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Usability of Road Infrastructure for Persons with Mobility Impairment

CHRISTY C. NWACHI[a], CHUKWUEMEKA G. OGBONNA[ab], MUSA A. WUSHISHI[a]

a. Department of urban and regional planning, Federal University of Technology, P.M.B. 1526 Owerri, Nigeria
b. SHELL Centre for Environmental Management and Control, University of Nigeria, Enugu Campus, 410001, Nigeria

ABSTRACT: Globally, there have been sustained efforts at addressing inclusion by providing access to safe, accessible, reliable, and affordable transport systems for all, including persons with mobility impairment. Individuals or groups such as children, the elderly, and people with disabilities, whose capacities to travel are restricted by some permanent or temporary frailties have been generally referred to as Persons With Mobility Impairment (PWMI). While many city dwellers take mobility for granted, it is not the case for PWMI as their travel experiences are marked by exclusion and frustrations due to inherent barriers in transport infrastructure and services. This study examined usability of road infrastructure for persons with mobility impairment. The study was centred on six randomly selected cities in Nigeria. Survey research design was employed by which primary data were collected through geometric measurement, observation, and the use of structured questionnaire. We adopted the Safety, Accessibility, Reliability and Affordability (SARA) analytical framework for data analysis. Statistical analyses of data were done using descriptive statistics, Analysis of Variants (ANOVA), and the Kruskal-Wallis H test. The study found insignificant numbers, and (in some cases), complete non-existence of pedestrian infrastructure and universal design facilities on major roads in the investigated cities. Most of the roads examined have facilities in less than 20% of the required locations. There was no statistically significant difference between the mean number of facilities across the selected roads and across the six cities studied. More than 90% of respondents rated each of the usability indices (safety, accessibility, reliability, and affordability) low. Generally, roads in Nigerian cities are characterised by structural barriers which impede safety and accessibility for people with mobility impairment thereby making them experience unreliable and less-affordable journeys, reflecting the low usability of road infrastructure across the cities.

KEYWORDS: Mobility impairment; Nigeria; People with disabilities; Road infrastructure; Usability

1. BACKGROUND

In recent years, accessibility of transport infrastructure has been considered a serious challenge faced by Persons with Mobility Impairment (PWMI). Despite efforts at sustainability and inclusivity, the urban built environment, and road infrastructure in particular have continued to impose barriers to children, the elderly, and people with disabilities, limiting their opportunities for mobility and social interactions (Stafford & Baldwin, 2018; Fasina *et al.*, 2020; Ross *et al.,* 2020). Persons with mobility impairment refer to individuals whose abilities to travel are restricted due to some permanent or temporary disabilities which may be physical, sensory or cognitive (European Conference of Ministers of Transport [ECMT], 2000). It includes persons who by reason of age, disease, accident or congenital condition find it difficult to move around. This includes children, aged persons, the sick, pregnant women, and persons living with disabilities including wheelchair users, people with vision impairment, people with hearing impairment, and other neuro-diverse people (Department for transport, 2021). Older people may have impairments which create limitations with reaching, stretching and dexterity. These are frequently the result of arthritis which may cause them some pain and difficulty in movement, or of muscular dystrophy, or of some distress of the nervous system ((Fasina *et al.*, 2020). In reality, virtually everybody experiences some degree of mobility impairment at one time or another (Stafford & Baldwin, 2018). Studies have shown that 20 to 30 percent of people travelling at any particular time have one type of mobility impairment or the other (ECMT, 2000). The Global Burden of Disease estimates a figure of 975 million (19.4%) persons who live with disability of which 785 million (15.6%) persons are 15 or more years old and 95 million (5.1%) are children (0-14 years) (World Health Organization [WHO], 2011). The WHO demographic and health survey reveals that in the year 2018, 29 million Nigerians (14.5 % of the total population) were people living with disabilities; 7 percent of household members above the age of five, as well as 9 percent of those 60 years or older have some degree of disability in at least one functional domain: seeing, hearing, communication, cognition, walking, or self-care (World Bank, 2020). It is the social responsibility of city authorities to ensure inclusiveness, eliminating barriers to mobility on road infrastructure and the built environment for this segment of the society.

Road infrastructure is critical to the social wellbeing of city dwellers as it is the primary means by which essential services such as healthcare, education, shopping, work, and recreation are accessed. Cities deficient of a universally accessible transport system naturally marginalise persons with mobility impairment, thereby breaching their fundamental human right to free movement (Agarwal and Steele, 2016). Andrews *et al.* (2018) observed that, while many people take mobility for granted, it is not the case for PWMI whose travel experiences are marked by exclusion and frustrations due to the inherent barriers in transport infrastructure. The characteristics and quality of people's built environment influence their travel decisions (Farinloye *et al.*, 2019). For this reason, there have been global concerted efforts at providing equitable access to transportation for all through inclusive planning for infrastructure and public space. This global initiative is encapsulated in the Agenda 2030 for inclusion of people with disabilities as contained in the Sustainable Development Goals (SGDs). Specifically, the SDGs Goal (11.2) commits by

2030, to providing access to safe, affordable, accessible and sustainable transport systems for all, improving road safety by expanding public transport, with special attention to the needs of those in vulnerable situations, including women, children, persons with disabilities and older persons (United Nations [UN], 2018). Nigeria ratified the United Nations convention on the rights of persons with disabilities and its optional protocol in March 30, 2007 and September 24, 2010 respectively. In a bid towards implementing these conventions and to actualizing the SDGs, the Nigerian government passed the 'discrimination against persons with disability' (prohibition) Act 2018, laws of the Federal Republic of Nigeria. The law in part II section 5, provides that road sidewalk, pedestrian crossings and all other special facilities shall be made accessible to and usable by persons with disabilities including those on wheelchair and the visually impaired. Part III section 10 provides that government transport services providers shall make provisions for lifts, ramps, and other accessibility aids to enhance the accessibility of their vehicles, parks and bus stops to persons with disability including those on wheelchair (Federal Government of Nigeria [FGN], 2019). Despite these and many other provisions of the law, the reality on ground suggests little effort at achieving inclusiveness in the provision of road infrastructure.

Inclusiveness in transport infrastructure has been relatively achieved in developed countries through the principle of universal design – a process which ensures that systems are usable by people of all ages and ability without the need for special adaptation or assistance (Mace, Hardie & Place, 2008). The application of universal design in road construction enhances access and creates an enabling environment for all road users, including persons with mobility impairment due to age, medical conditions, and latent diseases; unescorted children; pregnant women; victims of accident; and persons with temporary ailments (Agarwal & Chakravarti, 2014). Studies (Disabilities Opportunities Internetworking and Technology [DOIT], 2022; Department for Transport, 2021; Mace, et al., 2008) have identified components of universal design for road infrastructure to include the following.

