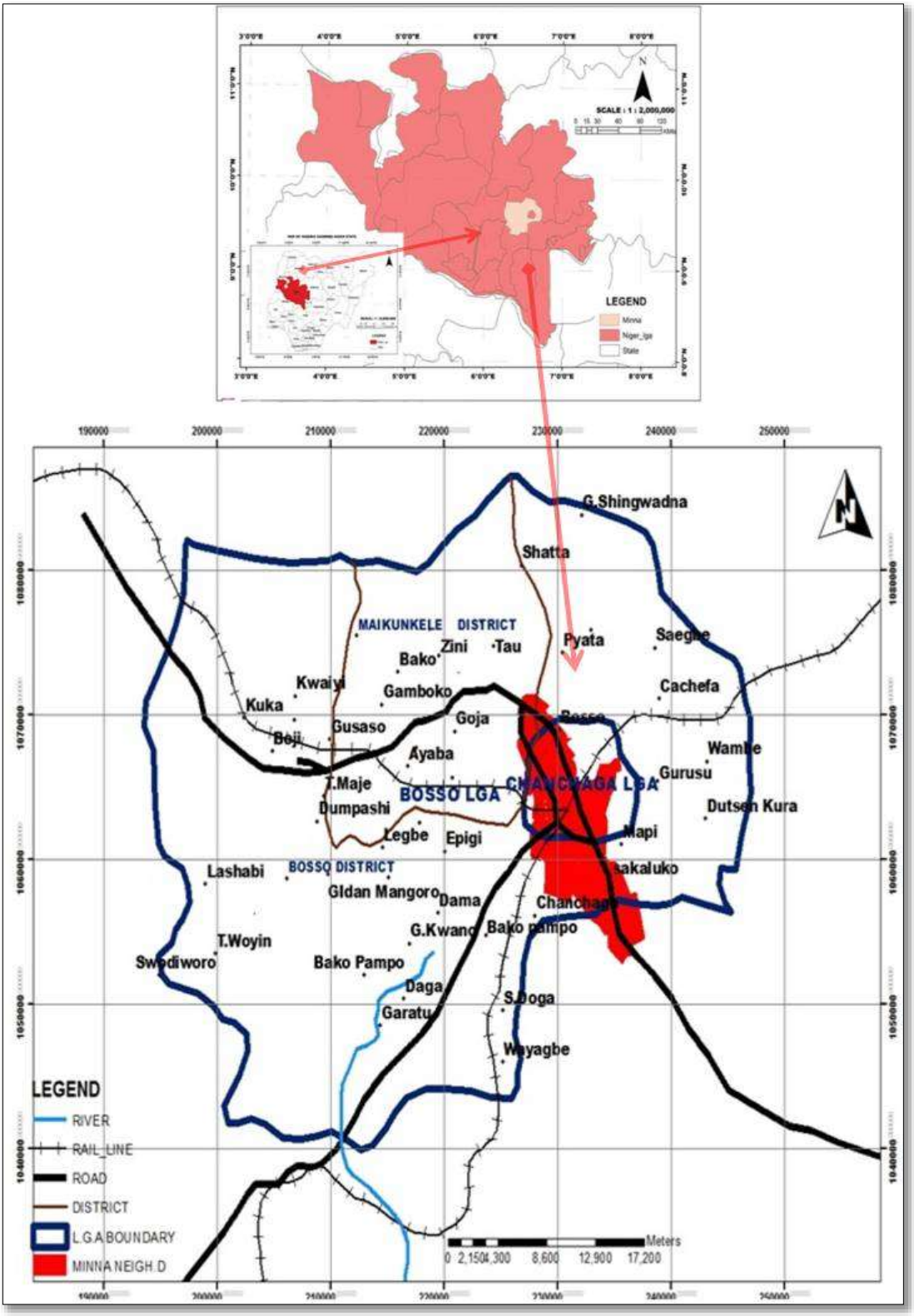

Figure 1. 1: Minna in context of Niger State and Nigeria.
(Source: Urban and Regional Planning Department, FUT Minna, 2021)

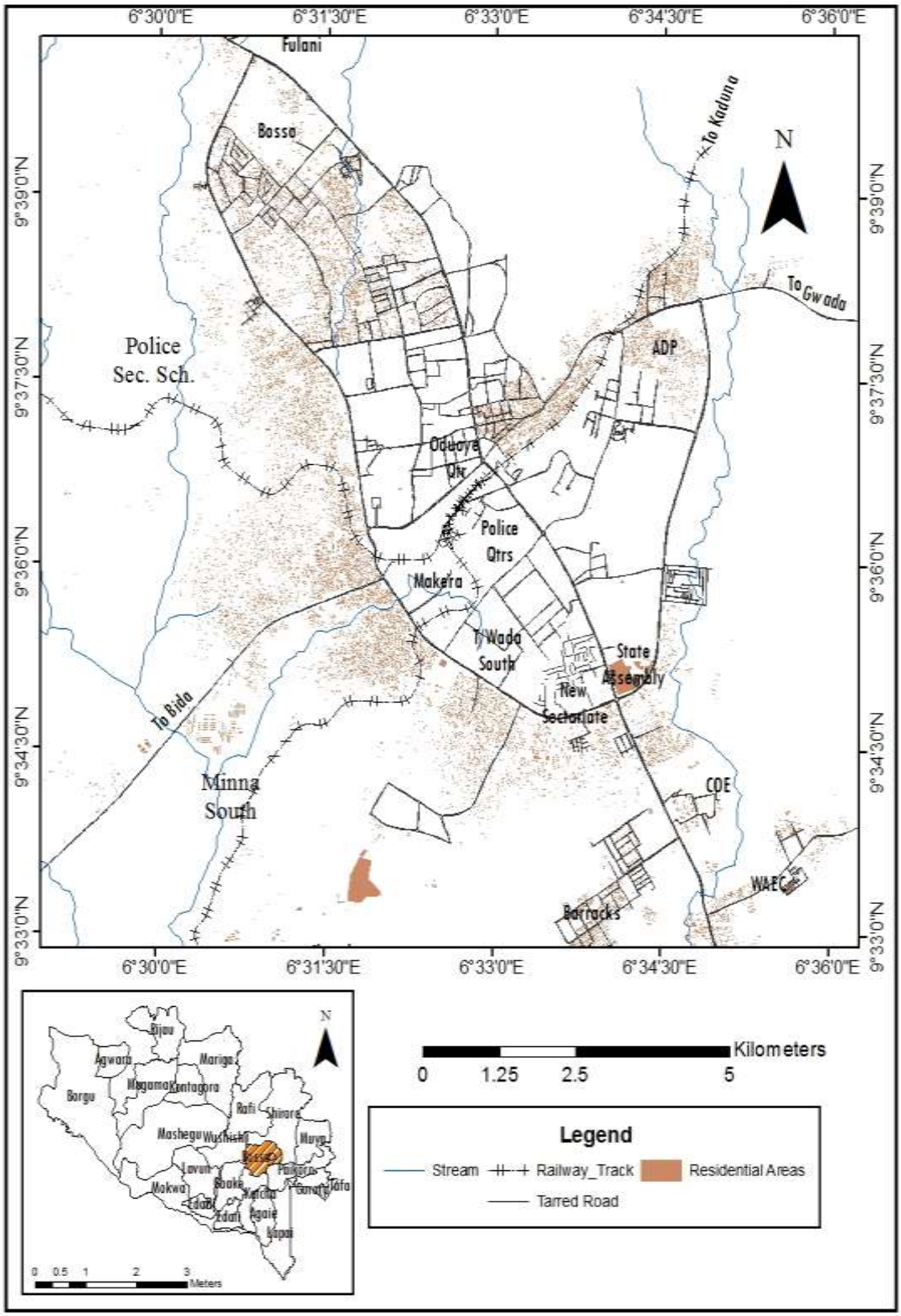

Figure 1. 2: Minna Metropolitan Area
(Source: Niger State Geographic Information System, 2020)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Transportation

Transportation is the action of moving someone or something or the process of being moved. It has been in existence since the earliest times where wooden carts and animals like horses, donkeys, and bulls were used exclusively. Transportation enables trade, commerce, and communication that establish civilization and acts as a link between manufacturing facilities and consumer markets (Bhasin, 2020). It has been recognized as very important in the development of any society as it inspires geographical distribution of people and their activities. Recreation, sightseeing, shopping, dining, educational purpose, works are the major purposes for taking trips (Chengwu *et al.*, 2022).

2.2 Modes of Transportation with Emphasis on Road

Transportation modes are vital components of a transport system since they are the means of supporting mobility. Modes can be grouped into five categories based on the medium they exploit. Each mode has its own requirements and features and is modified to serve the specific demands of freight and passenger traffic (Rodrigue *et al.*, 2016).

The various modes of transportation are air, land, water, cable, pipeline and space. Air transportation is the movement of passengers and freight by any conveyance that can sustain controlled flight. It is the fastest, most expensive and most recent form of transportation (Kolo, 2020). Land transport moves people, goods and animals from one location to another on land. The two main forms of land transport are the rail transport and the road transport. Water or maritime transport transports people and goods (cargo) via waterways. It is the cheapest means of transporting bulky and perishable goods over

long distances (Bongdap, 2020). Cable transport makes use of cables to transport goods and people in cable cars. The items are moved by pulling, sliding, sailing or by drives within the object being moved on cable ways. Pipeline transport is used to transport liquid and gas from one location to another in a safe, efficient and reliable manner (Johnstone, 2015). All these modes rely on one another for efficient transportation.

Road transportation is the most prevalent form of transportation. It is flexible and plays a vital role in linking communities within a district and communities with other regions. It complements all other forms of transportation (Kolo, 2020). Pavements are constructed to allow for safe and easy movement of vehicles. They are hard surfaces made from durable surface material lay down on an area intended to carry vehicular or foot traffic.

2.3 Road Transportation

Road transportation is the movement of people and goods using a prepared flat surface called roads (Rodrigue *et al.,* 2016). A road is a thoroughfare, route, or way on land between two places that has been paved or otherwise improved to allow travel by foot or some form of conveyance like cars, buses, trucks, motorcycles, bicycles and animals. It is the most accessible form of transportation which complements other forms of transportation and allows for day to day movement from places of work, study, worship and recreational centers.

Providing and managing the road transport system is a key issue facing regional and district councils as well as other providers of road transportation.

2.4 Road Network

A Road network is the system of interconnected roads designed to accommodate wheeled road going vehicles and pedestrian traffic. It consists of intersections, motorways, rural and urban roads, bicycle lanes, footpaths, bridges and tunnels. The road network facilitates the movement of people allowing for social interaction and economy growth. It has influenced the security of a place as the presence or absence of routes from one place to another can influence the mobility of the public and also of criminals. Nigeria has the largest highway and road network in West Africa and 95 percent of the movements done in the country are by road (Adebukola, 2022).

As at 2015, Nigeria had about 195,000 km road network out of which about 32,000 km are federal roads while 31,000km are state roads (Adebukola, 2022). The road system consists of Trunk A or federal roads, Trunk B or state Roads and Trunk C roads. It began in 1946 and was done for administrative purpose (Federal Ministry of Works, 2013). The Trunk A roads are roads under the federal government ownership. They are constructed, developed, financed and maintained by the federal government through the Federal Ministry of Works and Housing They are the skeleton trunk road system upon which the remaining of the road system of the country is built up and has the primary purpose of providing inter-regional communication between the federal and state capitals and other large towns and to provide international links with important centers in neighboring territories. It cuts across regional boundaries in the country and extends to the international borders of neighboring West African countries. Notable examples are Ijebuode- Benin Expressway, Abuja-Kaduna Expressway, Lagos-Ibadan Expressway, Akure-Ilesa road, etc. In addition the Badagry, Republic of Benin, road is a prominent international highway that links Nigeria with the neighboring Republic of Benin (Yakubu, 2016).

Trunk B roads link major cities within States with the State headquarters. These roads are financed by the State governments and are usually tarred. The primary objective is to enhance the socio-economic development of the States. Trunk C Roads are local feeder roads constructed and maintained by the Works Department of local government authorities in Nigeria. This class of road is usually untarred and seasonal in nature (Yakubu, 2016).

Safety is considered when planning a road network by classifying the roads, setting speed limits to match the functions of the road and separating motorized from non-motorized traffic, wherever possible. They are also designed so that accidents are minimized by providing self-explanatory road layouts, provision for pedestrians and cyclists, area-wide speed reduction and traffic calming, provision of crash-protective roadside objects and introducing safety impact assessment, audit and inspection.

2.5 Road Furniture

Road furniture are all fixtures (piece of equipment fixed in position) in the road and road reserves, they are used for safety, control of traffic, provision of utility and sometimes aesthetics. They are essential for the efficient and safe operation of the road network. Roads with poor signage or poorly maintained signs are unsatisfactory roads and cannot operate to their full traffic carrying capacity.

The placement and design of the furniture considers function, aesthetics, visual identity, safety and pedestrian movement. The sizes, colours and layout in most developing countries have been standardized in accordance with international protocol and incorporated in departmental standards and compliance with this standards are very important inorder to ensure accurate and reliable communication. Uniformity and standardization minimizes confusion and uncertainty about their meanings (Jose, 2018).

Therefore, all furniture are expected to be properly maintained to so they looks the way they were designed to look and enable them serve their functions effectively. This maintenance is usually carried out by transport authorities. However, it is sometime done by statutory undertakers and utility companies when it relates to subsurface equipment like telecommunications junction boxes (Husseine, 2013).

Road furniture provide the driver with the necessary warnings and rules, distance and directional information inorder to travel roads safely. Distance and directional information assist orientation and navigation along the road for drivers, motorcyclists and pedestrians. They reduce accidents and manpower requirement for regulation traffic. The main road furniture that influence the safety and traffic along a road are road signs, traffic signals, speed humps and roundabouts.

2.5.1 Traffic signals

A traffic signal is a device which contains one or more lights to caution an impending hazard or right-of-way change. They are mostly found at road intersections and are installed to respond to high vehicle and/or pedestrian volumes, or a high number of correctable crashes (Frank and Lynn, 2009). A justified signal, properly designed, installed, operated and maintained, is an asset to the traveling public but a traffic signal that is unjustified, poorly designed, installed, operated, or maintained may decrease the safety or the efficiency of an intersection. Their design, installations and operations are complex and should be undertaken by qualified persons with high level of skill and experience (Highway Manual Volume VI, 2013). The traffic light system used in Nigeria involves a green light followed by a yellow light signal and finally a red light signal arranged in a vertical manner. Arrows are used when there is possibility of more than one

direction. A green signal indicates that the driver may proceed, a yellow signal indicates that the green signal is about to commence and red indicates that the driver should stop.

Traffic signals are used in the following locations

1. Signalized intersections
2. Signalized pedestrian and cyclist crossing
3. Control of public transport lanes
4. Temporary road works
5. Railway crossings

Traffic signals should be installed where the existing method of control cannot cope with increasing delays and accidents as a result. Its design should ensure coordination with existing traffic signals in proximity.

A likely disadvantage of a traffic signal is that it may only be needed during the peak traffic flow hours. Therefore, other alternatives should also be considered. There are warrants often followed to determine the suitability for a traffic signal at a location. They require extensive surveys (Highway Manual Volume VI, 2013).

If the road is a dual carriageway with a median island 1.2mwide, the left hand traffic signal should be positioned on the median island. Traffic signal faces should be clearly visible and not be more than 16- 20m apart. Its visibility can be improved by equipping it with black backing boards or protective cones. The poles can also be painted yellow. The minimum sight distances for traffic signals are shown in Table 2.1.

Table 2.1: Minimum sight distances for traffic signals

Operating Speed (km/hr)	Urban Minimum (m)	Urban Preferable and Rural Minimum (m)	Minimum clear visibility distance of sign (m)
40	55	130	
50	80	160	60
60	110	190	80
70	140	215	100
80	170	240	120

(Source: Highway Manual Volume VI, 2013)

Traffic signals should be erected on poles or overhead cantilever support. The Lateral clearance should be 500mm or 1000mm if a steep cross fall of the road can cause vehicle tipping. The main traffic signal faces should not be more than 2m from the continuation of the edge of the road. The traffic faces should be 2.3 – 3m from the center on the lowest light. A clearance of 2.1m is required above the sidewalks. The position of traffic light and standard dimensions are shown in Figures 2.1 and 2.2.

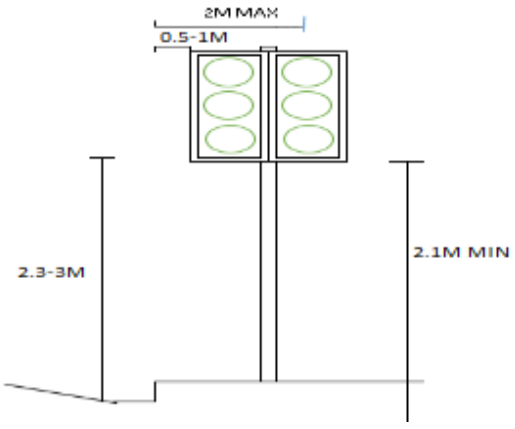

Figure 2. 1: Standard post mounting
(Source: Highway manual, Volume VI :Signs & Markings, 2013)

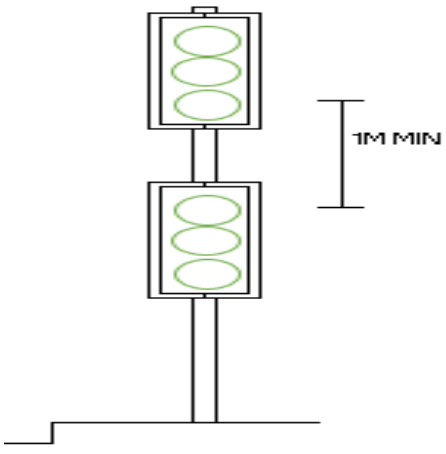

Figure 2.2: Extended post mounting
(Source: Highway manual, Volume VI :Signs & Markings, 2013)

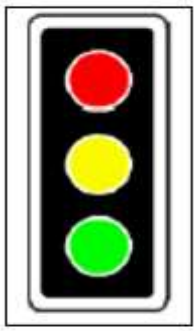

Figure 2. 3: Standard signal face for traffic signals
(Source: highway manual, Volume VI :Signs & Markings,2013)

2.5.2 Road signs

Road signs are specially designed objects carrying literal or pictorial information of condition, directions, regulations, hazards and safety on a road. They help to guide and control traffic and are usually coded and classified according to their usage for easy understanding and recognition. In Nigeria, there are 3 basic classifications of road signs which are the Types of road signs include Informational signs, Regulatory sign and Warning signs.