- Pedestrian infrastructure: walkways, footpaths, ramps, tactile paved surfaces
- Crossing infrastructure: zebra crossing, signal-controlled crossings, footbridge, refuge, dropped kerbs,
- Traffic calming infrastructure: road-bumps, chicanes, bollards, road-markings
- Pedestrian protection infrastructure: guardrails, hedges, road-kerbs
- Bus-stop facilities: stop-flags, shelter, waiting seats, boarding platform, toilets and conveniences
- Street furniture: street light, waste bin, roadside trees,
- Signage: traffic signs, direction signage, facility/hazard information signage

Virtually every journey begins and ends by walking or wheeling, and a significant proportion of PWMI perform their journeys by walking or wheeling (Mogaji, Adekunle, & Nguyen, 2021. Irrespective of the level of accessibility provided by a transport infrastructure, if the environment for walking contains barriers to mobility, then the usability of such facility will be diminished (Agarwal & Steele, 2016). There are sufficient reasons to believe that the travel conditions of unescorted children, the elderly, and persons living with disabilities on Nigerian roads are characterised by lots of constraints (World Bank, 2020). Some researchers believe that conditions creating significant mobility exclusion and hardship to PWD in Nigeria have to do with the quality (and the lack thereof) of pedestrian infrastructure and facilities (Mogaji, Bosah, & Nguyen, 2022; Igomy, 2021; Jirgba, Adeleke, & Adeke, 2020). Scholars have also outlined the accessibility challenges experienced by people with disabilities on Nigerian roads to include lack of walkways, ramps, crossing infrastructure; crowded pavements in the vicinity of bus stops and loading bays; non-existent or inefficient signalled crossings at road junctions; and total disregard for PWMI (especially those with hearing and visual impairment) by other road users (Mogaji & Nguyen, 2021; Igomy, 2021). Despite Nigeria having the largest share of people with disabilities in Africa (World Bank, 2020), and the numerous challenges and barriers they face on the roads, only a few studies have investigated the usability of road infrastructure for people living with disabilities (Mogaji & Nguyen, 2021). Yet, none has examined usability of road infrastructure relative to the three major classes of persons with mobility impairment (unescorted children, the aged, and PWD) – a research gap the present study seeks to fill. Examining the compliance of transport infrastructure with the principles of universal design and determining the extent to which the roads constitute barriers to the mobility of PWMI is necessary to help town planners, transport engineers and policy makers understand where and how to channel investment in road construction to achieve inclusiveness (Kett, Cole, & Turner, 2020).

Scholars have identified Safety, Accessibility, Reliability and Affordability (SARA) as primary indicators of universality and inclusivity of transport infrastructure (Agarwal & Chakravarti, 2014; Venter *et al.,* 2004) (fig.1). In using transport infrastructure, safety is the most fundamental concern for all categories of people regardless of gender, age, sex, or disability status (Agarwal & Chakravarti, 2014). Unsafe conditions deter users with mobility impairment and contribute to further injury and disability. Some transport infrastructure that enhance safety of PWMI include: tactile paving surfaces, zebra crossing, signalled control crossing, traffic calming infrastructure, street light, guardrails, and hazard information systems. Accessibility implies conditions that support persons of diverse abilities to enter and use all parts of a transport infrastructure system at all times (Agarwal & Chakravarti, 2014). It includes a consideration of environmental and usage features (like weather, lighting, transit times, etc.) and access features (like walkways, footpaths, ramps, footbridge, refuge, dropped kerbs, etc.) which enable travel at every time of the day and season (Agarwal & Steele, 2016). Reliability relates to the consistency of all the elements of a transport system in guaranteeing mobility convenience in terms of ease of movement, timeliness, comfort (like bus-stops with shelter, waiting seats, boarding platforms, rest-rooms), and connectivity of modes. Affordability refers to the ability of all users to pay for and make use of the transport facility or the provision of travel grants for PWD (Agarwal & Steele, 2016). Persons with disabilities often belong to the low income group especially in developing countries. Unfortunately, they also face conditions that warrant extra travel expenses when they have to carry mobility aids (such as folded wheelchair) or accompanied by a helper. Universal design for transport infrastructure incorporates these four elements (SARA) to achieve inclusive mobility (Venter *et al.,* 2004). This study therefore adopts SARA as analytical framework to assess the usability of road infrastructure for persons with mobility impairment.

The objectives of the study are: to examine the condition of roads in selected Nigerian cities relative to having the universal design facilities; and to determine usability based on the perceptions of persons with mobility impairment on the safety, accessibility, reliability and affordability of road transport system in Nigeria. The study hopefully provides empirical basis for transport planners and policy makers to mainstream inclusivity in urban mobility by adopting the concept of universal design for retrofitting existing roads and for future investments in transport infrastructure.

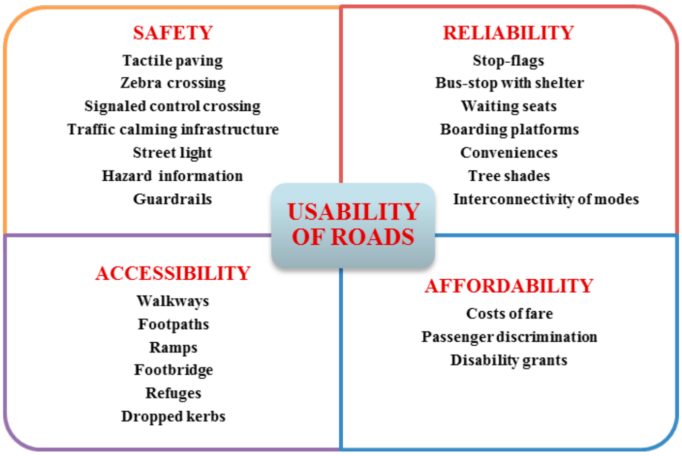

Fig.1. Safety, Accessibility, Reliability and Affordability (SARA), adopted from Venter *et al.* (2004).

2. MATERIALS AND METHODS

2.1 The study area

The study was centred on six randomly selected cities in Nigeria. Nigeria lies between Longitudes 3° and 14° north, and latitudes 4° and 14° east, in the West African region. It has a total landmass of 923,768 square kilometres stretching from the southern coast of the Atlantic Ocean to the northern Sahel border with Niger Republic and Chad (fig. 2). Nigeria is composed of thirty-six States and the Federal Capital Territory (Abuja), which is regionally divided into six geo-political zones: the north-west, north-east, north-central, south-west, south-east, and south-south regions. The road network system in Nigeria is managed by the three-tiers of government: the federal roads (which are inter-state roads), the State roads, and the local roads. With the exception of Abuja and Lagos which have comparatively better road infrastructure, the rest of the cities and towns in Nigeria are characterized by substandard roads and obsolete transport infrastructure in general (Mogaji *et al.,* 2021). Contextualising the study in Nigeria is significant for two reasons. Firstly, Nigeria has the largest share of people with disabilities in Africa, which was 29 million in the year 2018 (World Bank, 2020); and secondly, with over 200,000 km of road network, the country has the largest but one of the worst road infrastructure (Mogaji, Adekunle, & Nguyen, 2021), technological deficiencies (Abdulquadri *et al.,* 2021) and socio-economic conditions (Soetan *et al.,* 2021) in Africa.

The six cities where the study was centred are: Kaduna (latitudes 10° 25′ and 10° 36′ N, longitudes 7° 23′ and 7° 29′ E) from the north-west region; Makurdi (latitudes 7° 35′ and 7° 53′ N, longitudes 8° 24′ and 8° 42′ E) from the north-central; Yola (latitudes 9° 10′ and 9° 15′ N, longitudes 12° 11′ and 12° 27′ E) from the north-east; Ibadan (latitudes 7° 9′ and 7° 29′ N, longitudes 3° 47′ and 3° 59′ E) from the south-west; Aba (latitudes 5° 04′ and 5° 10′ N, longitudes 7° 20′ and 7° 30′ E) from the south-east, and Uyo (latitudes 4° 59′ and 5° 03′ N, longitudes 7° 53′ and 7° 57′ E) from the south-south region (fig. 2). The total areas of the cities/their respective unemployment rates in 2022 are as follows: Kaduna (153 km^2/44.3 %), Makurdi (216 km^2/12.0 %), Yola (352 km^2/44.2 %), Ibadan (466 km^2/18.0 %), Aba (91 km^2/50.1 %), and Uyo (362 km^2/51.0 %). Data for population, total length of roads, vehicle ownership, and number of primary/secondary schools were collected at regional (State) level for the fact that specific figures at city level are not available. Kaduna State has the largest population with 6,066,562 based on 2023 projected figures (NBS, 2021); followed by Oyo State – Ibadan (5,591,589); Benue State – Makurdi (4,219,244); Akwa-ibom State – Uyo (3,920,208); Adamawa State – Yola (3,168,101); and Abia State – Aba (2,883,999). The total length of statewide roads/vehicle ownership rate (vehicle/per person) are: Kaduna (1,818 km/0.14), Benue (1,632 km/0.08), Adamawa (1,364 km/0.09), Oyo (1,156 km/0.20), Abia (638 km/0.18), and Akwa-Ibom (607 km/0.12). The numbers of public primary/secondary schools per state are: Kaduna (4,211/767), Benue (4,486/749), Adamawa (1,890/296), Oyo (2,992/902), Abia (1,605/653), and Akwa-Ibom (1,146/608).

Fig.2. Map of Nigeria showing Sampled cities

Source: Modified from American Historical Association (https://www.historians.org)

2.2 Methodology

Six cities were selected by simple random sampling procedure (using simple ballot method) for the study; one city from each of the six-geopolitical regions of Nigeria. Furthermore, the research team randomly selected from each of the six cities: ten roads (n = 60) for geometric and observational survey; ten households (n = 60) with older citizens (those 80 years and above), and ten primary school pupils (n = 60) from at least 2 schools located along major roads, for questionnaire sampling. The first stage of data collection involved the research team's participation in stakeholders planning consultative workshop on access to transportation for PWD, organised in Abuja by the accessibility department of the National Commission for Person with Disabilities (NCPWD) on the 26th and 27th January 2022. We randomly selected 36 PWD from across the country, stratified according to type of disability (those on wheelchair, those using crutches, visually impaired, and hearing impaired). Then a pretested questionnaire based on eight structured questions was personally sampled on them (Appendix D). The second stage of data collection involved geometric/observational survey on each of the ten selected roads in the six cities across Nigeria. The research team adopted an observational survey protocol previously developed by traffic planning researchers (ECMT, 2000; Iwarsson & Stahl, 2003). Experts in the field of accessibility and usability of transport infrastructure developed a structured study-specific form for capturing the features of a walking environment along busy roads (Appendix A). The third stage involved administering structured questionnaire to 60 elderly persons (10 per city), and 60 primary school children between the ages of 5 and 12 years (10 students per city). Generally, the questionnaires were used to obtain data on the perceptions of these population groups on usability of roads.

Data analysis was carried out based on the SARA analytical framework (Agarwal & Chakravarti, 2014; Venter *et al.*, 2004) to assess the usability of roads for PWMI. Geometric/observational survey and questionnaire results were summarised with descriptive statistics. Analysis of variance (one-way ANOVA) was applied to determine the variation in the Universal Design Features (UDFs) of the selected roads across the six sampled cities. The *Kruskal-Wallis H* test (a rank-based nonparametric test) was applied on the questionnaire data to determine if there were statistically significant differences between the perceptions of the three groups of respondents (PWD, the elderly, and students) on the availability and conditions of the UDFs in the sampled cities. The assumptions that informed our use of the *Kruskal-Wallis H* test are: 1) the dependent variable for the study (scores for UDFs) was measured in ordinal (Likert) scale; 2) the independent variable consists three categorical, separate groups (PWD, the elderly, and students); and 3) the observations were completely independent. Descriptive statistical analysis, *Kruskal-Wallis H* test and ANOVA tests were all done using Statistical Product and Service Solutions (SPSS) for Windows, version 21.0, and Microsoft Excel 2016.

3. RESULTS

3.1 Universal design facilities and condition of roads

Seventeen component facilities of a universal design were examined for the six selected cities: Kaduna, Makurdi, Yola, Ibadan, Aba, and Uyo, and the results are summarized in table 1 (details in appendix A). None of the roads in the cities has tactile paving surfaces. Zebra-crossings were seen on few roads. Uyo has Zebra-crossings just in 10% of the required locations, followed by Makurdi (8%) while Yola has the least (1%). For signalled control crossings (traffic light, or crossings manned by traffic police), Uyo has 23% of the junctions on major roads serviced, followed by Kaduna (20%), while Yola recorded the least (4%). Few roads have traffic-calming facilities (speed bump or bollard) near schools and event centres. Makurdi has 11% of requisite locations for speed bumps covered, while Uyo scored the least with just 1%. The coverage of street-light was examined by the average number of lampstands per km of road space. Kaduna recoded highest with an average of 14 lampstands km^{-1}, followed by Uyo (13 Lampstands km^{-1}), while Yola has the least (5 Lampstands km^{-1}). Guard-rails were virtually absent in almost all the cities except for Uyo where 3% of the requisite road locations has it, mainly on the interchanges and bridges.

Pedestrian walkway is also rare in the study area. Ibadan has 10% of the major roads serviced with walkways, while there is no specific pedestrian walkway in Makurdi, Yola, and Aba. In Ibadan and Uyo, only 3% of appropriate locations has pedestrian bridges while the other cities have lesser proportions. Similarly, 2% of the required locations along major roads has ramps in Kaduna and Ibadan respectively whereas no ramp was seen in the rest of the cities. Concerning road refuge (median), Uyo scored highest with 17% of the metropolitan roads followed by Kaduna (16%) while Yola scored the least with 7%. Bus-stop was assessed on the basis of number of bus-stops with shelter per km of road space. Most of the roads in the sampled cities do not have designated bus-stops with shelter. The highest figure was recorded in Ibadan which has 4 bus-stops with shelter per 10 km, Makurdi has 1 bus-stop per 10 km, while Aba has zero bus-stop with shelter. Similar results were observed for waiting-seats in bus-stop. None of the roads surveyed across the six cities has toilet facilities in either bus-stop or separate location. Most of the roads have little or no landscaping. Best case scenario was noted in Kaduna with an average of 3 stands of shade-providing trees per km road space, while roads in the other cities have an average of less than 1 tree km^{-1}. Interconnectivity in this study is a measure of the average number of other transport modes (rail, footpath, bicycle lane, water transport) connected to the surveyed road per km road space. Interconnectivity was almost non-existence as Kaduna has an average of one interconnectivity per 50 km of road, Ibadan and Uyo (1 per 100 km) respectively, while the other cities have zero interconnectivity.