Informational signs are signs that indicate locations of important places like hospitals, gas stations, restaurants etc. they are rectangular in shape, surrounded by green background with a thin white border.

Figure 2. 4: Gas Station Sign
(Source: Winne, 2009)

Figure 2. 5: Hospital Sign
(Source: Winne, 2009)

Directional signs are also informational signs that give directions, distances to towns and cities. They help users navigate to their destination. They are rectangular in shape and have white texts on green backgrounds. Temporal directional signs usually have black legends and borders on an orange background. Some directional signs have one end pointed to indicate direction.

Figure 2. 6: Directional Sign
(Source: Uzodimma Obinna, 2020)

Figure 2. 7: Turn Right
(Source: Winne, 2009)

Regulatory sign are signs that indicate laws drivers must follow. They direct road users to appropriate routes to follow and convey traffic rules regulations like speed limits, weight limit, one way, no parking, etc. They are typically circular in shape and may be complemented by plates beneath them amplifying the message given by the sign. The exception to this is the stop sign which is hexagonal. Regulatory signs are either prohibitive signs or mandatory signs.

Figure 2.8: Stop Sign
(Source: Highway Manual Volume VI, 2013)

Figure 2.9: No Left Turn
(Source: Highway Manual Volume VI, 2013)

Figure 2. 10: No U turn
(Source: Highway Manual Volume VI, 2013)

Figure 2. 11: Maximum Speed Limit
(Source: Highway Manual Volume VI, 2013)

Prohibitive signs are road signs that inform road users of traffic regulations. They are circular in shape with yellow background and a red circle while some small percentages of them are surrounded by blue background. Examples include no right turn, no entry, speed limit, no u turn, no stopping. which are ones with red and yellow circles.

Mandatory signs are road signs that direct road users to appropriate routes to follow They are usually carried in circular object with blue background and white thin color closed to the edge of the circular object. Examples include, turn left, minimum speed, diversion, ahead only.

Figure 2.12: Ahead Only
(Source: Highway Manual Volume VI, 2013)

Figure 2.13: Minimum Speed Limit
(Source: Highway Manual Volume VI, 2013)

Warning signs are signs that warn road users of potential danger. They are diamond or triangular shaped except for temporary ones or the yield sign which is an inverted triangle. They usually have black legends and borders on a yellow background or have red perimeters. Examples include speed humps, narrow bridge, children crossing, beware of animals, pedestrian crossing, loose chippings, T junction. Incident management signs have pink backgrounds and work zone signs have orange backgrounds. Table 2.2 shows the Summary of shape and colors of road signs.

Figure 2. 14: Dangerous left bend ahead
(Source: Highway Manual Volume VI, 2013)

Figure 2.15: Pedestrian crossing
(Source: Highway Manual Volume VI, 2013)

Table 2.2: Summary of shape and colors of road signs

S/N	Type	Shape	Colour	Example
1	Regulatory Sign (Prohibitory)	Circular	Border :Red Background: Yellow Legend : Black	
	**Stop Sign	Octagon	Border :Red Background: Yellow Legend :	
2	Regulatory (Mandatory)	Circular	Border : None Background: Blue Legend : White	
3	Warning Sign	Triangular	Border :Red Background: Yellow Legend : Black	
4	Information Sign	Rectangular	Border : White/None Background: Green Legend : White	

(Source: Highway Manual Volume VI, 2013)

Placements of road signs

Longitudinal placement

The speed of vehicles determines the ideal longitudinal distance for placing road signs. Roads that permit higher speed require road signs to be placed at greater distance to allow

the driver to react and respond to the message. Guidelines for longitudinal placement of road signs are as follows.

I. The sight line of the sign must be free of obstructions
II. Signs should be placed on right hand side of the road except when it is not convenient.
III. Regulatory and warning signs should be placed at or as close as possible to the place where they refer. For example, stop sign should be placed at the stop line.
IV. Information signs should be placed so that traffic passes infront of the sign especially if the junction is controlled by a yield, stop of traffic signal. The allows time for the driver to read the sign.
V. Table 2.3 shows sight distance for warning signs and Table 2.4 shows the recommended distance of advance direction signs from a junction.

Table 2.3: Sight distance for warning signs

Operating speed: km/hr	Distance of sign from hazard	Distance of sign from hazard (m) gravel Road	Minimum clear visibility distance of sign (m)
60	120	160	60
80	160	218	80
100	240	320	100
120	330	400	120

(Source: Highway Manual volume VI, 2013)

Table 2.4: Distance of advance direction signs from a junction

Operating speed on the Approach km/hr	Operating speed at road junction (km/hr) 20	40	60	80
60	120m	90m	65m	65m
80	155-180m	140-165m	80m	80m
100	245-300m	220-275m	155m	130m
120	320-390m	310-360m	275-300m	145m

(Source: Highway Manual volume VI, 2013)

Overhead signs can be used where the roads are heavily trafficked roads, roads with multiple lanes where ground mounted signs may be obscured, at busy junctions and when mounting by the side of the road is uneconomical.

Lateral placement

Lateral distance of road signs have to be considered especially so the signs are not obscured by cut sloped. The recommended lateral placements for various road signs are shown in figures 2.16, 2.17,2.18, 2.19 and respectively. Standard dimensions for various road signs are indicated on Tables 2.5 and 2.6.

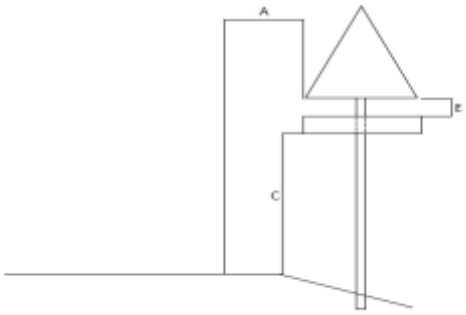

Figure 2. 16: Placement of warning signs at shoulders
(Source: Highway Manual Volume VI, 2013)

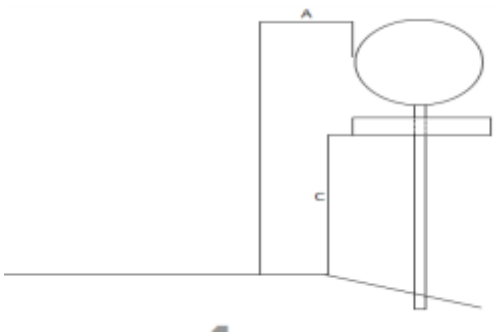

Figure 2. 17: Placement of regulatory signs at shoulders
(Source: Highway Manual Volume VI, 2013)

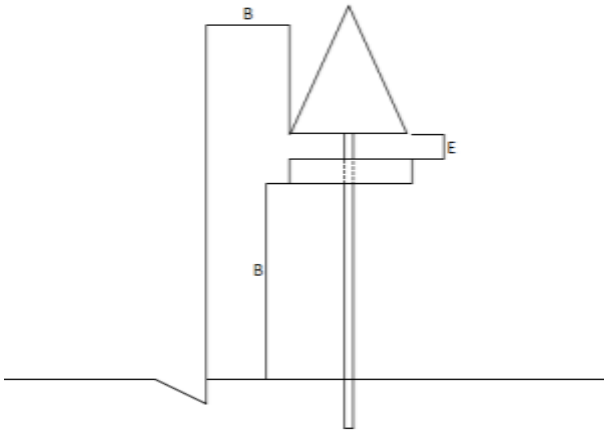

Figure 2. 18: Placement of warning signs where there are kerbs or sidewalks
(Source: Highway Manual Volume VI, 2013)

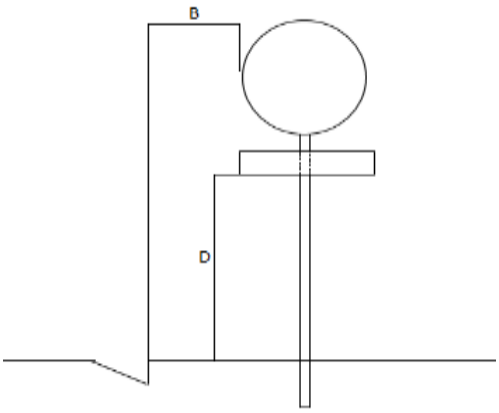

Figure 2.19: Placement of Regulatory where there are kerbs or sidewalks
(Source: Highway Manual Volume VI, 2013)

Table 2.5: Standard Dimensions for Regulatory and warning Signs

Dimension	Minimum(mm)	Preferred(mm)	Maximum(mm)
A	1200	1500	2000
B	500	750	-
C	600	2100	2500
D	2100	2500	3000
E	0	0	200

(Source: Highway Manual Volume VI, 2013)

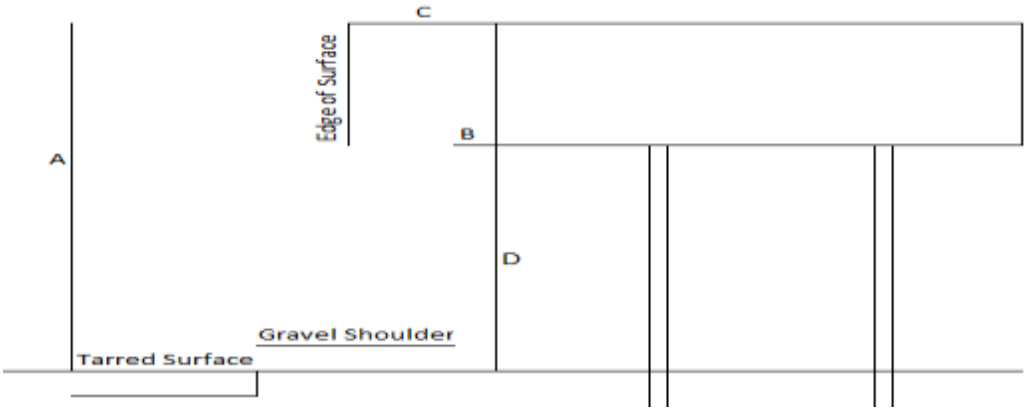

Figure 2. 20: Placement of multiple support information signs

(Source: Highway Manual Volume VI, 2013)

Table 2.6: Standard Dimensions for placing informative signs

Sign placement dimensions for informative signs			
Dimension	Minimum(mm)	Preferred (mm)	Maximum(mm)
A	-	-	6000
B	1500	2500	-
C	2500	4000	-
D	1600	2000	2400

(Source: Highway Manual Volume VI, 2013)

Sizes of road signs

The size of the sign is a function of the allowable speed along the road. The guidelines are shown in Tables 2.7, 2.8 and 2.9.

Table 2.7: Standard Sizes for Regulatory and informative signs

Operating Speed (km/hr)	100 or more	70 -90	0 - 60	Stopping/Parking	Overhead Signs
Circular Sign Diameter (mm)	1200	900	600	450	1600
Rectangular Sign (mm)	1200 x 900	900 x 675	600 x 450	450 x 340	1600 x 1200

(Source: Highway Manual Volume VI, 2013)

Table 2.8: Standard Sizes for warning signs

Operating Speed (km/hr)	120	100	80	60
Height of triangular warning signs	1500	1500	1200	900

(Source: Highway Manual Volume VI, 2013)

The numerals and letters on regulatory and warning signs are done using lettering on the DIN 1451 style. The width of the red borders varies according to the size of the sign. Table 2.8 shows standards for some signs.

Standard letter sizes determine the sizes of direction signs. However, the design is relatively complex taking into consideration the variations in letter sizes and layout. Therefore, computer applications are usually used.

Table 2.9: Standard sizes for some road signs

Sign Size (mm)	STOP	NO ENTRY	PEDESTRIAN CROSSING	ROUND ABOUT
450	20	40	-	-
600	25	50	50	50
900	40	75	75	75
1200	50	100	100	100

(Source: Highway Manual Volume VI, 2013)

Road signs should be retroreflective to aid visibility at night and in poor weather conditions especially directional signs along highways. However, regulatory signs don't need to be reflective but the black symbols can be semi-matt.

2.5.3 Speed humps

Speed humps are ridges set at intervals in a road surface to control the speed of vehicles. Although humps are effective in keeping vehicles speed down, their use is sometimes controversial as they increase traffic noise and cause damage if not properly places. Therefore, the following guidelines should be adhered to when constructing speed humps.

1. Speed humps should not be installed on highways but on streets/ Roads where the speed limit is 50km/hr or less.
2. Speed humps should not be installed on emergency routes or streets that provide access to hospitals and emergency medical series
3. Speed humps are not ideal for two travel lanes.
4. Speed humps should be installed on pavements that have good surfacing.
5. Speed Humps should not be more than 152m apart.
6. Speed humps should have a height of 76 -90mm and travel length of 3.7 – 4.3m.

Plate I: Typical picture of a Speed Hump
(Source: National Association of City Transportation Officials, 2021)

2.5.4 Roundabout

A roundabout is a type of circular intersection or junction in which road traffic flows continuously in one direction around a central island after first giving way to the circulating traffic. The capacity of a roundabout varies based on entry angle, lane width, and the number of entry and circulating lanes. The Signalized and Unsignalized Intersection Design and Research Aid (SIDRA) suggests a minimum central island diameter of 18 m to allow for circulating heavy vehicles. However, a minimum of 25m is preferred because a small island diameter cannot accommodate well the deflection needs of a roundabout for a double lane (Virginia and Heung-Un, 2001)

Various sizes of roundabouts and the range of traffic demand where this roundabout can been applied has also been identified (Werner, 2014) as shown in Table 2.10.

Table 2.10: Types of roundabouts by their inscribed circle diameter and their possible range of applicability in terms of average daily traffic (ADT)

S/N	Type of roundabout	Maximum ADT	Recommended Diameter
1	Single lane	20000	18- 24
2	Single Lane Urban	25000	20 – 35
3	Single Lane Rural	25000	30 -45
4	Compact semi two lane	31000	40 – 60
5	Turbo	32500	45 – 70
6	Signalized roundabout	60000	55 - 85

(Source: Werner, 2014)

An ovonde (Oval roundabout) may comprise of 2 roundabouts with a minimum tangent of 25m. Ovondes with smaller maximum diameter are more functional than ones with bigger diameters. The maximum value of the entry path radius for an ovonde is 55 m (Alfonso *et al.,* 2012).

Plate II: Round About at Kpakungu, Minna
(Source: Tribune Online, 2017)

Road furniture have a major impact on the appearance of a street and should be planned as part of the overall design concept. Street audits help to determine the existing furniture to help designers respond to the setting. In historic towns and conservation areas, attention is paid to the aesthetic quality of the road furnitureand lighting. Road furniture that encourages human activity can also contribute to a sense of a place (Shude and Shidu, 2022).

Road furniture follow a set of standards to help users understand them effectively by providing drivers with consistent messages that are recognized throughout the country. They have to be resistant of vandalism and be placed in positions that minimize risk of damage by vehicles. Guard railings should not be provided unless a clear need for it has been identified. Introducing measures to reduce traffic flows and speeds maybe helpful in removing the need for guard railing. Where barriers for pedestrian movement is

required, bench seating, planting and other options that can guide pedestrian movement should first be considered. Lighting helps in reducing risks of night-time accidents, protection of property, discouraging crime and vandalism, making residents and street users feel secure and enhancing the appearance of the area after dark.

A wide range of regulations, standards and codes of practice already cover the provision, positioning and design of road furniture. However, these have generally developed independently of one other and they usually deal with each issue in isolation. This means that there is little, if any, relationship between one set of regulations and another. Such a lack of integration frequently leads to a mix of positions and styles that can be confusing in the messages they convey and result in a negative visual impact on the landscape. The challenges emanating from this juncture are disregard of flexibility that exists within design guides, visual problems associated with current trends in traffic management and the impact of tourist signs and visual clutter from incremental increase in road furniture over time. The elements of the planning and design process considers the need for the furniture which may be a direction need, a safety issue, an information need and if the information is necessary or can be provided in another way (Shude and Shidu, 2022).

2.6 Road Furniture in Nigeria

Most Road furniture found in Nigeria are often geared towards controlling traffic along the roads. There is gross absence of road furniture on the three major highways in Abuja, the Federal Capital City of Nigeria, Lagos, the commercial centre and Ilorin, a state capital (Olawepo, 2010). 50% of Federal Road Safety officials interviewed in this study suggested that the absence of road furniture in Nigeria is grossly contributing to the high incidence of road traffic crashes. Bus terminals are altogether lacking, except in Lagos

where they are overcrowded, and in Abuja where they are few. In most Nigerian cities, a spread of motor parks has replaced the bus stops as terminals.

Conversely, the FRSC survey similarly found that there were no illegal motor parks in the country in 2009, though Nigerian motor parks are largely disorganized and unplanned sources of traffic congestion in the cities. In other places, pedestrian crosswalks and bridges are provided mostly at city centers, if at all. The poor state of road furniture in Nigerian cities has increased the need for enhanced traffic management to improve traffic flow and safe.

In 1988, the General Ibrahim Babangida administration gave a mandate to holistically address issues concerning road safety and road traffic administration in Nigeria to the Federal Road Safety Corps vide decree No 45 of 1988 as amended by decree 35 of 1992 and since the establishment of FRSC, her sustained efforts, innovations and unwavering sense of commitment has seen a reduction in the rate of Road Traffic Crashes in country from 25792 cases in 1988 to 9734 cases in 2015. This reduction though commendable, but when compared to other developed and developing countries, the statistics is still unacceptably high.

Road safety is a foremost priority in the mind of all road users. However, in Nigeria, in spite of efforts of road traffic enforcement agencies, the rate of road traffic accident is alarming and calls for investigation.

The Desire to have uninterrupted trip"; "Not to be seen as a fool", and "In a hurry to reach my destination" are the three main causes on which the drivers violate traffic rules in Minna, Niger State (Ohadugha *et al.*,2018). The study examined the amount of traffic rules violation in the city of Minna, discovered the reasons for the violations and factors influencing the reasons advanced by the drivers. A 15-hour physical surveillance was

mounted at a traffic light signal point. Self-reporting questionnaire were subsequently administered on 287 drivers selected from six motor parks. Analysis showed that 5,827 vehicles violating Red light, Zebra Crossing, Stop Line and Branching-Off Direction rules with the commercial motorcyclists alone accounting for 50% of the offenders."