Analysis of variance (one-way ANOVA) was applied to the data to determine if there were significant variations in the universal design features of the selected roads across the six sampled cities (Appendix B). For Kaduna roads, the homogeneity of variance was tested and found tenable under

		Average number of facility km–1 of road																
City		**Tactile paving**	**Zebra crossing**	**Signalled control**	**Speed bump**	**Street Light**	**Guard-rails**	**Walkway**	**Footbridge**	**Ramps**	**Refuge**	**Dropped kerb**	**Roofed Bus stops**	**Stop flag**	**Waiting seats**	**Toilet**	**Street trees**	**Inter-connectivity**
KADUNA	Mean	0	0.07	0.2	0.04	14	0	0.05	0.02	0.02	0.16	6	0.3	0	0.1	0	3	0.02
	%	0	7	20	4	-	0	5	2	2	16	-	-	0	-	0	-	-
MAKURDI	Mean	0	0.08	0.08	0.03	9	0	0	0.01	0	0.09	3	0.1	0	0.2	0	1	0
	%	0	8	8	3	-	0	0	1	0	9	-	-	0	-	0	-	-
YOLA	Mean	0	0.01	0.04	0.06	5	0	0.03	0	0	0.07	5	0.1	0	0.4	0	0	0
	%	0	1	4	6	-	0	3	0	0	7	-	-	0	-	0	-	-
IBADAN	Mean	0	0.04	1.0	1.1	8	0	0.1	0.03	0.02	0.12	6	0.4	0	0.2	0	0.4	0.01
	%	0	4	10	11	-	0	10	3	2	12	-	-	0	-	0	-	-
ABA	Mean	0	0.02	0.18	0.07	7	0	0	0.01	0	0.1	5	0	0	0	0	1	0
	%	0	2	18	7	-	0	0	1	0	10	-	-	0	-	0	-	-
UYO	Mean	0	0.1	0.23	0.01	13	0.03	0.05	0.03	0	0.17	12	0.2	0	0.03	0	0.6	0.01
	%	0	10	23	1	-	3	5	3	0	17	-	-	0	-	0	-	-

Table1. Universal design component of roads

(0.05) confidence level using Levene's Test ($P = 0.924$). There was no statistically significant difference between the mean number of universal design facilities of the 10 selected roads in the city ($F = 0.121$, $P = 0.999$). Similar results were obtained for Makurdi: where homogeneity of variance test was also tenable ($P = 0.796$), and there was no significant difference between the mean number of UDFs of the 10 selected roads ($F = 0.180$, $P = 0.996$). Levene's Test of homogeneity of variance for roads in Yola was equally not significant ($P = 0.102$), and there was no significant difference between the mean number of UDFs of the 10 selected roads ($F = 0.745$, $P = 0.667$). For Ibadan, the homogeneity of variance test was not significant ($P = 0.067$), and there was also no significant difference between the mean number of facilities of the 10 selected roads ($F = 0.440$, $P = 0.991$). Results for Aba proved equality of variance assumption ($P = 0.147$), and no significant difference between the mean number of UDFs for the 10 selected roads ($F = 0.493$, $P = 0.878$). Similar result was obtained for Uyo, with equality of variance assumption proven ($P = 0.101$), and no significant difference between the mean number of UDFs for the roads ($F = 0.349$, $P = 0.957$). Analysis of variance was also applied to the data across the six selected cities. The Levene's homogeneity of variance test was tenable ($P = 0.235$), and there was no statistically significant difference between the mean number of UDFs for the roads across the six selected cities ($F = 0.301$, $P = 0.911$).

3.2 Usability of roads for people with mobility impairment using SARA analytical framework

Questionnaires were personally sampled on 156 randomly selected persons with mobility impairment (36 PWD, 60 elderly persons, and 60 school children). The personal data of the respondents (fig. 2) show that more males (71%) participated in the survey than females (29%). Male dominance in this study was primarily driven by the 3 northern cities (Kaduna, Makurdi, and Yola) with an average of 89% male against 11% female participants in the survey compared with the southern cities (Ibadan, Aba, and Uyo) with an average of 51% male against 49% female participants. For PWD who participated in the survey, majority (45%) were young people, and middle aged person (35%). For the elderly respondents, majority (63%) were between the ages of 81– 85 years, followed by those between 86 – 90 years (32%). For students, those between 7 – 8 years comprised 45% of the respondents, those between 9 – 10 years (32%), while those between 5 – 6 years formed 18%. Out of the 36 PWD that participated in the study, 14 use wheelchairs, 10 make use of clutches, 5 are visually impaired, 4 suffer hearing impairment, and the remaining 3 have different sensory impairments.

Code/ No.	Journey Aspects		Responses 5-Point Likert Scale				
			1*	2	3	4	5
Q1	Safety of roads	Frequency (156)	117	34	5	0	0
		% (100)	**75.0**	**21.9**	**3.1**	**0**	**0**
Q2	Accessibility of roads	Frequency (156)	125	28	3	0	0
		% (100)	**80.2**	**17.7**	**2.1**	**0**	**0**
Q3	Reliability of roads	Frequency (154)	130	22	2	0	0
		% (100)	**84.4**	**14.6**	**1.0**	**0**	**0**
Q4	Affordability of travel on city roads	Frequency (152)	84	54	12	2	0
		% (100)	**55.2**	**35.4**	**8.3**	**1.1**	**0**

* Key: 1 = very low rating; 2 = low rating; 3 = uncertain; 4 = high rating; and 5 = very high rating

Table 2. Results from questionnaire sampling.

Respondents assessed the availability and conditions of seven UDFs (tactile paving surfaces, zebra crossing, signalled control crossing, speed bumps, street light, guardrails, and traffic –officers) as a collective measure of safety on the roads (Table 2). Results show that 75% of respondents rated safety on roads very low, while a combined proportion of 97% of respondents rated safety on roads as either low or very low. Accessibility of roads was examined (based on availability of walkways, footpaths, ramps, footbridges, refuges, and dropped kerbs), and was rated very low by 80.2% of respondents, while a combined proportion of 98% of respondents rated accessibility as either low or very low. Reliability of roads was assessed in terms of ease of movement, timeliness of journey along routes, travel convenience, and comfort afforded by infrastructure like bus-stop with shelter, waiting seats, toilets, and boarding platforms. Greater proportion of respondents either rated reliability of roads very low (84.4%) or low (14.6%). Affordability of journey on city roads was assessed in terms of transport fares, effects of discrimination by drivers and other passengers, availability of subsidies or