Similarly, the impact of traffic violations on road transportation in Port Harcourt Metropolis, Port Harcourt, Nigeria showed that speed violation (33.0%) and dangerous driving (23.0%) were the most occurring traffic violations in Port Harcourt City. The study revealed that all major junctions in Port Harcourt City were identified as areas prone to traffic violations. Majority (31.8%) agreed that drivers' attitude to reduce travel time or saving fuel was the cause of traffic violation while 48.12% and 31.38% agreed that commercial drivers and private drivers were the types of drivers largely prone to traffic violation. Though, 86.2% understood round about signs, 82.43% understood T-Junction, 71.55% understood pedestrian crossing while 32.22% understood double bend and 33.1% understood narrow bridge. No stopping sign (47.7%) was the least understood in regulatory signs while the acquaintance of the drivers on information signs was higher for filling station (92.05%) and telephone (phone booth) (80.8%). Likewise, No crossing sign (38.1%) was the least understood sign in road markings while more than 85% understood all the traffic lights (Emenike and Akpu, 2017). 79.1% of commercial drivers in the south-south Nigeria have fair knowledge of traffic signs, but only 25.5% observe them (Clement and Jones, 2018).

The communicativeness of road traffic signs in Uyo, Akwa Ibom State of Nigeria was investigated. The study involved presenting respondents with traffic signs and asking them to interpret the signs. Findings indicated that road traffic signs in Uyo are communicative to road users. In spite of this, the compliance level of road users with the

demands of road traffic is low, and educational background does not seem to correlate with the understanding of and compliance with road traffic signs by (Udo *et al.,* 2015).

The effectiveness of road safety education in Nigeria was done in Lagos after a road safety education intervention programme in the state. Assessment was done in terms of group driver education versus no education, and pre- versus post-intervention. 407 participated in the study, most of which had some form of formal education. For both groups, the knowledge scores pre-intervention were poor but improved significantly after the intervention in the intervention group. However, adherence to speed limits did not improve. The control group showed no significant changes. Post-license road safety education significantly improved knowledge but not self-reported observance to speed limits. Further studies were recommended to determine deterrent factors to behaviour change (Ifeoma *et al.,* 2014).

A study of commercial vehicle drivers' perception of the effectiveness of Federal Road Safety Commission road safety education programme in Jigawa State on their driving experience, age and behavior toward safety signs on the roads and highways by Abdul-Wahab (2016) showed that a significant difference existed in drivers' perception of the efficiency of FRSC road safety education programme on their driving experience toward road safety signs on the roads and highway. The study also investigated the influence of drivers' educational background, duration of learning road safety, behaviour and knowledge on their attitude to road safety education programme and observed that drivers who have been driving for more than twenty years experience have the best behavior on roads followed by those who have been driving for more than fifteen years.

2.7 Traffic Control System

Traffic control systems collect and analyze driving information of vehicles in the area, perform the optimal traffic signal control in accordance with the constantly changing traffic situation and provide beneficial traffic data to drivers based on the data collected. Traffic control devices include, street signs, traffic signs and road markings.

The effectiveness of road transportation relies heavily on several factors and the attitude of the road driver to traffic engineering, control and management requirement. Traffic management is the control, direction and supervision of all functions incident to the attaining and use of freight and passenger transportation services. It involves improving peak capacity and leveling traffic flows on busy major highways.

The unique purpose of transportation is to overcome space which is shaped by a variety of human and physical constraints such as distance, time, administrative divisions and topography (Rodrigue *et al.,* 2016). It coordinates the movement of people, goods and vehicles in order ensure the efficient utilization of routes and reduce transport costs by improving delivery times through effective timetabling and route management. Transportation creates links between regions and economic activities as such generating value. Its core components are the modes, infrastructure, networks and flows. Transport provides the arteries through which the economic life of people, information and raw materials as well as finished products can be moved from one place to another (Ighodaro, 2009). Transportation provides benefit both to nations and individuals by facilitating the movement of goods and people thereby enabling increased access to jobs, economic markets, education, recreation and healthcare, which in turn have direct and indirect positive impacts on the health of populations (World Health Organization, 2013).

The transport field is divided into infrastructure, vehicles and operations. The infrastructure is made up of installations such as roads, railways, waterways, airways, canals and pipelines and terminals such as airports, railway stations, bus stations, warehouses, trucking terminals, refueling depots (including fueling docks and fuel stations) and seaports. Terminals may be used both for maintenance and exchange of passengers and cargo. Vehicles traveling on these networks may include automobiles, bicycles, buses, trains, helicopters, watercraft, spacecraft and aircrafts. Operations deal with the way the vehicles are operated, and the procedures set for this purpose, including financing, legalities, and policies.

The notion of Road Traffic Management (RTM) has been defined inversely by numerous scholars, authors and institutions with each definition towing the line of thought of each author. Road Traffic Management refers to `the big, complex socio-technical systems that influence traffic by using a variety of actuators such as traffic signals and variable message signs, based on acquired data using various types of sensors such as video cameras and inductive loop (Soares *et al.*, 2013).

In a study, an analytical method for calculating urban road safety was proposed. The proposal relies on data such as geometric characteristics, road signs, and urban furniture collected during road safety inspections and presents a quantitative risk analysis of deaths and serious injuries caused by urban road accidents. Lighting, road signs, and urban furniture were among the categories of defects identified. The method hinges on the assumed ranges of variables and risk classes, as well as on the values attributed to the variables used for calculating the danger. The results from surveying 50 km of roads in an Italian municipality established the good performance of the proposed tool in recognizing, planning, and scheduling all the work required for enlightening urban road safety, because it is sensitive to improvements of infrastructure. The strategy proposed

by the authors could have a significant influence on the risk management of urban roads, and could be used in decision-making processes to design safer roads and improve the safety of existing roads. This view has been persuasively presented by Francesca *et al.* (2011).

The incessant surge in road traffic crashes on major intersections within the Nigeria's Federal Capital Territory, Abuja, provoked investigations into the causes and possible countermeasures. Traffic engineering measures such as the installation of speed humps, warning signs and markings were considered most suitable for the nature of problems detected. Observational studies of the traffic conditions on these sites, and the analysis of the "before" and "after" road crashes was piloted to assess the effectiveness of these countermeasures. The remarkable reduction in the road traffic crashes on these intersections made the consideration for the adoption of these measures on areas with similar problems (Omidiji, 2010)

However, a quick survey of the available road furniture on some roads within the city revealed a tolerant situation.

Available on some of these roads are known road safety furniture that protects the vulnerable road users, which include pedestrian walk ways that separate them from the vehicular traffic flow, zebra crossing with few having facilities for disables, and other traffic calming devices.

Though the survey shows the presence of road furniture such as road traffic signs, observations are some are defaced, or wrongly posted, to the extent that they make less meaning; the presence of traffic lights on most junctions is not buttressed by the required power supply to keep them operative all through; the road markings obviously makes less meaning to drivers; pedestrians on the pedestrian crossing are not given any priority by

drivers and are even not often used; and traffic calming devices such as rumble stripes which are still being run-over on high speed.

The Annual National Conference of the Nigerian Society of Engineers (NSE, 2011) have reported that traffic congestion has become a common sight in most urban cities of Nigeria. 300 questionnaires were circulated among participants comprising specialists in transportation planning and design as well as engineers of other disciplines, students, wives of engineers and other invited guests who constitute commuters, car owners/drivers, etc to carry out a study. 196 returns were made and these were examined to ascertain the broad perspectives concerning the causes of traffic congestion in most urban cities in Nigeria. The results show that poor driving habits, inadequate road capacity, poor road network, and lack of parking facilities constitute the greatest causes of traffic congestion in Nigeria. Also, Lagos, Port Harcourt and Abuja were recognized as cities most affected by traffic congestion. Lack of furniture causes 30% of congestion and will reduce it by 13% if provided.

The outcome of data evaluation from Analysis of Road Traffic Safety in Minna Niger State, Nigeria has shown particular variation in the pattern of road traffic accident and its attributes among the local government in Minna Niger State (Oyetubo *et al.*, 2018). The methodology used for the research was the collection of data using questionnaire and accident information from the Nigeria Police Force, FRSC etc. The primary data for this research was sourced through the use of questionnaires, personal observation and interviews of road users in the study area. Secondary data came from published and unpublished sources such as government records, internet, journals, books etc. About 23% of the respondents believe that poor road is the cause of road accident in Minna, 7% of the respondent said road accident is caused by the poor condition of the vehicle, 21% of the respondent said road accident are caused due to reckless driving of motorist, 24%

of the respondent agrees that accident is caused due to over speeding, 12% of the respondent are on the opinion that road accident is cause due to impatience of the road users, while 13% of the respondents are on the opinion that accident is cause as a result of non compliance with general traffic rules.

The growth of transport and traffic has created a number of severe problems like congestion which jeopardizes the accessibility of important economic and social centers. The human environment is affected by interferences especially in motorized traffic. Traffic accidents cause human suffering and social disruptions. Road furniture help to maintain order, decongest cities by controlling traffic and ensuring safe movement of people.

The failure of government to afford and preserve traffic signs in order to guide road users through the numerous accident black spots on the highways is the major cause of road accidents in Nigeria. The study argues that provision and maintenance of traffic signs present opportunity to improving safety on the highways and achieving the viable development goals (Christian *et al.*, 2018).

Despite the presence and administration of traffic laws, traffic violations had continued to surge on our roads in Nigeria and globally. There is very high level of downgrade of traffic rules in ranging from disregarding speed limits, traffic signs, therefore drivers engage in dangerous overtaking, over speeding, aggressive driving. Driving against the traffic lights has been recognized as the foremost factor resulting to crashes of vehicles in the urban centers. It is one of the most regularly violated traffic law in the world today (Peltzer, 2008).

Oyetubo *et al.*,2018 have discussed that, 13% of the respondents surveyed in Minna are of the opinion that non compliance with general traffic rules is the cause of accidents in

the city, 12% said road accidents are caused due to impatience of the road users, 24% stated that accident is caused due to over speeding, 23% believe that poor road is the cause of road accident, 7% said road accident is caused by the poor condition of the vehicle and 21% of the respondent said road accident are caused due to reckless driving of motorist.

2.8 Geographic Information System (GIS) Mapping

Geographic Information System (GIS) is a framework for gathering, managing and analyzing data. It analyses spatial location and organizes layers of information into visualizations using maps and 3D scenes. It reveals deeper insight into data such as patterns, relationships and situations hereby helping users to make smart decisions.

Herika *et al.* (2017) undertook a study of a GIS Modeling accessibility of community facilities study in Depok City, Indonesia and reported that. Among the models for community facilities by cars, train and buses, car was the best model of access since it can access all the community facilities compared with the others. The study included distributed locations of schools, shopping malls, hospital, prayer facilities (worship place) and natural recreational facilities (Lake), as well as supporting data, such as street and road networks, population density and land use type. This study covered redefining community transport facilities, modeling accessibility and analyzing the social pattern.

Similarly, Ayo *et al. (*2014) discussed factors responsible for accidents and assessed their pattern with a view to mapping the black spots in the city of Abuja using GIS techniques. Road accidents data from road users, National Union of Road Transport Workers (NURTW) and Federal Road Safety Corps (FRSC) were acquired using structured questionnaire. Also, secondary data including topographical map, quick bird image, accident records between 2009 and 2011, and Global Positioning System (GPS)

points of areas prone to road accidents were plotted on the Abuja base map. These data were integrated and analyzed using spatial analysis tools of AcrGIS 9.3. Table data were also imported into ArcGIS database. Overlay function and query operation were performed to determine the accident hotspots based on the frequency of road accidents and their spatio-temporal trend. The study identified dangerous driving, loss of control, over speeding, tyre burst, rough surface of the road, brake failure and wrong overtaking as the contributory causes of road accident in the study area.

2.9 Nearest Neighborhood Analysis

Nearest neighborhood analysis is used to classify multi variant data into distinct classes according to a given distance metric over the data. This determines if the points are regular, random or clustered. The Nearest neighborhood index is calculated using the formula in Equation 2.1.

$$\text{NNI} = 2\overline{D}\sqrt{\frac{n}{A}} \tag{2.1}$$

Where NNI = Nearest neighborhood index

D = Mean of distances between each point and its nearest neighbor

n = Total Number of points

A = Area of Map on which the points lie

The Nearest neighborhood index figure lies between 0 – 2.15. The closer the figure is to 0, the more clustered the points are, the closer it is to 1, the more random they are and the closer it is to 2.15, the more regular they are. Therefore, the points are clustered if they fall between 0 to 0.5, random if they fall between 0.5 and 1.575 and regular if they fall between 1.575 to 2.15.

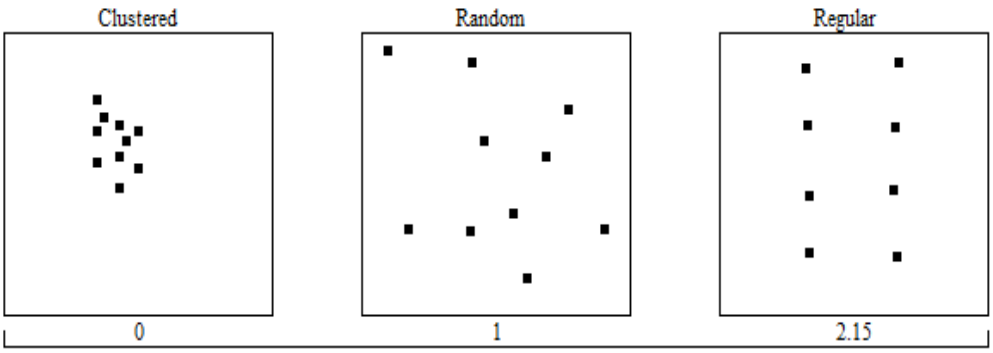

Figure 2. 21: Pattern for distribution for spatial data

(Source: Author's Analysis, 2020)

To test for significance, Rn value is plotted against the number of points on a standard graph similar to Figure 2.23. Where the point intersects determines the significance.

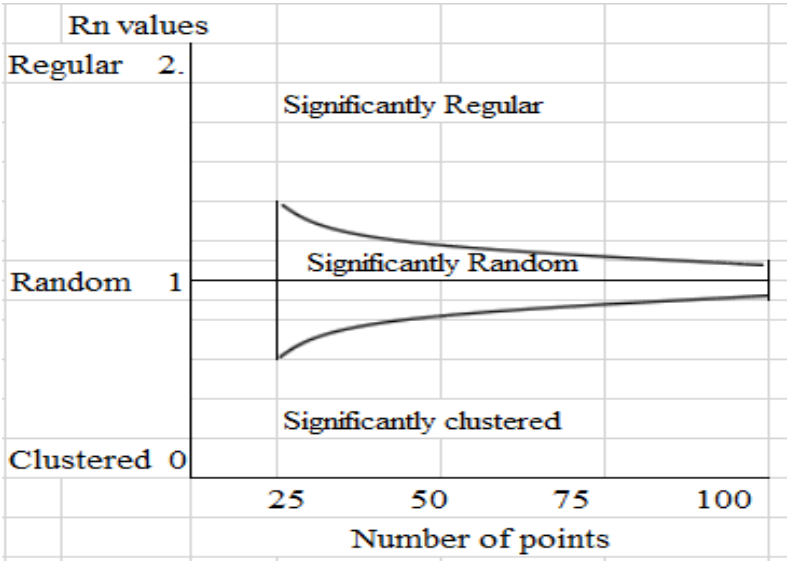

Figure 2. 23: Sample graph to determine significance of distribution pattern

(Source: Author's Analysis, 2020)

The average nearest neighborhood tool on ArcGis measures the distance between each feature centroid and the nearest neighbor centroid location and takes the mean of these distances. If the mean distance is less than the mean for a hypothetical random distribution, the distribution of the features being analyzed is considered clustered. If

the average distance is greater than a hypothetical random distribution, the features are considered dispersed. The average nearest neighbor ratio is calculated as the observed mean distance divided by the expected mean distance (Junxian, 2021).

The average nearest neighbor ratio is given by Equation 2.2.

$$\text{ANN}= \frac{D_0}{\bar{D}_E} \tag{2.2}$$

Where ANN is the average nearest neighbor ratio, $\bar{D}_O$ is the observed mean distance between each feature and its nearest neighbor given by Equation 2.3.

$$\bar{D}_O = \frac{\sum_{i-1}^{n} d_i}{n} \tag{2.3}$$

And $\bar{D}_E$is the expected mean distance for the features given in a random pattern is shown in Equation 2.4.

$$\bar{D}_E = \frac{0.5}{\sqrt{n/A}} \tag{2.4}$$

$d_i$is the distance between feature i and its nearest neighboring feature, n is the total number of features and A is the area of a minimum enclosing rectangle around all features or a user specified area feature.

The average nearest neighbor z score is calculated as in shown in Equations 2.5 – 2.6.

$$\text{Z}= \frac{\bar{D}_O - D_E}{SE} \tag{2.5}$$

Where:

$$\text{SE}= \frac{0.26136}{\sqrt{n^2/A}} \tag{2.6}$$

If the average nearest neighbor ratio is less than 1, the pattern exhibits clustering. If the index is greater than 1, the tendency is toward dispersion.

The average nearest neighbor tool computes 5 values. The observed mean distance, expected mean distance, nearest neighbor index, z- score and p- value. the p and z values determine if will indicate whether you can reject or accept the null hypothesis or not. The p value is a numerical approximation of the area under the curve for a known distribution. It is a probability which implies that the smaller it is, the more unlikely. The z scores are standard deviations. Very high or low z scores are associated with low p values.

To reject the null hypothesis, a subjective judgment with regard to the degree of risk you are willing to accept for being wrong is considered. Typical confidence levels are 90%, 95% and 99%. Out of which 99% is the most conservative. Table 2.11 shows the uncorrected critical p values and z scores for different confidence levels.

Table 2. 11: Uncorrected critical p values and z scores for different confidence levels.

Z score (standard Deviation)	P value (probability)	Confidence level (%)
< -1.65 or > 1.65	< 0.10	90
<-1.96 or > 1.96	<0.05	95
< -2.58 or > 2.58	< 0.01	99

(Source: Highway Manual Volume VI, 2013)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Research Design

This section explores the use of systematic approach to address the research objectives. The study examines topical issues in traffic control and the effectiveness of furniture that control it. The conceptualization of these thought helped in developing the methodology framework required for this study. Four aspects were considered to achieve the aim of this research. The aspects include.

i. Distribution/ Sufficiency of Road Furniture
ii. Quality of existing Road Furniture
iii. Familiarity of Road Users with Road Furniture
iv. Regard/Compliance with Road Furniture

The first 2 aspects were examined using data from field, records/standards, and ArcGIS technology while the last 2 aspects were achieved from questionnaires. From these analysis findings, conclusion and recommendations were drawn to achieve the aim of conducting this study.