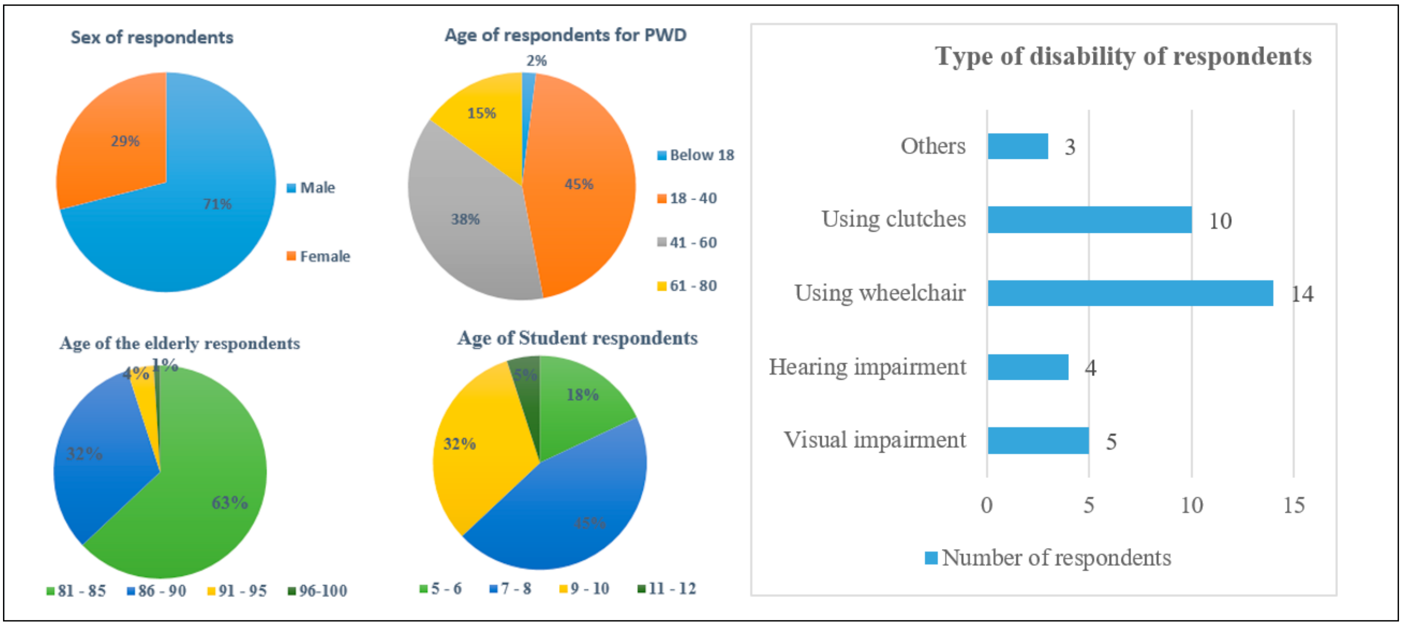

Fig.2. Personal data of respondents.

priority considerations for school children and persons with disabilities, and cost of carrying additional aid (like wheelchair) by PWD. Majority of respondents rated affordability either as very unaffordable (55.2%) or unaffordable (35.4%), giving a combined proportion of more than 90% who were of the opinion that their journeys were generally unaffordable on Nigerian roads.

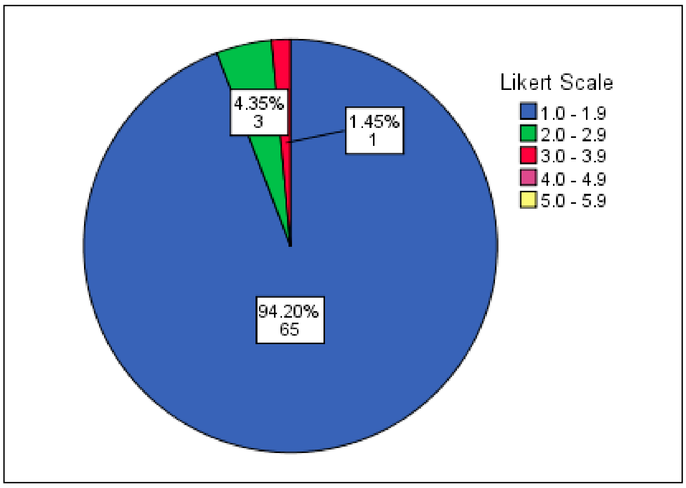

Fig.3. Proportion of mean scores per grade in the 5-point Likert scale.

The study participants rated the availability/conditions of 23 UDFs in their cities, and the mean scores were computed for the three categories of respondents (Table 3). The mean scores for PWD ranged from 1.0 to 2.3 on the 5-point Likert scale, whereas mean scores for the elderly, and student respondents ranged from 1.0 to 3.29, and 1.0 to 2.7 respectively. The proportion of mean scores per grade in the 5-point Likert scale was graphically illustrated (fig.3). It shows that the 'very-low' rating (1.0 – 1.9) recorded 94.2%, the 'low' rating (2.0 – 2.9) recorded 4.3%, and the middle rating – 'uncertain' (3.0 – 3.9) got just 1.5%. The 'high' and the 'very-high' ratings (4.0 – 4.9 and 5.0 – 5.9) got zero responses. We further applied the *Kruskal-Wallis H* test to determine if there were statistically significant differences between the perceptions of the three groups of respondents on the availability and conditions of the UDFs in the sampled cities (Appendix C). The results indicate that there was no statistically significant difference in mean scores between the different groups of respondents ($P = 0.389$), with mean rank scores of 31.52 for PWD, 34.02 for the elderly respondents, and 39.46 for the students.

4.0 DISCUSSION

This study found that road infrastructure in the study area do not guarantee safety and easy accessibility for PWMI, while at the same time creating barriers that make them experience unreliable and unaffordable journeys. There is insignificant number, and (in some cases), complete non-existence of UDFs on major roads in the investigated cities thereby constituting considerable barriers to the mobility of PWMI. Most of the roads examined have facilities in just less than 20% of the required locations suggesting that there were no conscious efforts to include the mobility needs of PWMI in the planning and construction of the roads. The physical limitations of PWMI in combination with the environmental barriers posed by the lack of, or poor condition of the UDFs make the roads unusable thereby creating further isolation and exclusion of this population group. These findings are in line with that of Mogaji, Bosah, and Nguyen (2022) who observed that conditions creating significant mobility exclusions and hardships to people with disability in Nigeria have to do with the quality (and the lack thereof) of pedestrian infrastructure

Universal Design facilities		**Mean score by category of respondents**		
		PWD	The elderly	Students
SAFETY:	Tactile paving surfaces	1.18	1.24	1.37
	Zebra crossing	1.23	1.19	1.24
	Signalled control crossing	1.49	1.50	1.60
	Speed bumps	1.29	1.36	1.40
	Street light	2.30	3.29	2.71
	Guardrails	1.01	1.00	1.02
	Traffic –officers	1.40	1.28	1.33
ACCESSIBILITY	Walkways	1.22	1.19	1.53
	Footpaths	1.01	1.12	1.06
	Ramps	1.00	1.03	1.02
	Footbridges	1.01	1.07	1.11
	Refuges	1.21	1.19	1.30
	Dropped kerbs	1.44	1.35	1.50
RELIABILITY	Timeliness of journey	1.32	1.29	1.30
	Travel convenience	1.15	1.27	1.14
	bus-stop with shelter	1.00	1.01	1.07
	Bus-stops with waiting seats	1.01	1.00	1.02
	Boarding platforms	1.00	1.00	1.02
	Restroom (toilets)	1.00	1.00	1.03
AFFORDABILITY	Transport fares	1.37	2.11	1.40
	Effects of discrimination by drivers/passengers	1.12	1.09	1.20
	subsidies available	1.19	1.24	1.17
	Cost for additional aid (e.g. wheelchair)	1.02	1.07	1.13

* Figure is gotten by dividing the sum of scores (in the 5-point Likert scale) for all respondents by total number of respondents per category

Table 3. Mean score of respondents on the availability/condition of the Universal Design facilities (Q5).

and facilities. The physical barriers identified include nonexistence or poor design and maintenance of pedestrian and crossing facilities; high kerbs and narrow pavements; lack of bus stop facilities like shelter, waiting seats, and toilets; sloppy or slippery surfaces; poor coverage and condition of streetlights; vehicles with low usability; and discrimination on PWMI by drivers and other road users. Scholars in other regions have found similar barriers on city roads and public spaces against older citizens (Risser, Haindl, & Stahl, 2010), children (Ciesla, 2021), and people with disabilities (Jirgba, Adeleke, & Adeke, 2020).