3.2 Data Required

The data required in this study were determined by series of investigation on the understanding of the problem, in line with the set objectives.

The following data were sourced and used for this study.

i. High resolution satellite imagery of Minna with emphasis on Chanchaga – Mobil – Tudun Fulani, Western Bypass and Kpakungu – Gidan Kwano roads.
ii. Locations of existing road furniture as well as their distance, size, visibility, locations, and others.

iii. Accident records along the routes to identify the hotspots along the routes.

3.3 Sources and Methods of Data Collection

The sources and method used for data collection in this study are as follows.

Primary data

The primary data required in this study were sourced from the field. The coordinate locations of existing road furniture as well as their distances, shapes, colours, composition and sizes were determined.

Secondary Data

For the purpose of this study, previous accident records were sourced from the Federal Road Safety Corp, the street guide map and satellite imagery of Minna was collected from Niger State Geographic Information System (NIGIS).

Data Collection Procedure

Reconnaissance survey was conducted within the area earmarked as the study area. Physical observations on the road furniture and other facilities on the roads were considered. Coordinates of the furniture were taken, and other relevant parameters were measured and recorded. Google earth map/ imageries were employed in the study and questionnaires were administered accordingly.

3.4 Instruments for Data Collection

The instruments used in data collection are GPS devices, physical observation, Measuring tapes, camera, google earth imageries and questionnaire.

GPS Devices

These were used to get the geographic position of each of the existing furniture.

Physical observation.

The colours, sizes and conditions of each of the road furniture were determined using physical observation.

Measuring tape

This was used to measure the dimensions of the existing furniture as well as their longitudinal and lateral placements.

Camera

The visual images of the existing furniture were captured using a camera.

Satellite images

Satellite images were used as a guide to digitize the study area and plot furniture on a map

Questionnaire

Closed ended questionnaires were prepared for this study and relevant data were collected. The questionnaires were to ascertain the familiarity of road users with road furniture as well as their compliance level. It focused on the commuters perspective of the road furniture and utilization as well as their familiarity and compliance with these furniture. 100 questionnaires were administered to the respondents out which 95 copies were returned completed representing a success rate of 95%.

3.5 Sampling Technique

3.5.1 Sampling population

The United Nations projection of metro area population for Minna metropolis for 2020 is estimated at 448,000 (United Nations Population Projection, 2020). This estimate represents the urban collection of Minna which typically includes Minna's population in addition to adjacent suburban areas.

3.5.2 Sampling frame

For the sampling frame, data for the study was drawn for Tudun Fulani – Mobil – Chanchaga Road, Western By Pass and Kpakungu – Gidan Kwano Roads which are the major roads in the city.

Sampling size

The sample size was determine by Yamane (1967) formula in Equation 3.1.

$$n = \frac{N}{1+N\,(e)^2} \qquad (3.1)$$

Where:

n = Sample size

N = Population size

= Level of significance

1 = Constant

$$n = \frac{448{,}000}{1+448{,}000(0.1)^2} = 100$$

3.5.3 Sampling procedure

Stratified sampling technique was used where target population was broken down into group (strata) and questionnaires were administered to each groups. The target population was grouped into three; the road users 70%, the road workers 15%, and the traffic law enforcement agencies 15% and a sample was taken from each group. To determine how many questionnaire to administer to each group, the required percentage of the sampling size was computed.

Road Users = 70% x 100 = 70

Road workers 15% x 100 = 15

Traffic law enforcement agents = 15% x 100 = 15

3.6 Techniques for Data Analysis

To examine the distribution of road furniture along major routes in Minna Metropolis, Coordinate locations of the existing road furniture were generated with the use of GPS and then plotted on ArcGIS. The nearest neighbourhood analysis was carried out on the points to determine the pattern of distribution of the infrastructure. Accident records were also studied to investigate the relationship with the road furniture. The sufficiency was determined by considering the number of existing furniture in relation to the total number of furniture that are required along the road. The sufficiency is shown in Equation 3.2.

$$S = \frac{N_E}{N_E + N_P} \times 100 \qquad (3.2)$$

Where S = Sufficiency

N_E = Number of existing furniture

N_P = Number of proposed Furniture

The sufficiency was rated on a five point Likert scale. The scale rates 0 – 20% as very poor, 20 – 40% as poor, 40 – 60% as fair, 60 - 80% as good and 80 – 100% as Excellent. Table 3.1 shows the techniques used for data analysis for each objective.

Table 3. 1: Technique for data analysis

Objective	Data required	Type of Data	Method of analysis
Examine the distribution of road furniture along major routes in Minna Metropolis.	i. Coordinate locations of existing road furniture ii. High resolution satellite imagery of Minna with emphasis on the major roads. iii. Accident records along the routes to identify the hotspots along the routes.	Primary and Secondary data	ArcGis Technology
Assess the conformity of the road furniture to the conventional standards	i. Lateral and longitudinal placements of furniture. ii. Shape, colors and composition of road furniture. iii. Size of road furniture. iv. Visibility of road furniture.	Primary data	Descriptive analysis
Determine the compliance level of road users to the road furniture in the town.	i. Familiarity of road users with meanings of road furniture ii. Compliance Level of road users with road furniture.		Questionnaires Likert's Scale SPSS

In assessing the conformity of the road furniture to the conventional standards, the lateral and longitudinal placements, shapes, colors composition, size and visibility of furniture obtained from the field were compared with conventional standards obtained from the Highway Manual. Descriptive analysis were carried out on the result.

For the determination of compliance level of road users, questionnaires were used. The questionnaires were analyses using a three point Likert's scale. A Likert's scale is a rating scale that quantitatively assesses opinions, attitudes or behaviors. Statistical package for social scientist (SPSS) was also used for the data collected.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Preamble

This chapter presents the result of assessment carried out to determine the adequacy of road furniture along the major roads in Minna Metropolis. The road furniture that influences traffic and behaviors of road users such as road signs, roundabouts, traffic signals and speed humps were considered. This was achieved by determining their distribution and sufficiency, their conformity to conventional standards and familiarity/compliance level of road users. These three aspects were discussed in this chapter and represented pictorially for appreciation.

4.2 The Distribution and Sufficiency of Road Furniture Along the major Roads

4.2.1 Distribution of existing road furniture

A total of 126 different types of furniture were identified along the roads selected for this study. Tables 4.1a, 4.1b, 4.1c and 4.1d show the road signs along the roads while Tables 4.2, 4.3 and 4.4 show the inventory of traffic signals, roundabouts, and speed humps along the roads respectively.

Table 4. 1a: Inventory of information road signs in X and Y coordinate along the major Roads in Minna

		Coordinates			
S/N	Type Of Furniture	Y	X	Category	Condition
1	Road Signs	9.54288	6.58163	Information Sign	Damaged
		9.54582	6.58298	Information Sign	Functional
		9.55225	6.58152	Information Sign	Functional
		9.55835	6.58003	Information Sign	Functional
		9.56398	6.5768	Information Sign	Functional
		9.5653	6.57612	Information Sign	Functional
		9.56582	6.57587	Information Sign	Functional
		9.5679	6.57488	Information Sign	Functional
		9.57247	6.5721	Information Sign	Functional
		9.57422	6.5712	Information Sign	Functional
		9.58073	6.56803	Information Sign	Functional
		9.58272	6.56745	Information Sign	Damaged
		9.58683	6.56597	Information Sign	Functional
		9.58775	6.56563	Information Sign	Functional
		9.60505	6.55585	Information Sign	Functional
		9.60755	6.55392	Information Sign	Functional
		9.61017	6.55172	Information Sign	Damaged
		9.61017	6.55172	Information Sign	Functional
		9.61048	6.55143	Information Sign	Functional
		9.61138	6.5507	Information Sign	Functional
		9.6184	6.5465	Information Sign	Functional
		9.6356	6.54288	Information Sign	Functional
		9.63905	6.5418	Information Sign	Functional
		9.64022	6.54147	Information Sign	Functional
		9.66818	6.51518	Information Sign	Functional
		9.66917	6.51323	Information Sign	Functional
		9.6708	6.50988	Information Sign	Functional
		9.66808	6.5124	Information Sign	Functional
		9.64837	6.50767	Information Sign	Functional
		9.6452	6.50933	Information Sign	Functional
		9.59765	6.53335	Information Sign	Functional

Table 4. 1b: Inventory of direction information road signs in X and Y coordinate along the major Roads in Minna

		Coordinates			
S/N	Type Of Furniture	Y	X	Category	Condition
1	Information signs	9.5305	6.57933	Direction Sign	Functional
2		9.58152	6.56785	Direction Sign	Functional
3		9.58157	6.56782	Direction Sign	Functional
4		9.58328	6.56722	Direction Sign	Functional
5		9.60393	6.55693	Direction Sign	Functional
6		9.60518	6.55588	Direction Sign	Functional
7		9.61203	6.5501	Direction Sign	Functional
8		9.63282	6.54402	Direction Sign	Functional
9		9.67065	6.5102	Direction Sign	Functional
10		9.66858	6.51273	Direction Sign	Functional
11		9.66808	6.5124	Direction Sign	Functional
12		9.65143	6.5063	Direction Sign	Functional
13		9.6286	6.52227	Direction Sign	Functional
14		9.60983	6.52938	Direction Sign	Functional
15		9.59772	6.53313	Direction Sign	Damaged
16		9.57952	6.5577	Direction Sign	Functional
17		9.57988	6.56135	Direction Sign	Functional
18		9.58158	6.56625	Direction Sign	Functional

Table 4. 1c: Inventory of warning road signs in X and Y coordinate along the major Roads in Minna

		Coordinates			
S/N	Type Of Furniture	Y	X	Category	Condition
1	Warning Signs	9.56837	6.5743	Warning Sign	Functional
2		9.57075	6.57303	Warning Sign	Functional
3		9.59327	6.56325	Warning Sign	Functional
4		9.65432	6.53082	Warning Sign	Damaged
5		9.64985	6.50687	Warning Sign	Functional
6		9.64893	6.50737	Warning Sign	Functional
7		9.64827	6.50795	Warning Sign	Functional
8		9.64658	6.50883	Warning Sign	Functional
9		9.63893	6.51267	Warning Sign	Functional
10		9.63617	6.51427	Warning Sign	Functional
11		9.63167	6.51888	Warning Sign	Functional
12		9.59938	6.53192	Warning Sign	Functional
13		9.59732	6.53377	Warning Sign	Functional
14		9.59177	6.53762	Warning Sign	Functional
15		9.6472	6.50832	Warning Sign	Damaged
16		9.597	6.52943	Warning Sign	Functional
17		9.59668	6.52818	Warning Sign	Functional

Table 4. 1d: Inventory of prohibitory road signs in X and Y coordinate along the major Roads in Minna

		Coordinates			
S/N	Type Of Furniture	Y	X	Category	Condition
1	Prohibitory Sign	9.57073	6.57307	Prohibitory Sign	Functional
2		9.57075	6.57303	Prohibitory Sign	Functional
3		9.59723	6.56128	Prohibitory Sign	Functional
4		9.60702	6.55438	Prohibitory Sign	Functional
5		9.61702	6.54678	Prohibitory Sign	Functional
6		9.61757	6.54663	Prohibitory Sign	Functional
7		9.61805	6.54653	Prohibitory Sign	Functional
8		9.62062	6.546	Prohibitory Sign	Functional
9		9.62167	6.54573	Prohibitory Sign	Functional
10		9.62133	6.54578	Prohibitory Sign	Functional
11		9.63242	6.54413	Prohibitory Sign	Functional
12		9.63282	6.54402	Prohibitory Sign	Functional
13		9.65432	6.53082	Prohibitory Sign	Functional
14		9.63927	6.51272	Prohibitory Sign	Functional
15		10.6359	6.51452	Prohibitory Sign	Functional
16		9.60685	6.52988	Prohibitory Sign	Functional
17		9.58835	6.54147	Prohibitory Sign	Functional
18		9.58815	6.54182	Prohibitory Sign	Functional
19		9.58143	6.55327	Prohibitory Sign	Functional

Table 4. 2: Inventory of traffic signs in X and Y coordinate along the major Roads in Minna

S/N	Type Of Furniture	Y	X	Category	Condition
1	Traffic Signal	9.59717	6.56132	Electronic	Functional
2		9.61702	6.54678	Electronic	Functional
3		9.62167	6.54573	Electronic	Functional
4		9.63242	6.54413	Electronic	Functional
5		9.58835	6.54147	Electronic	Functional
6		9.58162	6.55295	Electronic	Functional
7		9.6231	6.52665	Electronic	Functional

Table 4.3: Inventory of roundabouts in X and Y coordinate along the major Roads in Minna

		Coordinates			
S/N	Type Of Furniture	Y	X	Category	Condition
1	Roundabout	9.58202	6.56775	Structure	Functional
2	Roundabout	9.6039	6.55712	Structure	Functional
3	Roundabout	9.60457	6.55667	Structure	Functional
4	Roundabout	9.61085	6.5512	Structure	Functional
5	Roundabout	9.61433	6.54757	Structure	Non-Functional
6	Roundabout	9.63947	6.5417	Structure	Non-Functional
7	Roundabout	9.60513	6.53023	Structure	Functional
8	Roundabout	9.59848	6.5325	Structure	Functional

Table 4.4: Inventory of speed humps in X and Y coordinate along the major Roads in Minna

S/N	Type Of Furniture	Y	X	Category	Condition
1	Speed Humps	9.07527	6.50097	Structure	Good
2		9.67518	6.50083	Structure	Good
3		9.67465	6.50228	Structure	Bad
4		9.6576	6.52732	Structure	Bad
5		9.655	6.52843	Structure	Bad
6		9.64025	6.5412	Structure	Bad
7		9.63923	6.54168	Structure	Good
8		9.56513	6.575	Structure	Bad
9		9.5678	6.57482	Structure	Bad
10		9.5637	6.57675	Structure	Good
11		9.5633	6.57718	Structure	Good
12		9.56513	6.5762	Structure	Bad
13		9.6617	6.50937	Structure	Good
14		9.66208	6.50957	Structure	Good
15		9.66243	6.50962	Structure	Bad
16		9.6625	6.50977	Structure	Good
17		9.66273	6.50987	Structure	Good
18		9.66278	6.50978	Structure	Good
19		9.66308	6.50993	Structure	Bad
20		9.66338	6.5101	Structure	Good
21		9.6617	6.50937	Structure	Bad
22		9.6625	6.50977	Structure	Bad
23		9.66273	6.50987	Structure	Bad
24		9.66278	6.50978	Structure	Bad
25		9.50275	6.45306	Structure	Good

92 furniture were identified along 20km Chanchaga – Mobil – Tudun Fulani Road signifying an average of 4.6 road furniture per km. 52 furniture were identified along 13.5km western by pass implying an average of 3.9 road furniture per km while 7 furniture were observed along 14km Kpakungu – Gidan Kwano road suggesting an average of 2.4 road furniture along the road.

The data shows that road furniture are most concentrated along Chanchaga – Mobil – Tudun Fulani Road followed by the western by pass and making Kpakungu – Gidan Kwano road the least concentrated road. Figure 4. 1 shows their distribution.

The analysis gathered that the road furniture are dispersed. The nearest neighbor ratio was gotten as 1.2, the z score as 1.90 and the p value as 0.057, hereby making the significance level of the dispersion to be 0.1. This implies that there is a less than 10 percent likelihood that the dispersed pattern could be the result of random chance. The observed mean distance was gotten as 1010m and the expected mean distance as 818m. Figure 4.2 shows the distribution pattern for the analysis and Table 4.5 shows the data set information and the summary of analysis.

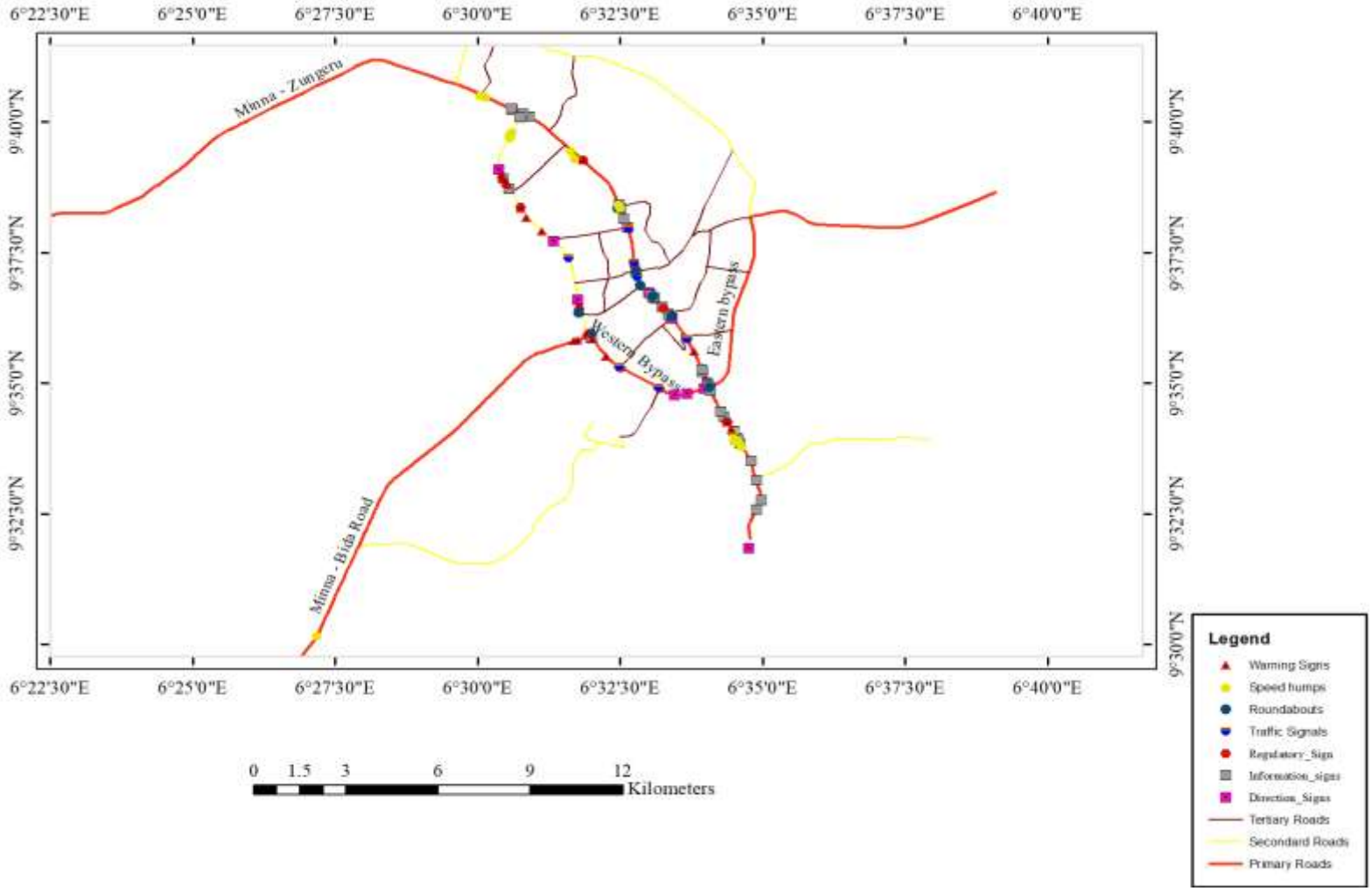

Figure 4. 1: Distribution of Road Furniture along the Major Roads in Minna

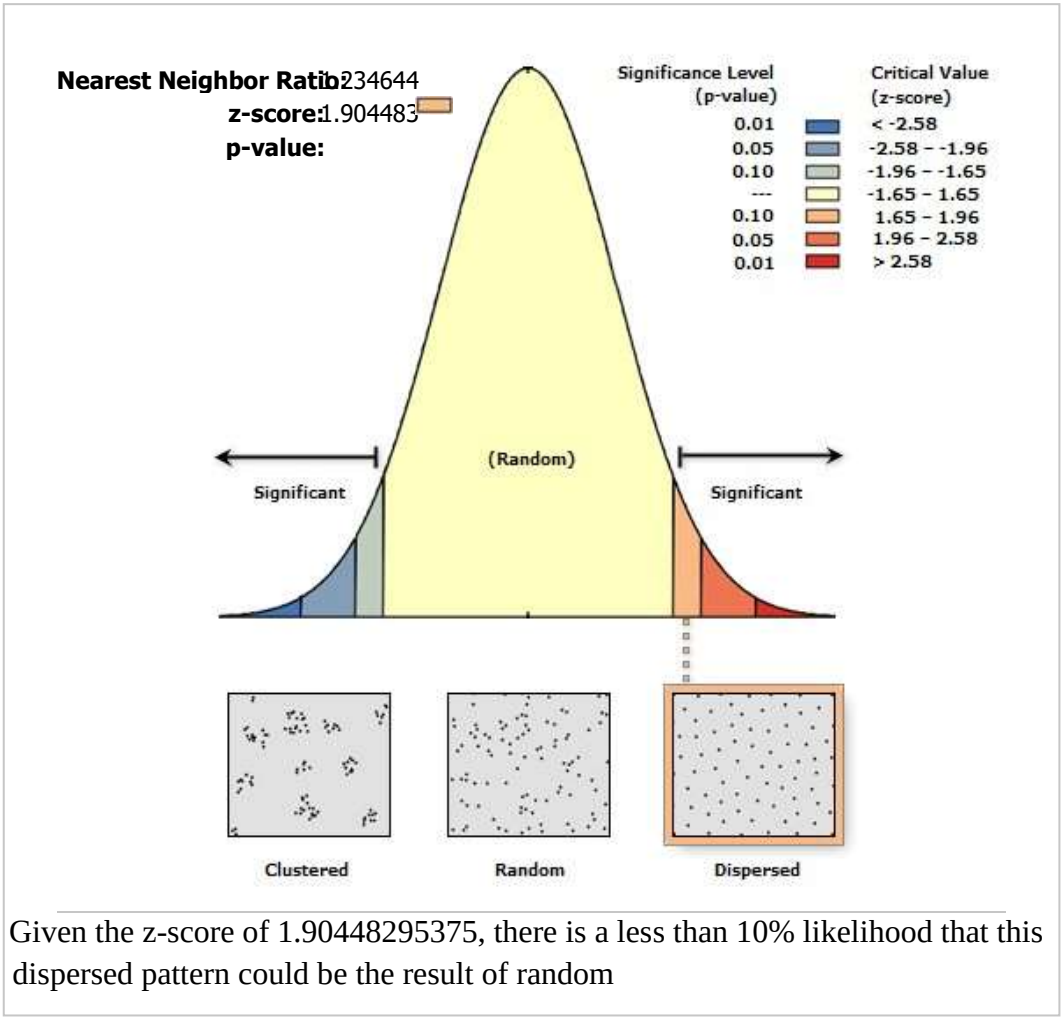

Figure 4. 2: Distribution curve for existing Road Furniture along the major Roads in Minna

Table 4. 5: Data set information and the summary of analysis for road Furniture.

Input feature class	Road Furniture
Distance method	Euclidean
Study area	48,233,081.96
Observed mean distance	1010.5m
Expected mean distance	818.5m
Nearest neighbor ratio	1.23
z- score	2.89
p- value	0.0038

4.2.2 Distribution of traffic signals

The analysis carried out identified a total number 7 traffic signals along the roads which were all observed to be functional (Table 4.6).The locations and conditions of the traffic signals are included therein.

Table 4. 6: Inventory of Traffic Signals along the Major Roads in Minna

S/N	Road	Location	Condition
1	Chanchaga - Bosso - Tudun Fulani	Top Medical Junc.	Functional
2		Ogbomosho Junc.	Functional
3		Stadium Junc.	Functional
4		Gvt House Junc.	Functional
5		Shiroro Junc.	Functional
6	Western Bypass	Mandela Rd Junc.	Functional
7		Shaibu Way Junc.	Functional

The analysis carried out gathered that the traffic signals along the roads are dispersed. The nearest neighbor ratio was gotten as 1.5, the z score as 2.89 and the p value as0.0038, hereby making the significance level of the dispersion to be 0.01 (low). This implies that there is a less than 1% likelihood that this dispersed pattern could be the result of random chance. The observed mean distance was gotten as 906m and the expected mean distance as 602m.

The distribution of furniture are shown on Figure 4.3, Figure 4.4 shows the distribution graph for the analysis and Table 4.7 shows the data set and summary of analysis.

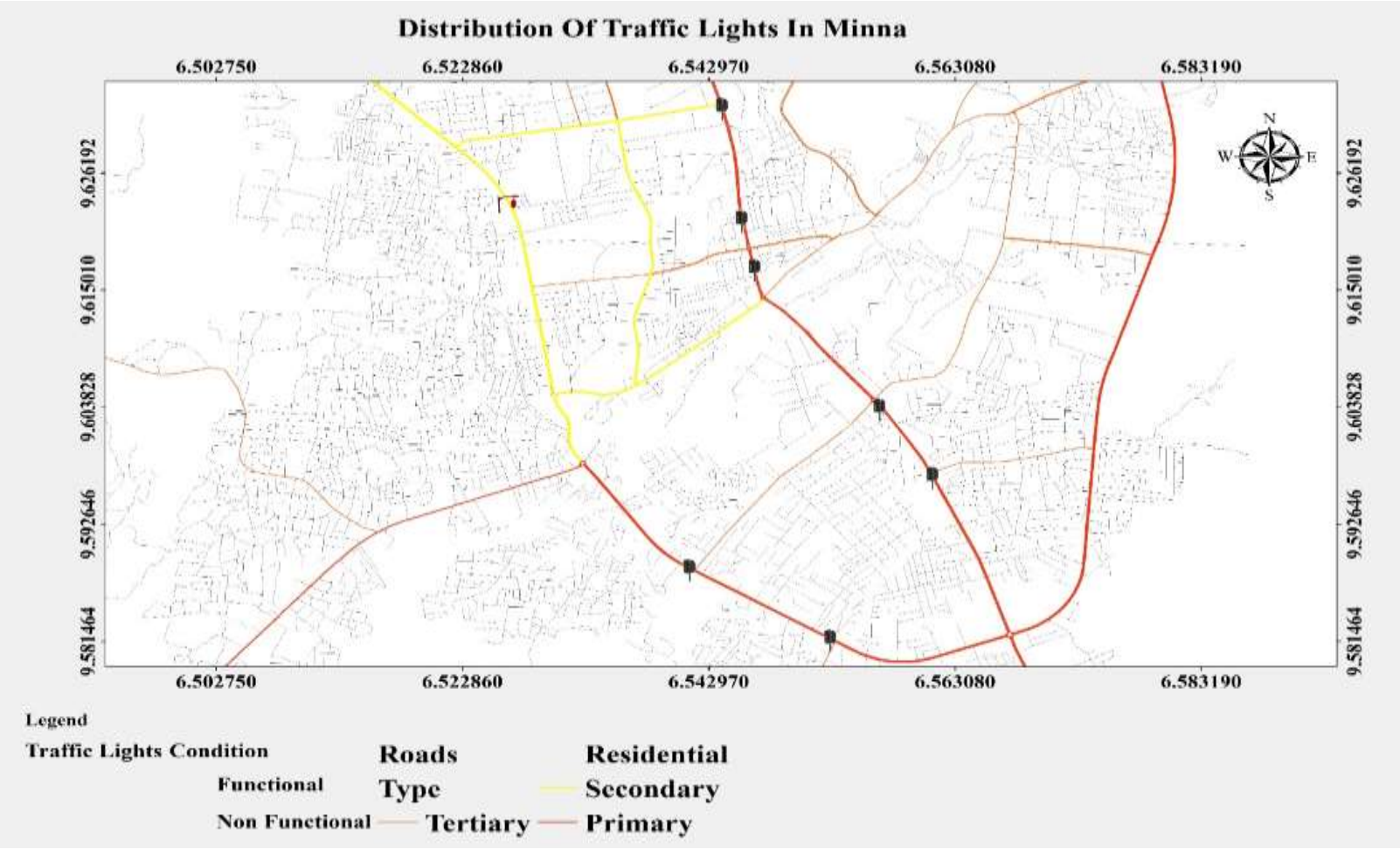

Figure 4. 3: Distribution of Traffic Signals along Major Roads in Minna

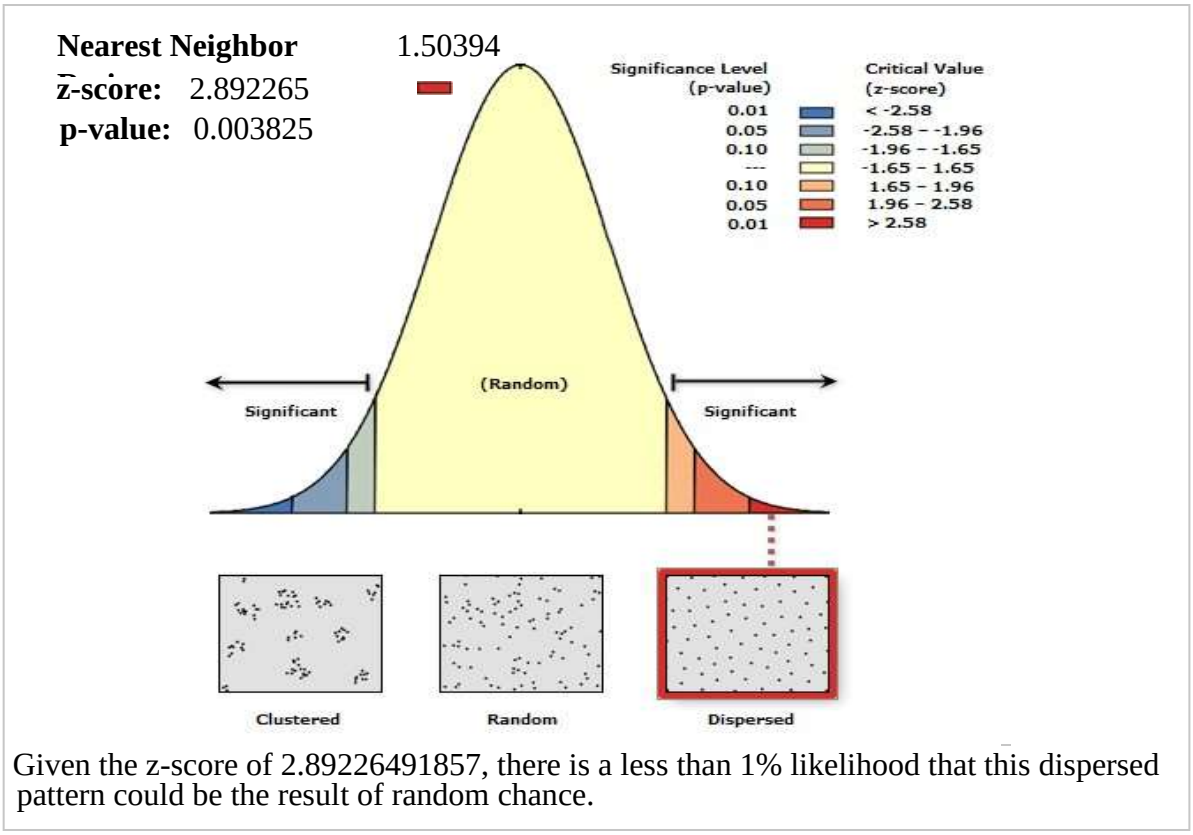

Figure 4. 4: Distribution pattern of traffic Signals

Table 4. 7: Data set information and the summary of analysis for traffic signals.

Input feature class	Traffic Signal
Distance method	Euclidean
Study area	13,052,059
Observed mean distance	905.57m
Expected mean distance	602.13m
Nearest neighbor ratio	1.50
z- score	2.89
p- value	0.0038

4.2.3 Distribution of roundabouts

As shown in Table 4.8, the total numbers of Roundabouts identified along the major roads were eight. 6 were observed to be adequate while 2 is inadequate. Figure 4.5 shows their dissemination.

The roundabout were discovered to be dispersed as the nearest neighbor ratio was attained as 1.5, the z score as 2.72 and the p value as 0.0065, hereby making the significance level of the dispersion to be low (0.01). This signifies that there is a less than 1% likelihood that this dispersed pattern could be the result of random chance. The observed mean distance was gotten as 1152m and the expected mean distance as 766m. Figure 4.6 shows the pattern for the analysis and Table 4.9 shows the data set information and the summary of analysis.

All roundabouts except the one located at the Obasanjo complex was found to have diameters above 24m. This implies that they can accommodate an average daily traffic of 25,000 annual daily traffic. Traffic count analysis carried out at Mobil and Kpakungu roundabout computed the average daily traffics as 31,176 and 24,929 respectively. Since these are the sections with the highest traffic in Minna metropolis, the average daily traffics for the other roundabouts are below 25,000.

Table 4.8: Inventory of Roundabouts along the Major roads in Minna

S/N	Road	Location	Diameter	Condition
1	Chanchaga - Mobil - Tudun Fulani	Bahago	90 x 23.84 (Oval Shape)	Inadequate
2		OBJ Complex	22.76	Inadequate
3			34.46	Inadequate
4		Paiko	30.9	Adequate
5		Tunga	68.36	Adequate
6	Western By Pass	City Gate	40.2	Adequate
7		High Court	30.58	Adequate
8		Kpakungu	63.2	Adequate

Figure 4. 5: Distribution of Roundabouts along the Major Roads in Minna

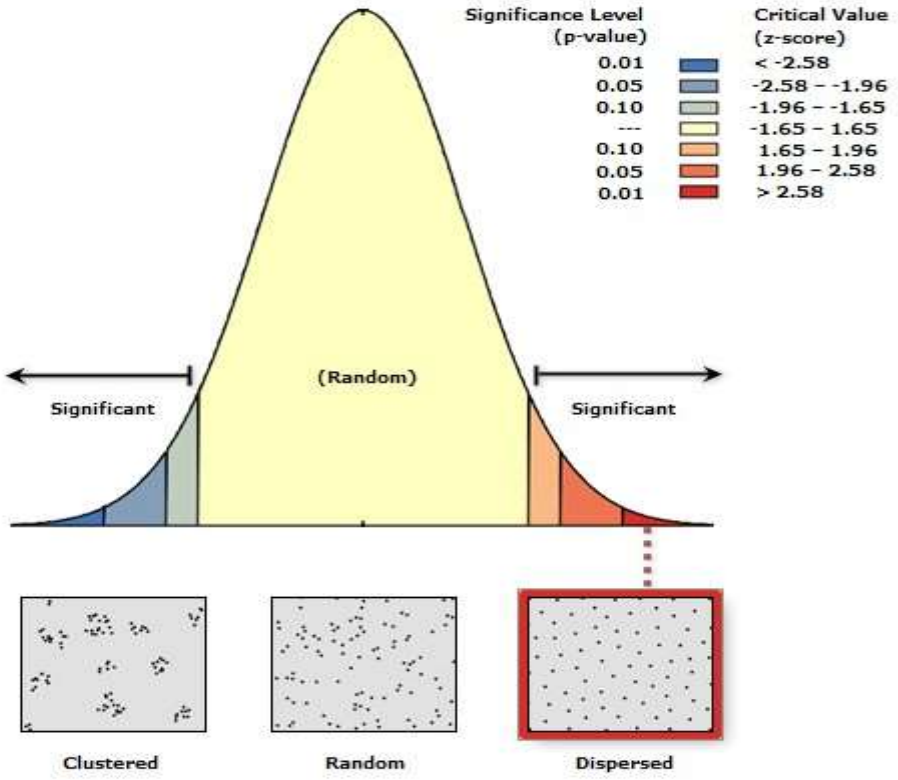

Figure 4. 6: Distribution curve for roundabouts along major roads in Minna

Table 4.9: Data set information and the summary of analysis for traffic signals.

Input feature class	Roundabout
Distance method	Euclidean
Study area	18,788,877
Observed mean distance	1151.687m
Expected mean distance	766.259m
Nearest neighbor ratio	1.50
z- score	2.72
p- value	0.0065

4.2.4 Distribution of speed humps

25 Speed humps were observed along the major roads. 11 were observed to be in poor condition while the remaining 14 were good. Table 4.10 shows the locations and conditions of the speed humps and Figure 4.7 shows their distribution.