The study found no statistically significant difference between the mean number of UDFs across the selected roads and across the six cities studied. This means that the identified conditions creating mobility barriers did not happen by chance but are rather common across all roads in cities in this region. It is also to be noted that this study focused mainly on major roads, which were randomly selected. Major roads in Nigeria cities otherwise called trunk A and B roads are either Federal Government roads, or priority roads of the State Government. Generally, trunk A and B roads in Nigeria are better designed, and managed. Since the major roads have been found to be grossly deficient in UDFs in this region, it means that local roads may be worse off and may pose greater barriers to PWMI. Condition of roads and public spaces in Nigeria with respect to low usability and lack of inclusion for PWMI have been blamed on poor implementation of the 'discrimination against persons with disability' (prohibition) Act 2018 (Igomy, 2021). Some provisions of this act were targeted at mainstreaming inclusivity in the design and construction of roads, and the operations of public transport in Nigeria. The act provided that every transport facility (including roads) shall be retrofitted to ensure the removal of barriers for PWD within five years of its commencement. But four years along the line, no single road (whether old or new) has effectively complied with the law as observed by Mogaji, Bosah, and Nguyen (2022).

Using SARA analytical framework, the study found that more than 90% of respondents rated each of the usability indices (safety, accessibility, reliability, and affordability) low. This means that road infrastructure in the study area do not guarantee safety and easy accessibility for PWMI, while at the same time creating barriers that make them experience unreliable and less-affordable journeys. There are sufficient facts to indicate that people with mobility impairment suffer untold frustration on Nigerian roads. This finding is corroborated by Igomy (2021) who observed that, unavailability of ramps for passengers on wheelchair, lack of boarding platforms, poor location of crossing facilities, non-dedicated seats for PWD, insensitivity by passengers, and discrimination by bus drivers combined to make mobility a frustrating experience for people with disabilities on the BRT buses in Lagos. There were no statistically significant differences between the perceptions of the three groups of respondents (PWD, the elderly, and students) in their assessment of how safe, accessible, reliable, and affordable the roads in the cities are. This implies that commuters with diverse mobility impairments in this region share common opinion regarding the low usability of road infrastructure, creating limitations and exclusion for their independent access to employment, shopping, education, social networks, healthcare, and recreational activities. This explains the recent upsurge in advocacy for mobility justice in Nigeria by disability associations, and in other developing countries (Anazonwu *et al.*, 2022; Holstein *et al.*, 2020).

The sex distribution of participants in this survey was highly skewed in favour of the male (71%) against the female (29%) primarily because of cultural factors in northern Nigeria which restrict the female population group from actively participating in social activities. Considering the fact that the female folk are more marginalized and suffer more disabilities in this region (Mandy & Jawad, 2018), there is the possibility that greater proportion of public space users than reported in this study face exclusion. The barriers and exclusions experienced by PWMI in Nigerian cities have been found to be widespread partly because, the existing institutional framework for the protection of the rights of people with disabilities lacks the capacity to enforce the extant disability-rights laws, or to persuade government to retrofit existing infrastructure systems and design new ones towards the elimination of such barriers.

Relating these findings with the conceptual definitions of accessibility, usability, and universal design by Iwarsson and Stahl (2003) suggests that considerations for public space usage in Nigeria in particular, and in the larger African context is currently defined by the 'accessibility' function. In other words, public space usage in this region is less defined by a consideration of the capacity of individuals or groups based on knowledge of how human beings function, but more by the description of barriers in the environment relative to established norms and standards. In both perspectives, human interaction with public space have fallen short of basic accessibility requirements, which according to Iwarsson and Stahl is a more obsolete definition of person-environment relationship since it emphasizes disability and hence, more stigmatizing. Unlike most western countries which have already embraced the concepts of usability and universal designs both of which bear more of democratic values and human right perspectives and tend to lead to the fulfilment of equal opportunities for PWMI, most African countries still struggle with the structural basis having more to do with physical deficiencies in the public space, with less consideration of personal differences and peculiarities of the potential user groups.

5. CONCLUSION

This study examined usability of road infrastructure for persons with mobility impairment, with surveys conducted in six selected Nigerian cities. The authors observed insignificant numbers, and (in some cases), complete non-existence of pedestrian infrastructure and universal design facilities on major roads in the cities thereby constituting considerable barriers to people with mobility impairment. The mobility needs of children, the elderly, and people with disabilities are not put into consideration in the design and construction of transport infrastructure, and the operation of commercial transport systems in Nigeria. Roads in the study area are characterised by structural barriers which impede safety and accessibility for people with mobility impairment, and make them experience unreliable and less-affordable journeys. Residents with diverse mobility impairments express common opinion reflecting the low usability of road infrastructure across cities, creating limitations and exclusion for their independent access to employment, shopping, education, social networks, healthcare, and recreational activities. This paper opens up the need for further study about mobility barriers faced by people with disabilities in their use of both public and private commercial transport vehicles including other modes like rail and air transports.

The findings of this study lead to some critical issues that need to be considered by transport planners and policy makers in this region and other parts of the world in the development of public transport systems. People with mobility impairment need to be involved in the planning and design of transport infrastructure. There is the need for sustained advocacy by the civil society, non-governmental organizations, and associations of PWD towards inclusive and sustainable mobility systems, with greater pressure on city authorities to adopt universal design principles in the development of transport infrastructure and services. Advocacy by disability organizations is vital in putting usability considerations on the social agenda over and above issues of accessibility. It is also very important for policy makers in Nigeria and across the developing world to significantly commit to global agenda of mainstreaming the rights of people with disabilities, to guarantee safe, accessible, reliable, affordable, and sustainable transport systems for all by the year 2030.

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REFERENCES

Abdulquadri, A., Kieu, T. A., and Nguyen, N. P. (2021). Digital transformation in financial services provision: A Nigerian perspective to the adoption of chatbot. *Journal of Enterprising Communities: People and Places in the Global Economy*, 15(2), 258–281. doi.org/10.1108/JEC-06-2020-0126

Agarwal, A. and Chakravarti, D. (2014). Universal accessibility guidelines for pedestrian, non-motorised vehicles and public transport infrastructure. *New Delhi: SSEF*. Retrieved from https://shaktifoundation.in/wp-content/uploads/2014/02/Universal-accessibility-guidelines.pdf

Agarwal, A. and Steele, A. (2016). Disability considerations for infrastructure programmes. *Evidence on Demand – Climate and infrastructure livelihoods*. doi.org/10.12774/eod_hd.march2016.agarwaletal

Anazonwu, N., Okah, P., Chukwu, N., Agha, A., Iwuagwu, A., Onalu, C. *et al.* (2022). Barriers to domestication and implementation of disability Act in Southeast Nigeria. *Journal of Social Work in Developing Societies* Vol.4(1). Pp. 33-50. Retrieved from https://journals.aphriapub.com/index.php/JSWDS/article/view/1532

Andrews, N., Clement, I., and Aldred, R. (2018). Invisible cyclists? Disabled people and cycle planning–a case study of London. *Journal of Transport & Health*, 8, 146–156. doi.org/10.1016/j.jth.2017.11.145