Table 4. 10: Inventory of Speed Humps along the Major Roads in Minna

S/N	Road	Location	Condition
1	Chanchaga - Mobil - Bosso	Rafin Yashi	Good
2		Rafin Yashi	Good
3		Rafin Yashi	Bad
4		FUT Bosso	Bad
5		FUT Bosso	Bad
6		Bahago	Bad
7		Bahago	Good
8		COE	Bad
9		COE	Bad
10		Barrack	Good
11		Barrack	Good
12		COE	Bad
13	Western By Pass	New Bosso Market	Good
14		New Bosso Market	Good
15		New Bosso Market	Bad
16		New Bosso Market	Good
17		New Bosso Market	Good
18		New Bosso Market	Good
19		New Bosso Market	Bad
20		New Bosso Market	Good
21	Kpakungu - Gidan Kwano	Kowa School	Bad
22		Flaik	Bad
23		Flaik	Bad
24		Beganu	Bad
25		Gidan Kwano	Good

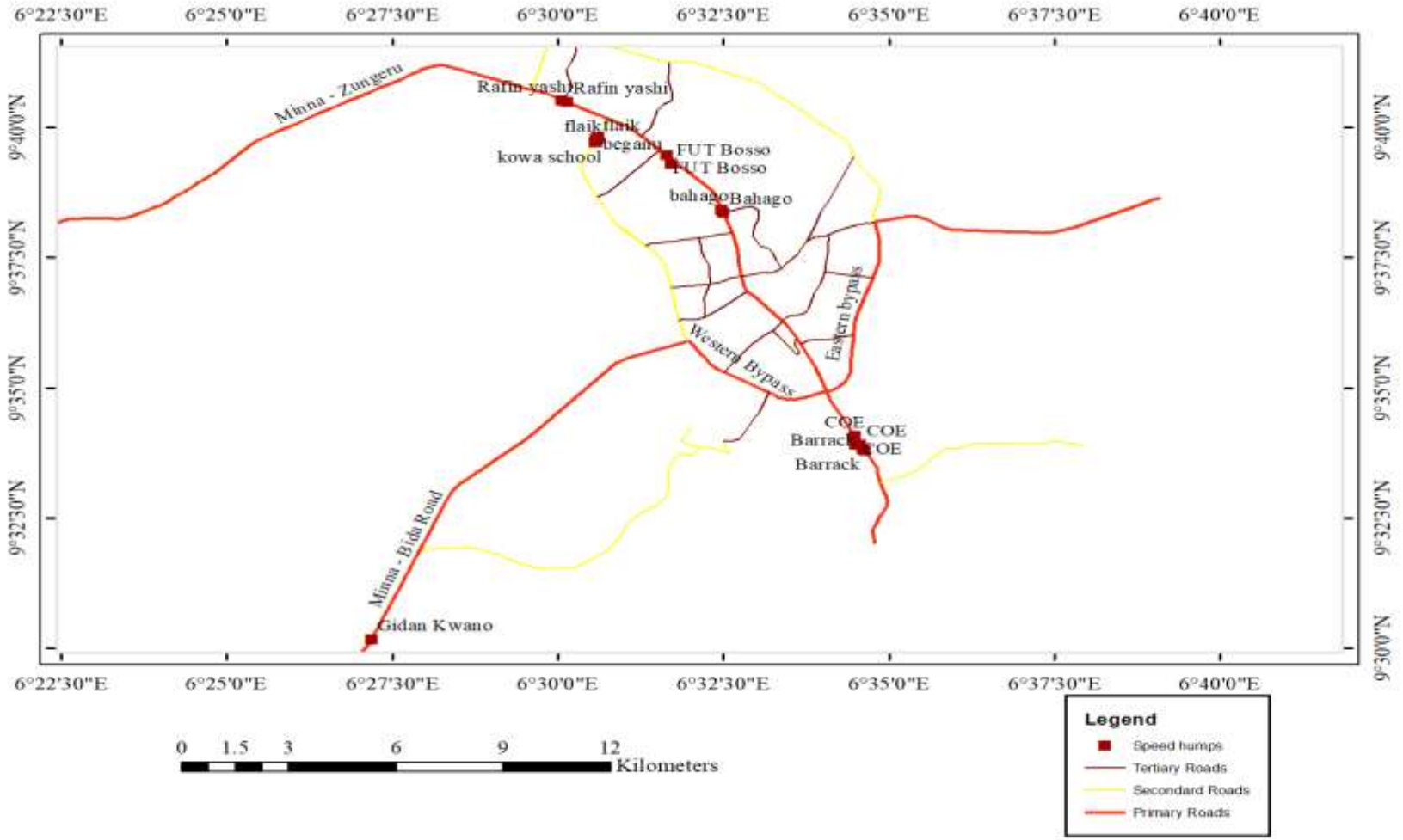

Figure 4. 7: Distribution of Speed Humps along the Major Roads in Minna

The Speed Humps along the roads were indicated to be randomly distributed. The nearest neighbor ratio was obtained as 0.91, the z score as 0.90 and the p value as 0.37. Therefore, the pattern appears to be significantly random. The observed mean distance was obtained as 2588m and the expected mean distance as 2857m. Figure 4.8 shows the distribution pattern for the analysis and Table 4.11 shows the data set information and the summary of analysis.

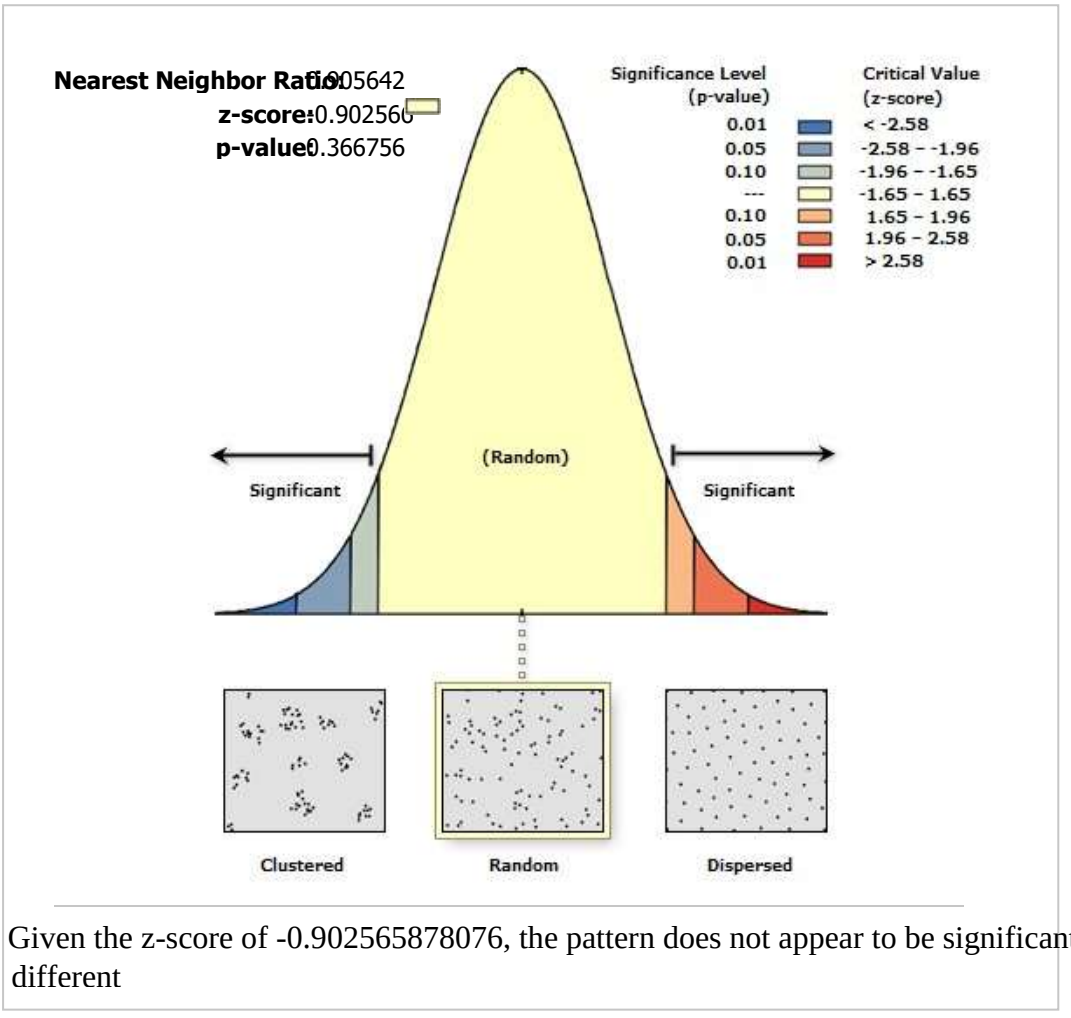

Figure 4. 8: Distribution pattern for speed humps

Table 4. 11: Data set information and the summary of analysis for speed humps.

Input feature class	Speed Humps
Distance method	Euclidean
Study area	815,839,234
Observed mean distance	2586.78m
Expected mean distance	2856.29m
Nearest neighbor ratio	1.50
z- score	2.72
p- value	0.0065

4.2.5 Distribution of road signs

The field investigation carried out discovered 85 road signs along the major roads in Minna metropolis. Tables 4.12a, 4.12b a, 4.12c and 4.12d show an inventory which encompasses the locations and conditions of the road signs. Figure 4.9 shows the distribution for each sign.

Table 4. 12a: Information Road Signs Along The Major Roads In Minna

S/N	Type of Furniture	Category	Name of Furniture	Condition
1	Road Signs	Information Sign	Sign (unidentified)	Damaged
2		Information Sign	Bus Stop Sign	Functional
3		Information Sign	Pharmacy Sign	Functional
4		Information Sign	Bus Stop Sign	Functional
5		Information Sign	Command Sign	Functional
6		Information Sign	Bus Stop Sign	Functional
7		Information Sign	Bus Stop Sign	Functional
8		Information Sign	Bus Stop Sign	Functional
9		Information Sign	Bus Stop Sign	Functional
10		Information Sign	Bus Stop Sign	Functional
11		Information Sign	Round About Sign	Functional
12		Information Sign	Sign (unidentified)	Damaged
13		Information Sign	Pharmacy Sign	Functional
14		Information Sign	Abdulsalam. Garage Sign	Functional
15		Information Sign	Round About Sign	Functional
16		Information Sign	NYSC Secretariat Sign	Functional
17		Information Sign	Overhead Sign	Damaged
18		Information Sign	Round About Sign	Functional
19		Information Sign	Union Bank Sign	Functional
20		Information Sign	Overhead Sign	Functional
21		Information Sign	Round About Sign	Functional
22		Information Sign	Bus Stop Sign	Functional
23		Information Sign	Round About Sign	Functional
24		Information Sign	Round About Sign	Functional
25		Information Sign	Overhead Sign	Functional
26		Information Sign	T Junction Sign	Functional
27		Information Sign	Bus Stop Sign	Functional
28		Information Sign	T Junction Sign	Functional
29		Information Sign	T Junction Sign	Functional
30		Information Sign	T Junction Sign	Functional
31		Information Sign	Round About Sign	Functional

Table 4. 12b: Direction Information Road Signs Along The Major Roads In Minna

S/N	Type of Furniture	Category	Name of Furniture	Condition
1		Direction Sign	Direction Sign	Functional
2		Direction Sign	Direction Sign (Zungeru)	Functional
3		Direction Sign	Welcome To Minna Sign	Functional
4		Direction Sign	Direction Sign	Functional
5		Direction Sign	Direction Sign	Functional
6		Direction Sign	Direction Sign	Functional
7		Direction Sign	Zungeru Sign	Functional
8		Direction Sign	Direction Sign	Functional
9		Direction Sign	Direction Sign	Functional
10		Direction Sign	Direction Sign	Functional
11		Direction Sign	Direction Sign	Functional
12		Direction Sign	Direction Sign	Functional
13		Direction Sign	Direction Sign	Functional
14		Direction Sign	Direction Sign	Functional
15		Direction Sign	Direction Sign	Damaged
16		Direction Sign	Direction Sign	Functional
17		Direction Sign	Direction Sign	Functional
18		Direction Sign	Overhead Sign	Functional

Table 4. 12c: Warning Road Signs Along The Major Roads In Minna

S/N	Type of Furniture	Category	Name of Furniture	Condition
1		Warning Sign	Walking Sign	Functional
2		Warning Sign	Sign For Bump Ahead	Functional
3		Warning Sign	Zebra Crossing Sign	Functional
4		Warning Sign	Bump Ahead Sign	Damaged
5		Warning Sign	Children Crossing	Functional
6		Warning Sign	Crossing Sign	Functional
7		Warning Sign	Sharp Bend Ahead Sign	Functional
8		Warning Sign	Person Crossing Sign	Functional
9		Warning Sign	Sharp Bend Ahead Sign	Functional
10		Warning Sign	Crossing Sign	Functional
11		Warning Sign	Crossing Sign	Functional
12		Warning Sign	Crossing Sign	Functional
13		Warning Sign	Crossing Sign	Functional
14		Warning Sign	Bump Ahead	Functional
15		Warning Sign	Sign Stand With No Sign	Damaged
16		Warning Sign	Crossing Sign	Functional
17		Warning Sign	Crossing Sign	Functional

Table 4. 12d: Prohibitory road Signs along the Major Roads In Minna

S/N	Type of Furniture	Category	Name of Furniture	Condition
1		Prohibitory Sign	Speed Limit Sign 40km/hr	Functional
2		Prohibitory Sign	Speed Limit Sign 50km/Hr	Functional
3		Prohibitory Sign	No U Turn Sign	Functional
4		Prohibitory Sign	No Parking Sign	Functional
5		Prohibitory Sign	No U Turn Sign	Functional
6		Prohibitory Sign	No U Turn Sign	Functional
7		Prohibitory Sign	No Parking Sign	Functional
8		Prohibitory Sign	No Parking Sign	Functional
9		Prohibitory Sign	No U Turn Sign	Functional
10		Prohibitory Sign	No U Turn Sign	Functional
11		Prohibitory Sign	No U Turn Sign	Functional
12		Prohibitory Sign	No Parking Sign	Functional
13		Prohibitory Sign	No Parking Sign	Functional
14		Prohibitory Sign	Speed Limit 80	Functional
15		Prohibitory Sign	No Parking Sign	Functional
16		Prohibitory Sign	Speed Limit Sign	Functional
17		Prohibitory Sign	No U Turn Sign	Functional
18		Prohibitory Sign	No U Turn Sign	Functional
19		Prohibitory Sign	No U Turn Sign	Functional

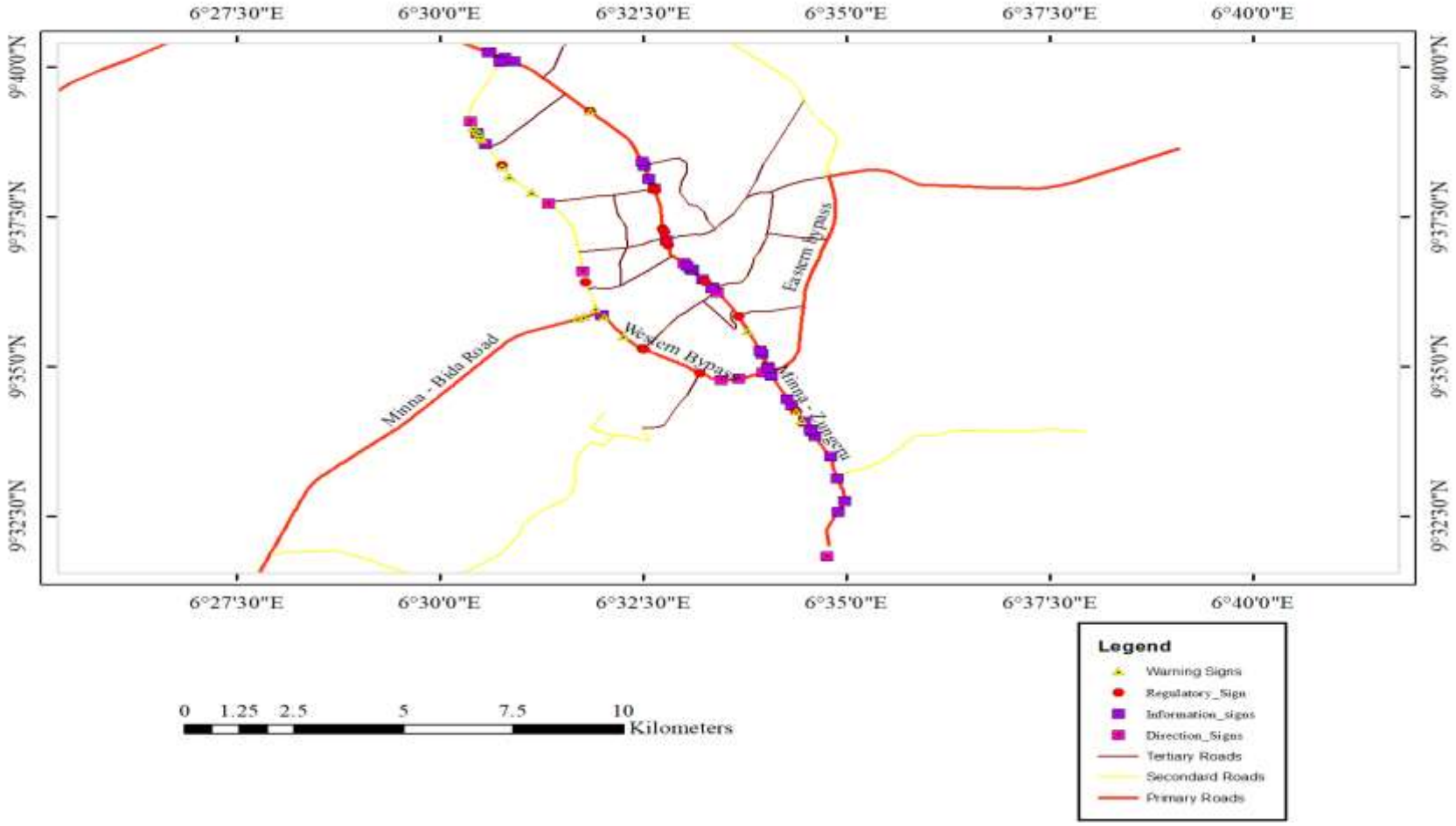

Figure 4. 9: Distribution of Road Signs along the Major Roads in Minna

The road signs along the major roads in Minna were discovered to be clustered. The nearest neighbor ratio was gotten as 0.5, the z score as -4.87 and the p value as 0.00001, hereby making the significance level of the dispersion to be 0.01(low). This implies that there is a less than 1 percent likelihood that the dispersed pattern could be the result of random chance. The observed mean distance was gotten as 334.6m and the expected mean distance as 616.28m. Figure 4.10 shows the distribution graph for the analysis and Table 4.13 shows the data set information and the summary of analysis.49 randomly distributed informative signs, 17 randomly distributed warning signs and 19 randomly distributed regulatory signs were observed.

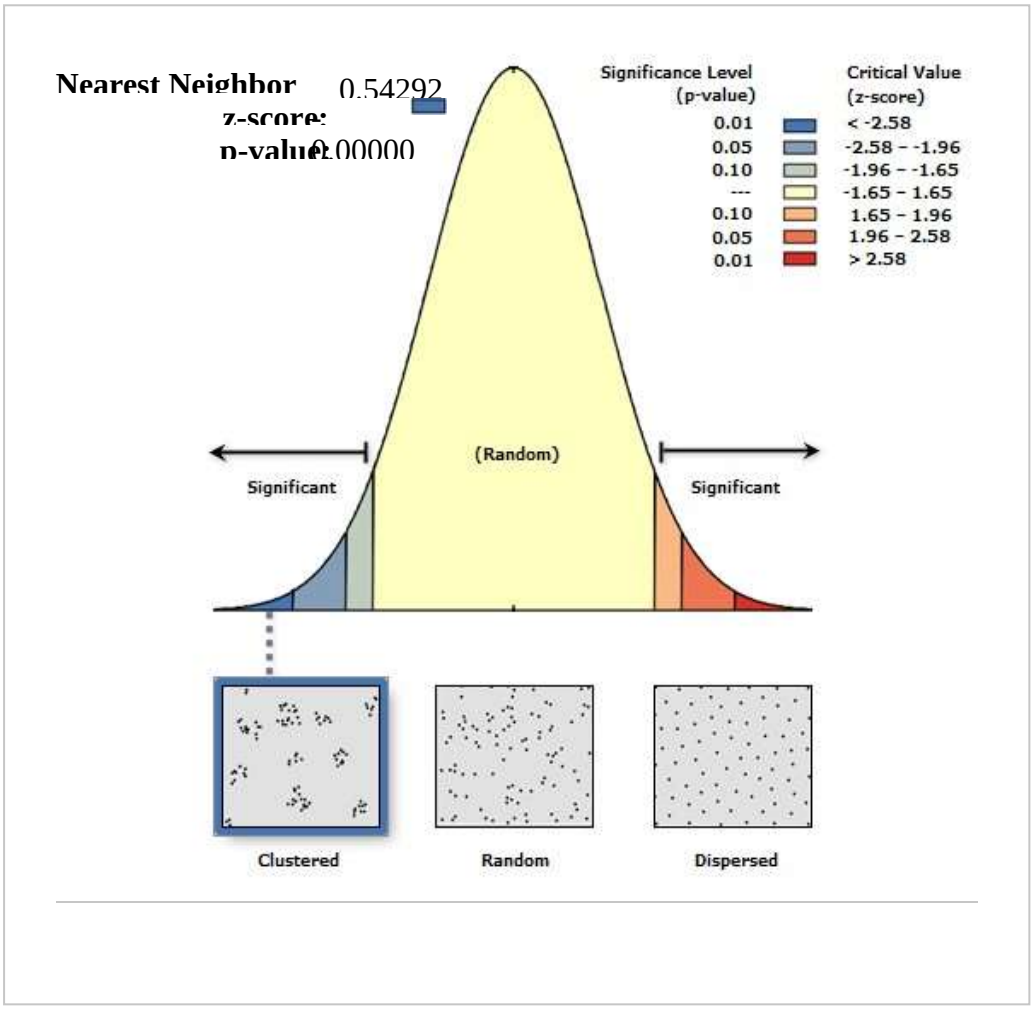

Figure 4. 10: Distribution curve for road signs

Table 4. 13: Data set information and the summary of analysis for road signs.

Input feature class	Road Signs
Distance method	Euclidean
Study area	47095251.85
Observed mean distance	334.6m
Expected mean distance	616.28m
Nearest neighbor ratio	0.54
z- score	-4.87
p- value	0.000001

4.2.6 Sufficiency of road furniture

The roads were investigated to determine the sufficiency of the existing road furniture. Location where road furniture are required but have not been provided were identified. This was done by traversing the roads with professionals and carrying out relevant analysis. Accident records from 2016 – 2020 were also gotten from the Federal Road Safety Corp and plotted on Arc Gis to determine the hotspots along the roads. The causes of accidents at those sections were considered to determine relationship with Road furniture at those sections. 189 accidents have been recorded along the roads between 2016 – February, 2020 (Federal Road Safety Corp, 2021). The records show that 67% of the accidents occurred as a result of Speed violations, Sign Light Violations and Route Violations. Table 4.11 shows the summary of accident recorded along the roads between 2016 – 2020.

The hotspots identified are Fidelity Bank and trade fare, Tunga, Figure 4.14 shows location of accident recorded within the period.

Table 4. 14: Summary of accident records along the roads between 2016 – 2020.

S/N	Cause of Accident	2016	2017	2018	2019	2020	TOTAL
1	Sign Light Violation (SLV)	3(6%)	10(50%)	3 (8%)	23(34%)	4(36%)	**43(23%)**
2	Speed Violation (SPV)	32(63%)	-	7 (18%)	-	1(9%)	**40(21%)**
3	Route Violation (RTV)	3(6%)	4(20%)	13(33%)	24(35%)		**44(23%)**
4	Road Obstruction Violation (OBS)	1(2%)	-	1(3%)			**2(1%)**
5	Wrong Overtaking	1(2%)	-	4(10%)	1(1%)		**6(3%)**
6	Lost of Control (LOC)	7(14%)	2(10%)	6(15%)	9(13%)	4(36%)	**28(15%)**
7	Wrong u turn	-	-	3(8%)		1(9%)	**4(2%)**
8	Brake Failure (BFL)	-	-		1(1%)		**1(1%)**
9	Dangarous Driving (DGD)	-	-	1(3%)	1(1%)		**2(1%)**
10	Fatigue (FTQ)	-	-		2 (3%)		**2(1%)**
11	Hit and Run	-	-		6 (9%)		**6(3%)**
12	Mechanically Deficient Vehicle (MDV)	-	1(5%)	1(3%)	1(1%)		**3(2%)**
13	Overloading (OVL)	1(2%)		-			**1(1%)**
14	Tyre Burst (TBT)	3(6%)	3(15%) -	-			**6(3%)**
15	Impatience		-			1(9%)	**1(1%)**
	TOTAL NUMBER RECORDED	51	20	39	68	11	**189**

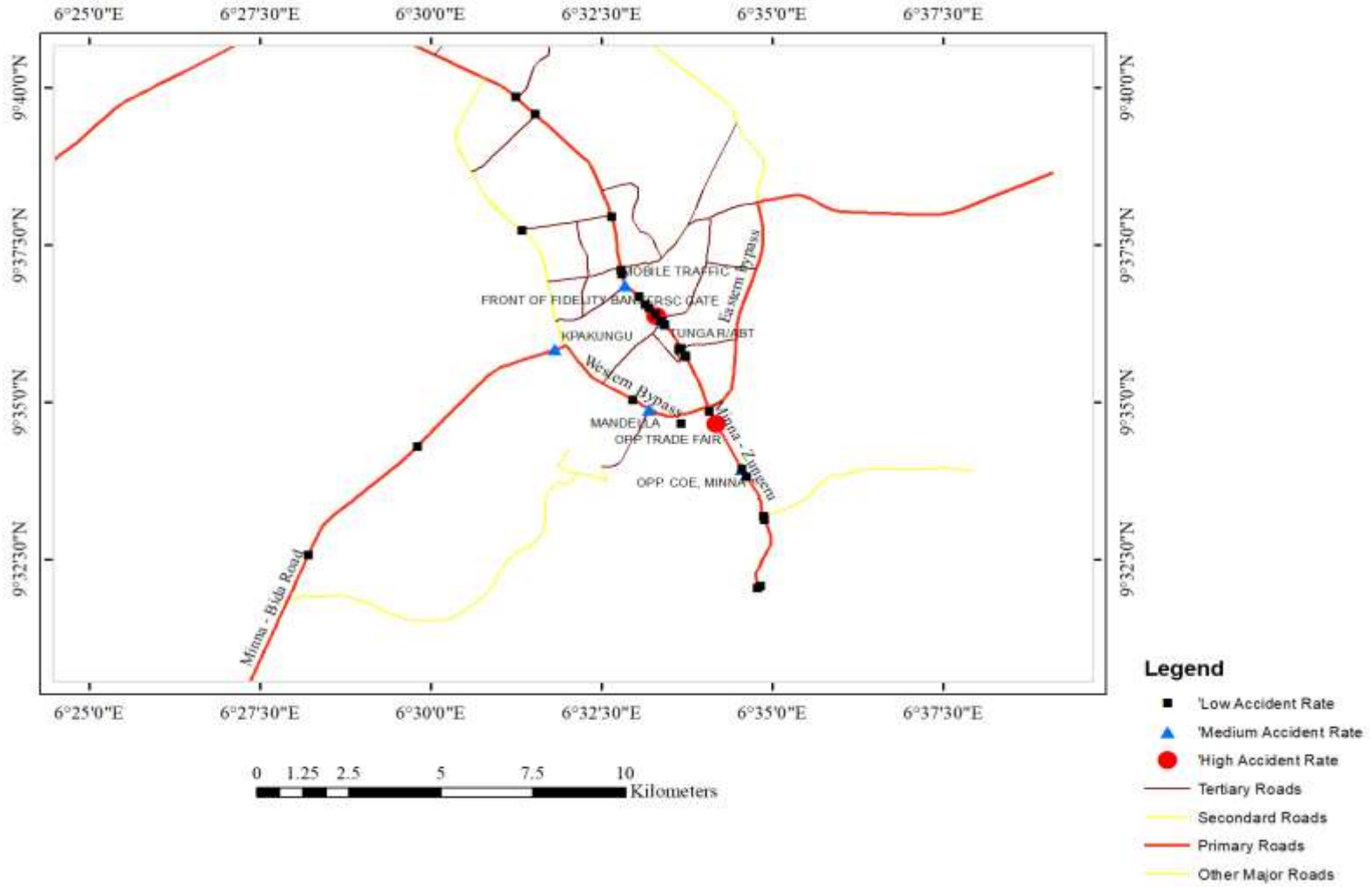

Figure 4. 11: Accident hotspots along major roads in Minna

From the analysis carried out to determine the adequacy of road furniture with regard to quantity, 204 points were identified to be deficient of relevant road furniture. The analysis for their distribution showed that the points are randomly distributed having a nearest index of 0.7. Speed humps were observed to be deficient at 18 locations. Road signs were observed to be deficient at 186 locations.Out of which 155are warning signs and warning and 31 are informative signs.No traffic signal or roundabouts were observed to be required.

To determine the sufficiency, the number of existing furniture is considered with reference to the total number of furniture considered to be ideal along the roads. Therefore, the sufficiency is given in Equation 4.1.

$$S = \frac{N_E}{N_E + N_P} \times 100 \quad (4.1)$$

Where S = Sufficiency

N_E = Number of existing furniture

N_P = Number of proposed Furniture

The number of existing furniture was identified as 126 while 204 number were proposed. Their locations are shown in appendix B.

Therefore,

$$S = \frac{126}{106+204} \times 100 \quad (4.2)$$

S =38%

This value rates fair which rates poor on a five point likert scale.

4.3 Conformity of the Road Furniture to Conventional Standards

The parameters of existing road furniture were determined from the field and compared with conventional standards to determine their conformity. From the analysis, it was discovered that 69 out of 126 (55%) of the furniture conform to conventional standards while the remaining 45% do not.

4.3.1 Traffic signals

The analysis showed that 7 out of 7 (100%) of traffic signals conform to standards. Table 4.15 shows their locations and conformity.

Table 4. 15: Conformity of Traffic Signals to conventional standards

S/N	Road	Location	Conformity to Standard
1	Chanchaga - Bosso - Tudun Fulani	Top Medical Junc.	Yes
2		Ogbomosho Junc.	Yes
3		Stadium Junc.	Yes
4		Government House Junction	Yes
5		Shiroro Junc.	Yes
6	Western By Pass	Mandela Rd Junc.	Yes
7		Shaibu Way Junc.	Yes

4.3.2 Roundabouts

The analysis showed that 6 out of 8 (75%) of roundabouts conform to standards. The remaining 2 (25%) do not conform to the conventional standards for roundabouts. Table 4.16 shows their locations and conformity.

Table 4. 16: Conformity of existing roundabouts to conventional standards

S/N	Road	Location	Shape	Diameter	Conformity
1	Chanchaga - Mobil - Tudun Fulani	Bahago	Oval	90 x 23.84 (Oval Shape)	No
2		OBJ Complex	Circular	22.76	No
3		Mobil	Circular	34.46	Yes
4		Paiko	Circular	30.9	Yes
5		Tunga	Circular	68.36	Yes
6	Western By Pass	City Gate	Circular	40.2	Yes
7		High Court	Circular	30.58	Yes
8		Kpakungu	Circular	63.2	Yes

4.3.3 Speed humps

The analysis showed that 12 out of 25 (48%) of speed humps conform to standards. The remaining 13 have deteriorated or do not conform to the conventional standards. Table 4.17 shows their locations and conformity.

Table 4. 17: Conformity of speed humps to conventional standards

SN	Road	Location	Conformity to Standard
1	Chanchaga - Mobil - Tudun Fulani	Rafin Yashi	Yes
2		Rafin Yashi	Yes
3		Rafin Yashi	No
4		Fut Bosso	No
5		Fut Bosso	No
6		Bahago	No
7		Bahago	Yes
8		COE	No
9		COE	No
10		Barrack	Yes
11		Barrack	Yes
12		COE	No
13	Western By Pass	New Bosso Market	Yes
14		New Bosso Market	Yes
15		New Bosso Market	No
16		New Bosso Market	Yes
17		New Bosso Market	Yes
18		New Bosso Market	Yes
19		New Bosso Market	No
20		New Bosso Market	Yes
21	Kpakungu - Gidan Kwano	kowa school	No
22		flaik	No
23		flaik	No
24		beganu	No
25		Gidan Kwano	Yes

The analysis showed that 44(41.5%) out of 106 road signs conform to standards. 23 (62%) out of 37 warning signs conform to conventional standards as shown in Table 4.15. 6 out of 37 (16%) regulatory signs conform to standards as shown in Table 4.16 and 16 out of 32 (50%) informative signs conform to standards as shown in Tables 4.18a, 4.18b and 4.18c.

Table 4. 18a: Conformity of Warning Signs along Chanchaga - Mobil - Tudun Fulani to Conventional Standards

S/N	Category	Road	Type	Color	Shape	Condition	Stand Height	Width	Sign Height	Conformity to Standard
1	Warning Sign	Chanchaga - Mobil - Tudun Fulani	Bump Ahead	Red, Black & White	Triangular	Good	1.57	0.6	0.7	No
2			Bump Ahead	Red, Yellow & Black	Triangular	Bad	0.6	0.61	0.65	No
3			Bump Ahead	Red, Yellow & Black	Triangular	Fair	0.98	0.61	0.6	No
4			Caution Sign	Yellow	Triangular	Fair	1.84	1.12	1.2	No
5			Damaged Sign	Blank	Inverted Triangle	Bad	1.84	1.12	1.2	No
6			Children Crossing	Black, Red & White	Triangular	Good	1.81	0.661	0.7	No
7			Children Crossing	Black, Red & White	Triangular	Good	1.81	0.661	0.7	No
8			Heavy Duty Crossing	Red & White	Triangular	Good	1.8	0.91	0.9	No
9			T Junction Sign	Black, Red and White	Triangular	Good	1.8	0.77	0.8	No
10			Children Crossing	Red, Black & Yellow	Triangular	Fair	1.65	0.76	0.68	No
11			Children Crossing	Red, Black & Yellow	Triangular	Fair	1.65	0.76	0.68	No
12			Children Crossing	Red, Black & Yellow	Triangular	Good	1.46	0.77	0.67	Yes
13			Children Crossing	Red, Black & Yellow	Triangular	Good	1.78	0.77	0.68	Yes
14			Children Crossing	Red, Black & Yellow	Triangular	Good	1.84	0.71	0.67	Yes
15			Children Crossing	Red, Black & Yellow	Triangular	Good	2.24	0.69	0.69	Yes
16			Person Crossing Sign	Red, Black & Yellow	Triangular	Good	1.78	0.77	0.68	Yes
17			Sharp Bend Ahead	Red, Black & Yellow	Triangular	Good	1.85	0.77	0.68	Yes
18			Sharp Bend Ahead	Red, Black & Yellow	Triangular	Good	1.82	0.77	0.67	Yes
19			Sharp Bend Ahead	Red, Black & Yellow	Triangular	Good	1.66	0.78	0.26	Yes
20			T Junction Sign	Red, Black & Yellow	Triangular	Good	1.82	0.78	0.67	Yes
21			T Junction Sign	Red, Black & Yellow	Triangular	Good	1.68	0.77	0.68	Yes
22			T Junction Sign	Red, Black & Yellow	Triangular	Good	1.86	0.77	0.67	Yes

Table 4. 18b: Conformity of Warning Signs along Western by pass to Conventional Standards

S/N	Category	Road	Type	Color	Shape	Condition	Stand Height	Width	Sign Height	Conformity to Standard
1	Warning Signs	Western by pass	Children Crossing	Red, Black and Yellow	Triangular	Fair	1.65	0.76	0.68	No
2			Children Crossing	Red, Black and Yellow	Triangular	Fair	1.65	0.76	0.68	No
3			Children Crossing	Red, Black and Yellow	Triangular	Good	1.46	0.77	0.67	Yes
4			Children Crossing	Red, Black and Yellow	Triangular	Good	1.78	0.77	0.68	Yes
5			Children Crossing	Red, Black and Yellow	Triangular	Good	1.84	0.71	0.67	Yes
6			Children Crossing	Red, Black and Yellow	Triangular	Good	2.24	0.69	0.69	Yes
7			Person Crossing Sign	Red, Black and Yellow	Triangular	Good	1.78	0.77	0.68	Yes
8			Sharp Bend Ahead	Red, Black and Yellow	Triangular	Good	1.85	0.77	0.68	Yes
9			Sharp Bend Ahead Sign	Red, Black and Yellow	Triangular	Good	1.82	0.77	0.67	Yes
10			Sharp Bend Ahead Sign	Red, Black and Yellow	Triangular	Good	1.66	0.78	0.26	Yes
11			T Junction Sign	Red, Black and Yellow	Triangular	Good	1.82	0.78	0.67	Yes
12			T Junction Sign	Red, Black and Yellow	Triangular	Good	1.68	0.77	0.68	Yes
13			T Junction Sign	Red, Black and Yellow	Triangular	Good	1.86	0.77	0.67	Yes