Ciesla, M. (2021). Modern urban transport infrastructure solutions to improve the safety of children as pedestrians and cyclists. *Infrastructures*, 6, 102. doi.org/10.3390/infrastructures6070102

Department for Transport. (2021). Inclusive Mobility: A guide to best practice on access to pedestrian and transport infrastructure. *Department for Transport Great Minister House 33 Horseferry Road London SW1P 4DR.* Retrieved from www.gov.uk/government/organisations/department-for-transport

Disabilities Opportunities Internetworking and Technology [DOIT]. (2022). What is the difference between accessible, usable, and universal design? Retrieved from https://www.washington.edu/doit/

European Conference of Ministers of Transport [ECMT]. (2000). Improving transport for people with mobility handicap – A guide to good practice. *OECD Publications Service, Paris, France.* Retrieved from http://www.oecd.org/cem/

Farinloye, T., Aririguzoh, S., and Kieu, T. A. (2019). Qualitatively exploring the effect of change in the residential environment on travel behaviour. *Travel Behaviour and Society*, 17, 26–35. doi.org/10.1016/j.tbs.2019.06.001

Fasina, S. O., Salisu, U. O, Odufuwa, B. O., and Akanmu, A. A. (2020). Travel behaviour and mobility challenges of disabled elderly in selected cities of Ogun State, Nigeria. *LOGI – Scientific Journal on Transport and Logistics* Vol. 11 (1); pp.25-36. doi.10.2478/logi-2020-0003

Federal Government of Nigeria [FGN]. (2019). Discrimination against persons with disability (prohibition) Act 2018, laws of the Federal Republic of Nigeria. *Nigeria Health Watch.* Retrieved from https://nigeriahealthwatch.com

Holstein, E. V., Wiesel, I, and Legacy, C. (2020). Mobility justice and accessible public transport networks for people with intellectual disability. *Applied mobilities,* Vol. 7(2), pp. 46-162. https://doi.org/10.1080/23800127.2020.1827557

Igomy, T. (2021, September 12). Disabled by fate, denied rights to mobility: Nigerians living with disabilities tell tales of anguish accessing public transportation. *The Punch Newspaper*. Retrieved from https://www.punchng.com

Iwarsson, S. and Stahl, A. (2003). Accessibility, usability and universal design--positioning and definition of concepts describing person-environment relationships. *Disabil. Rehabil.* 2003, *25*, 57–66. doi.org/10.1080/dre.25.2.57.66

Jirgba, K., Adeleke, O. O. and Adeke, P. T. (2020). Evaluation of the accessibility of public transport facilities by physically challenged commuters in Ilorin town, Nigeria. *AZOJETE*,16(4):651-662. Retrieved from www.azojete.com.ng

Kett, M., Cole, E., and Turner, J. (2020). Disability, mobility and transport in low- and middle-income countries: A thematic review. *Sustainability*, *12*, 589; doi.org/10.3390/su12020589

Mace, R. L., Hardie, G. J., and Place, J. P. (2008). Accessible environment: Towards universal design. *The Centre for Universal Design, North Carolina State University, USA.* Retrieved from http://www.ncsu.edu/ncsu/design/cud/about_ud/about_ud.htm

Mandy, J. B. and Jawad, S. (2018). Women's marginalization in Nigeria and the way forward. *Human Resource Development International*, 21(2), pp.1-19. doi.org/10.1080/13678868.2018.1458567

Mogaji, E., Adekunle, I. A., and Nguyen, N. P. (2021). Enhancing transportation service experience in developing countries: A post pandemic perspective. The future of service post-COVID-19 pandemic, vol.1, 177. doi.org/10.1007/978-981-33-4126-5_9

Mogaji, E., and Nguyen, N. P. (2021). Transportation satisfaction of disabled passengers: Evidence from a developing country. Transportation Research Part D. *Transport and Environment*, 98, 102982 doi.org/10.1016/j.trd.2021.102982

Mogaji, E., Bosah, G., and Nguyen, N. P. (2022). Transport and mobility decisions of consumers with disabilities. *Journal of Consumer Behaviour*, 1–17. doi.org/10.1002/cb.2089

Risser, R., Haindl, G., and Stahl, A. (2010). Barriers to senior citizens' outdoor mobility in Europe. *Eur. J. Ageing* 2010, 7, 69–80. doi.org/10.1007/s10433-010-0146-4

Roberts, P. and Babinard, J. (2004). Transport strategy to improve accessibility in developing countries. *Washington, D. C.: World Bank*. Retrieved from https://openknowledge.worldbank.org/handle/10986/17685

Ross, T., Bilas, P., Buliung, R., and El-Geneidy, A. (2020). A scoping review of accessible student transport services for children with disabilities. *Transport Policy*, 95, 57–67. doi.org/10.1016/j.tranpol.2020.06.002

Soetan, T. O., Mogaji, E., and Nguyen, N. P. (2021). Financial services experience and consumption in Nigeria. *Journal of Services Marketing*, 35(7), 947–961. doi.org/10.1108/JSM-07-2020-0280

Stafford, L., and Baldwin, C. (2018). Planning walkable neighbourhoods: Are we overlooking diversity in abilities and ages? *J. Plan. Lit.33*, 17–30. doi.org/10.1177/0885412217704649

Stjernborg, V. (2019). Accessibility for all in public transport and the overlooked (social) dimension—a case study of Stockholm. *Sustainability*, 11, 4902; https://www.doi:10.3390/su11184902

United Nations [UN]. (2018). Transforming our world: The 2030 Agenda for Sustainable Development. *Department of Economic and Social Affairs Sustainable Development.* Retrieved from https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Venter, C., Sentinella, J., Rickert, T., Maunder, D. and Venkatesh, A. (2004). Enhancing the mobility of disabled people: Guidelines for practitioners*. TRL Limited, Berkshire.* Retrieved from https://trl.co.uk/uploads/trl/documents/

World Bank. (2020). Disability inclusion in Nigeria: A rapid assessment. *World Bank, Washington*. Retrieved from https://openknowledge.worldbank.org/handle/10986/34073

World Health Organization [WHO] (2011). *World report on disability. WHO/NMH/VIP/11.01.* Retrieved from http://www.who.int