Table 4. 18c: Conformity of Warning Signs along Kpakungu – Gidan Kwano to Conventional Standards

S/N	Category	Road	Type	Color	Shape	Condition	Stand Height	Width	Sign Height	Conformity to Standard
1		Kpakungu - Gidan Kwano	Children Crossing	Red, Black and White	Triangular	Good	1.92	0.6	0.74	No
2			Children Crossing	Red, Black and White	Triangular	Good	1.48	0.59	0.6	No

Table 4. 19a: Conformity of Regulatory Signs along Western by pass to Conventional Standards

S/N	Category	Road	Type	Color	Shape	Condition	Stand Height (m)	Diameter (m)	Conformity to Standard
1		Western By Pass	Bump Ahead	Yellow and Black	Circular	Good	2		No
2			No U Turn	Red, Black and White	Circular	Fair	2.11	0.59	No
3			No U Turn Left	Red, Black and White	Circular	Bad	1.89	0.59	No
4			No U Turn Right	Red, Black and White	Circular	Good	1.9	0.59	No
5			Round About Sign	Blue and White	Circular	Fair	1.63	0.61	No
6			Speed Limit 80	Red, Yellow and Black	Circular	Good	1.79	0.61	Yes
7			Speed Limit Sign	Red, Black and Yellow	Circular	Good	2	0.61	Yes
8			Turn Left	Blue and White	Circular	Fair	1.59	0.75	No
9			Turn Right	Blue and White	Circular	Fair	1.71	0.83	No

Table 4. 19b: Conformity of Regulatory Signs along Chanchaga – Mobil – Tudun Fulani to Conventional Standards

S/N	Category	Road	Type	Color	Shape	Condition	Stand Height (m)	Diameter (m)	Conformity to Standard
1	Regulatory Sign	Chanchaga - Mobil - Tudun Fulani	Bus Stop	Purple and White	Circular	Bad	1.8	0.76	No
2			Bus Stop	Purple and White	Circular	Bad	1.75	0.76	No
3			Bus Stop	Purple and White	Circular	Fair	1.55	0.76	No
4			Bus Stop	Purple and White	Circular	Bad	1.6	0.76	No
5			Bus Stop	Purple and White	Circular	Fair	1.84	0.76	No
6			Bus Stop	Purple and White	Circular	Fair	1.84	0.76	No
7			Bus Stop	Purple	Circular	Good	1.7	0.76	No
8			Bus Stop	Purple	Circular	Bad	1.84	0.76	No
9			Bus Stop	Purple and White	Circular	Fair	1.55	0.76	No
10			Bus Stop	Purple	Circular	Good	1.69	0.76	No
11			Bus Stop	Purple and White	Circular	Bad	1.73	0.76	No
13			Roundabout Sign	Blue and White	Circular	Good	1.73	0.62	Yes
14			Round About Sign	Purple and White	Circular	Fair	2.39	0.62	No
15			Round About Sign	Blue and White	Circular	Bad	2.39	0.62	No
16			Round About Sign	Blue and White	Circular	Good	2.3	0.61	Yes
17			Round About Sign	Blue and White	Circular	Good	2.13	0.62	Yes
18			Round About Sign	Blue and White	Circular	Good	2.13	0.62	Yes
19			Speed Limit 40	Red , White & Blue	Circular	Fair	0.94	0.6	No
20			Speed Limit 50	Red, White and Blue	Circular	Fair	1.43	0.6	No
21			Damaged Sign	White With Posters	Circular	Bad	1.43	0.6	No
23			Turn Right	Blue and White	Circular	Fair	1.65	0.75	No
24			No U Turn	Red Black and White	Circular	Good	2.8	0.6	No
25			No U Turn	Red Black and White	Circular	Good	2.8	0.6	No
26			No U Turn	Red Black and White	Circular	Good	2	0.59	No
27			No U Turn	Red Black and White	Circular	Good	2.8	0.6	No
28			No U Turn	Red Black and White	Circular	Good	2.8	0.6	No

Table 4.20: Conformity of Informative Signs along Chanchaga – Mobil – Tudun Fulani Road to Conventional Standards

S/N	Category	Road	Type	Color	Shape	Condition	Conformity to Standard
1	Information Sign	Chanchaga - Mobil - Tudun Fulani	Command Sign	Blue and Black	Rectangular	Good	No
2			Overhead Information Sign	Blue and White	Rectangular	Good	No
3			Damaged Overhead	Nil	Rectangular	Bad	No
4			Damaged Overhead Sign	Nil	Rectangular	Bad	No
5			Damaged Sign	Nil	Rectangular	Bad	No
6			Direction Sign	Green and White	Rectangular	Good	yes
7			Direction Sign	Green and White	Rectangular	Good	yes
8			Direction Sign	Green and White	Rectangular	Good	yes
9			Direction Sign	Green and White	Rectangular	Good	yes
10			Direction Sign	Green and White	Rectangular	Good	yes
11			Direction Sign (Zungeru)	Green and White	Rectangular	Good	yes
12			Direction Sign(Middle)	Green and White	Rectangular	Good	yes
13			Nysc Secretariat Sign	Green and White	Rectangular	Good	yes
14			Overhead Sign	Blue and White	Rectangular	Good	No
15			Overhe}kn'ad Sign	Blue and White	Rectangular	Good	No
16			Pharmacy	Green, White and Yellow	Rectangular	Good	No
17			Pharmacy	Green and White	Rectangular	Good	No
18			Union Bank Sign	Blue and White	Rectangular	Good	No
19			Welcome To Minna Sign	Green and White	Rectangular	Good	yes
20			Zungeru Sign (2nos)	Green and White	Rectangular	Good	yes

Table 4. 21: Conformity of Road Furniture to Conventional Standards

4.4 Familiarity and Compliance Level of Road Users

S/N	Type of Furniture	Road	Category	Conformity to Standards	Non Conformity to Standard	Total
1	Traffic Signal	Chanchaga - Tudun Fulani	-	5	0	5
		Western by pass	-	1	1	2
		Kpakungu - Gidan Kwano	-	0	0	0
		Cumulative	-	**6(86%)**	**1(14%)**	**7**
2	Roundabouts	Chanchaga - Bosso - Tudun Fulani	-	4	1	5
		Western by pass	-	3	0	3
		Kpakungu - Gidan Kwano	-	0	0	0
		Cumulative	-	**7(87.5%)**	**1(12.5%)**	**8**
3	Speed Humps	Chanchaga - Bosso - Tudun Fulani	-	5	7	12
		Western by pass	-	6	2	8
		Kpakungu - Gidan Kwano	-	1	4	5
		Cumulative	-	**12(48%)**	**13(52%)**	**25**
4	Road Signs	Chanchaga - Mobil - Tudun Fulani	Warning Sign	11	11	22
			Regulatory Signs	4	24	28
			Informative Sign	10	10	20
		Cumulative		**25(35.7%)**	**45(64.3%)**	**70**
		Western by pass	Warning Sign	11	2	13
			Regulatory Signs	2	7	9
			Informative Sign	6	6	12
		Cumulative		**19(55.9%)**	**15(44.1%)**	**34**
		Kpakungu - Gidan Kwano	Warning Sign	0	2	2
			Regulatory Signs	0	0	0
			Informative Sign	0	0	0
		Cumulative		**0(0%)**	**2(100%)**	**2**
		Cumulative		**44(41.5%)**	**62(58.5%)**	**106**
	TOTAL			**69 (47%)**	**77(53%)**	**146**

The level of familiarity and compliance with various road furniture were determined using questionnaires. In general, the familiarity of road users with the meaning of road furniture rated good on the lakerts scale, the self compliance with the furniture also rated good while the perception of general compliance with the various furniture rated fair. The socioeconomic characteristics of the respondents were considered to determine the reliability of that data collected.

4.4.1 Socio- economic characteristics of respondents

The socioeconomic characteristics considered in the questionnaires include age structure, gender structure, educational level and occupational structure. This was collected to confirm the reliability of the data collected. The analysis were carried out using descriptive statistics.

4.4.1.1 Age structure of respondents

The age range for most of the respondents were identified to fall between 20 – 50 years. This is suitable because they are matured and are capable of giving reliable data that can be treated with accuracy. Table 4.22 shows the distribution.

Table 4.22: Age Structure of Respondents

Age Range	**20-24**	**25-29**	**30-34**	**35-39**	**40-45**	**45-50**	**50 and Above**
Percentage	8.9%	24.4%	27.8%	22.2%	10.0%	5.6%	1.1%

4.4.1.2 Gender structure of respondents

68.4% of the respondents were males while the remaining 31.6% were females. The distribution is shown in Table 4.23.

Table 4. 23: Gender Structure of Respondents

Gender	Frequency	Female
Male	65	68.4%
Female	30	31.6%
Total	**95**	**100.0%**

4.4.1.3 Level of education

The analysis showed that almost 80 percent of the respondents have at least a secondary education. Therefore making them literate and increasing the reliability of data collected from them. Table 4.24 shows the distribution

Table 4. 24: Level of Education of Respondents

Educational Status	Frequency	Percentage
No Education	9	9.6%
Primary	12	12.8%
Secondary	19	20.2%
Tertiary	55	58.5%
Total	**95**	**100.0%**

4.4.1.4 Occupation structure of respondents

The occupation structure shows of the respondents show that 51.6% accounts for the largest single unit of occupational structure among the respondents. Table 4.25 shows the distribution.

Table 4. 25: Occupations of Respondents

Occupation	Frequency	Percentages
Civil Servant	49	51.6%
Artisan	16	16.8%
Self Employed	25	26.3%
Unemployed	5	5.3%
Total	**95**	**100.0%**

4.4.2 Familiarity of road users with meanings of road furniture

The analysis carried out showed that the familiarity of road users with the meaning of road furniture rated good on the lakerts scale. 56.1% of the respondents rated good on the scale, 30% rated fair while the remaining 13.7% rated poor. Table 4.26 shows percentage of familiarities with individual furniture.

Table 4. 26: Familiarity of Road Users with Meanings of Road Furniture

	Self Compliance with Road Furniture	Poor	Fair	Good
1	Traffic Signals	8.4%	31.6%	60.0%
2	Direction Signs	11.6%	26.3%	62.1%
3	Warning Signs	15.8%	37.9%	45.3%
4	Information sign	13.7%	33.7%	52.6%
5	Regulatory Signs	15.8%	42.1%	42.1%
6	Speed humps	11.6%	20.0%	68.4%
7	Roundabout	13.7%	20.0%	66.3%
	AVERAGE	**13.7%**	**30.0%**	**56.1%**

4.4.3 Self compliance of road users with meanings of road furniture

The analysis carried out showed that Self Compliance of road users with the meaning of road furniture rated good on the lakerts scale. 53.7% of the respondents rated good on the scale, 29.7% rated fair while the remaining 16.6% rated poor. Table 4.27 shows percentage of Self Compliance with individual furniture.

Table 4. 27: Self Compliance with Road Furniture

Furniture	Poor	Fair	Good
Traffic Signals	9.5%	26.3%	64.2%
Direction Signs	14.8%	30.5%	54.7%
Warning Signs	17.9%	30.5%	51.5%
Information sign	17.9%	26.3%	55.8%
Regulatory Signs	23.2%	34.7%	42.1%
Average	**16.6%**	**29.7%**	**53.7%**

4.4.4 General public compliance of road users with meanings of road furniture

The analysis carried out showed that the perception of general compliance with road signs is poor. 40% of the respondents rated poor on the lakert's scale, 31.6% rated fair while the remaining 28.4% rated good. Table 4.28 shows percentage of General Compliance with individual furniture.

Table 4.28: General Compliance with Road Furniture

S/N	Furniture	Poor	Fair	Good
1	Traffic Signals	38.9%	34.7%	26.4%
2	Direction Signs	47.3%	32.6%	20.0%
3	Warning Signs	51.6%	34.7%	13.7%
4	Information sign	25.3%	25.3%	49.5%
5	Regulatory Signs	36.9%	30.5%	32.6%
	AVERAGE	40.0%	31.6%	28.4%

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CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

A total of 126 different types of furniture were identified to be dispersed along the roads selected for this study. 92 furniture were identified along 20km Chanchaga – Mobil – Tudun Fulani Road, 52 furniture along 13.5km western by pass and 7 along 14km Kpakungu – Gidan Kwano road making Chanchaga – Mobil – Tudun Fulani Road the most concentrated and Kpakungu – Gidan Kwano road the least concentrated road. These furniture were observed to be insufficient as analysis carried out determined its sufficiency to be poor. 204 points were identified to be deficient of relevant road furniture.

The analysis also showed that the general quality of existing furniture is inadequate as only 55% of the furniture conform to conventional standards. Most of the existing furniture have deteriorated and/or do not conform to conventional standard.

Finally, it was realized that road users are generally familiar with the meanings of road furniture. However, the compliance level was discovered to be poor.

5.1 Recommendations

Road furniture are important in guiding traffic and making the roads safer for road users. However, their importance is greatly underestimated as limited attention has been paid to erecting and maintaining them. Road users are not aware of the importance of these furniture and the need for compliance.

Frequent inventory which will take into cognizance the conditions and adequacy of the road furniture should be carried out inorder to enable relevant agencies fill in the gaps in their functionality. This will require funds to be set aside for the maintenance and construction of new ones as the need arise. To improve compliance, relevant authorities must ensure that they are consistently erected. There is also need for adequate sensitization of road users on the importance and danger of neglecting these furniture. Strict penalties should also be place to punish violators.

The study identified 204 randomly distributed points that necessitate road furniture but have not been provided. No location was identified to be deficient of traffic signals or roundabouts but speed humps were noticed to be lacking at 18 randomly distributed points and road signs at 186 randomly distributed points. The road signs include 155 warning sign and 31 informative signs. These proposed furniture and location are attached as appendix B.

5.3 Contribution to Knowledge

The following are the contributions of this research to knowledge;

1. The study disclosed that 126 road furniture have been provided along the major highways in Minna with 204 points deficient of relevant furniture. 92 furniture were identified along Chanchaga – Mobil – Tudun Fulani Road, 52 along the western by pass and 7 along Kpakungu – Gidan Kwano road making Chanchaga – Mobil – Tudun Fulani Road the most furnished road. These furniture are randomly distributed having obtained a nearest neighborhood ratio of 1.2. This has helped to identify the gaps in general safety of the roads and providing an input to the government particularly the Federal Road Safety Commission, in evolving policies aimed at reducing or possibly eliminating accidents on the roads.
2. It was identified that only 55% of the road furniture along the major roads within Minna metropolis conform to the conventional standards. This has provided an insight on the functionality of the existing furniture.
3. The study disclosed that road users generally have a good understanding of the meanings of these road furniture having obtained an average percentage of 56.1% for familiarity level from the study. However, the average compliance level was obtained as 28.4% which is poor. Therefore, there is need to adequately sensitize road users of the importance of complying with the road furniture.

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APPENDIX A

QUESTIONNAIRE

QUESTIONNAIRE FOR RESPONDENTS

DEPARTMENT OF CIVIL ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

Dear Respondent,

I am a Master of Engineering (M. Eng.) student of the Department of Civil Engineering, Federal University of Technology, Minna carrying out a research on the assessment of road furniture along the major roads in Minna, Niger State.

The road furniture under consideration are road signs, traffic signals, roundabouts and speed bumps.

I therefore solicit for your cooperation to respond to the following questions by ticking at the appropriate box and where necessary, you filling the blank spaces. All information given will be treated as confidentially as the research is only for academic purpose.

The roads under consideration are Chanchaga – Mobil – Tudun Fulani, Western By Pass and Kpakungu – Gidankwano Roads

Thank you.

Azih Mercy Akare

SECTION A – GENERAL INFORMATION

Location of Respondent

Type of respondent

Road users [ ] Road worker [ ] Traffic law enforcement agent [ ]

SECTION B: BIO DATA OF RESPONDENT

INSTRUCTION: Tick appropriately as it applies to you

1	Gender:	Male [ ]		Female [ ]		
2	Age Range	< 20 [ ]	20-24 [ ]	25–29 [ ]	30-34 [ ]	35-39[ ]
		40-44 [ ]	45-49 [ ]	50-54 [ ]	55-59[ ]	60 > [ ]
3	Education	Primary [ ]	Secondary[ ]	Tertiary [ ]	Non [ ]	Other [ ]
4	Occupation	Civil servant [ ]	Artisan [ ]	Self employed [ ]	Unemployed [ ]	Other [ ]

5 How often do you ply the major roads

Road	Very Often	Quite Often	Moderately	Rarely	Very Rarely
Chanchaga – Mobil – Tudun Fulani	[ ]	[ ]	[ ]	[ ]	[ ]
Western By Pass	[ ]	[ ]	[ ]	[ ]	[ ]
Kpakungu – Gidankwano	[ ]	[ ]	[ ]	[ ]	[ ]

SECTION C: FAMILIARITY AND COMPLIANCE WITH ROAD SIGNS

FAMILIARITY WITH ROAD SIGNS AND FURNITURE

S/N	FURNITURE	GOOD	FAIR	POOR
1	Traffic signals			
2	Direction signs			
3	Warning signs			
4	Information signs			
5	Regulatory Signs			
6	Speed Bumps			
7	Roundabout			

SELF COMPLIANCE WITH ROAD SIGNS AND FURNITURE

S/N	FURNITURE	GOOD	FAIR	POOR
1	Traffic signals			
2	Direction signs			
3	Warning signs			
4	Information signs			
5	Regulatory Signs			
6	Speed Bumps			
7	Roundabout			

GENERAL COMPLIANCE WITH ROAD SIGNS AND FURNITURE

S/N	FURNITURE	GOOD	FAIR	POOR
1	Traffic signals			
2	Direction signs			
3	Warning signs			
4	Information signs			
5	Regulatory Signs			
6	Speed Bumps			
7	Roundabout			

APPENDIX B

PROPOSED ROAD FURNITURE IN MINNA METROPOLIS