APPENDIX

Appendix A: Structured study-specific form

CITY - KADUNA		Average number of facility Per Kilometres of road*																
S/N	Road	Tactile paving	Zebra crossing	Signalled control	Speed bump	Street Light	Guard-rails	Walkway	Footbridge	Ramps	Refuge	Dropped kerb	Roofed Bus stops	Stop flag	Waiting seats	Toilet	Street trees	Inter-connectivity
1	Ahmadu Bello way	0	0.3	0.5	0	20	0	0.5	0.1	0	0.5	9	0.1	0	1	0	0	0.1
2	Independence way	0	0.4	0.5	0	18	0	0	0	0	0	7	0	0	0	0	6	0
3	Katsina Road	0	0	0.2	0	6	0	0	0	0	0.3	8	0.1	0	0	0	4	0
4	Ibrahim Taiwo road	0	0	0.5	0	8	0	0	0	0	0.4	8	0.1	0	0	0	8	0
5	Yakubu Gowon way	0	0	0	0	14	0	0	0	0	0.2	6	0	0	0	0	0	0
6	Ilorin road	0	0	0	0	12	0	0	0	0	0	6	0	0	0	0	0	0.1
7	Lagos road	0	0	0.3	0.2	20	0	0	0.1	0	0	5	0	0	0	0	4	0
8	Zaria road	0	0	0	0.1	16	0	0	0	0	0	8	0	0	0	0	0	0
9	Kano road	0	0	0	0.1	12	0	0	0	0	0.2	6	0	0	0	0	0	0
10	Jos road	0	0	0	0	10	0	0	0	0	0	7	0	0	0	0	5	0
	Mean	0	0.07	0.2	0.04	14	0	0.05	0.02	0	0.16	6	0.3	0	0.1	0	3	0.02
	%	0	7	20	4	-	0	5	2	0	16	-	-	0	-	0	-	-
MAKURDI																		
11	Old Otukpo road	0	0.3	0.4	0	10	0	0	0.1	0	0.3	4	0.05	0	1	0	3	0
12	Makurdi-Jos road	0	0	0.2	0.1	12	0	0	0	0	0.2	6	0.05	0	0	0	2	0
13	Senator Akume way	0	0.1	0	0	8	0	0	0	0	0	3	0	0	0	0	1	0
14	Barrack road	0	0.1	0	0	7	0	0	0	0	0	4	0	0	1	0	0	0
15	David Mark bypass	0	0	0	0.2	7	0	0	0	0	0	0	0	0	0	0	1	0
16	Makurdi Gboko road	0	0	0	0	10	0	0	0	0	0	4	0	0	0	0	0	0
17	Makurdi-Adoka road	0	0	0.2	0	8	0	0	0	0	0	5	0	0	0	0	0	0
18	Kashim Abrahim way	0	0.1	0	0	6	0	0	0	0	0.2	0	0	0	0	0	1	0
19	Ahmadu Bello way	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	2	0
20	Abubaka Atiku road	0	0.2	0	0	10	0	0	0	0	0.2	4	0	0	0	0	0	0
	Mean	0	0.08	0.08	0.03	9	0	0	0.01	0	0.09	3	0.01	0	0.2	0	1	0
	%	0	8	8	3	-	0	0	1	0	9	-	-	0	-	0	-	-
YOLA																		
21	Abuja road	0	0	0.2	0.1	0	0	0	0	0	0	3	0	0	0	0	0	0
22	Gombe-Yola road	0	0	0	0	0	0	0.1	0	0	0	6	0.05	0	1	0	0	0
23	Chiroma road	0	0	0	0.1	0	0	0	0	0	0	4	0	0	0	0	0	0
24	Jalingo road	0	0	0	0	8	0	0.1	0	0	0	7	0	0	0	0	0	0
25	Sandra road	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Konguo road	0	0	0.1	0.1	12	0	0.1	0	0	0.5	8	0.05	0	2	0	0	0
27	Numan road	0	0	0	0	9	0	0	0	0	0.2	6	0	0	0	0	0	0
28	Modibbo Adamawa	0	0	0.1	0.2	14	0	0	0	0	0	5	0	0	0	0	0	0
29	Lamido road	0	0.1	0	0	10	0	0	0	0	0	4	1	0	1	0	0	0
30	Shehu road	0	0	0	0.1	0	0	0	0	0	0	5	0	0	0	0	0	0
	Mean	0	0.01	0.04	0.06	5	0	0.03	0	0	0.07	5	0.01	0	0.4	0	0	0
	%	0	1	4	6	-	0	3	0	0	7	-	-	0	-	0	-	-
IBADAN																		
31	Lagos-Ojo road	0	0	0	0.1	0	0	0.2	0.1	0.1	0.4	6	0	0	0	0	0	0
32	Basorun Gate road	0	0.2	0.2	0.2	16	0	0.4	0	0	0	8	0.1	0	2	0	0	0.1
33	Airport road	0	0	0.3	0.1	8	0	0.1	0.1	0	0	5	0	0	0	0	0	0
34	Old-Ife road	0	0.1	0.2	0	12	0	0	0	0	0	8	0	0	0	0	0	0
35	Orita-Aperin-Beere	0	0	0.1	0	10	0	0.2	0	0	0	4	0.1	0	0	0	0	0
36	Ikolaba road	0	0	0	0.1	0	0	0	0	0	0	4	0	0	0	0	4	0
37	Ogbere Idi-Obi road	0	0	0	0.1	0	0	0	0	0	0	6	0	0	0	0	0	0
38	Polo road	0	0	0	0.2	20	0	0.1	0	0	0.5	8	0	0	0	0	0	0
39	Mokola road	0	0.1	0.2	0.1	9	0	0	0.1	0	0.3	6	0.1	0	0	0	0	0
40	Olomi road	0	0	0	0.2	8	0	0	0	0.1	0	5	0	0	0	0	0	0
	Mean	0	0.04	1.0	1.1	8	0	0.1	0.03	0.02	0.12	6	0.04	0	0.2	0	0.4	0.01
	%	0	4	10	11	-	0	10	3	2	12	-	-	0	-	0	-	-
ABA																		
41	Aba-Owerri road	0	0.2	0.5	0	12	0	0	0.1	0	0.3	6	0	0	0	0	4	0
42	Ikot-Ekpene road	0	0	0.3	0.1	0	0	0	0	0	0.2	5	0	0	0	0	4	0
43	Okigwe road	0	0	0.1	0	4	0	0	0	0	0	5	0	0	0	0	0	0
44	Asa road	0	0	0.2	0	6	0	0	0	0	0.1	4	0	0	0	0	0	0

45	Park road	0	0	0.1	0	10	0	0	0	0	0	5	0	0	0	0	0	0
46	New-Umuahia road	0	0	0.1	0.4	8	0	0	0	0	0.1	6	0	0	0	0	5	0
47	Azikiwe road	0	0	0.2	0	18	0	0	0	0	0.4	7	0	0	0	0	1	0
48	Eziukwu road	0	0	0.1	0.1	12	0	0	0	0	0	3	0	0	0	0	0	0
49	Ngwa road	0	0	0.1	0.1	0	0	0	0	0	0	4	0	0	0	0	0	0
50	Faulks road	0	0	0.1	0	2	0	0	0	0	0	5	0	0	0	0	0	0
	Mean	0	0.02	0.18	0.07	7	0	0	0.01	0	0.1	5	0	0	0	0	1	0
	%	0	2	18	7	-	0	0	1	0	10	-	-	0	-	0	-	-
UYO																		
51	Uyo-Ikot Ekpene rd	0	0.2	0.3	0	20	0	0.2	0.1	0	0.2	14	0	0	0	0	8	0.1
52	Aka road	0	0.1	0.3	0	16	0	0	0	0	0.3	11	0	0	0	0	9	0
53	Udo-Umana road	0	0.1	0.2	0	8	0	0	0	0	0	8	0	0	0	0	7	0
54	Ikpa road	0	0.1	0.2	0	12	0.1	0.1	0.1	0	0.2	12	0.1	0	0.2	0	8	0
55	Abak road	0	0.2	0.3	0	14	0	0	0	0	0.2	16	0	0	0	0	5	0
56	Atiku Abubaka way	0	0	0.1	0.1	6	0	0	0	0	0	7	0	0	0	0	0	0
57	Ukana Offot road	0	0	0.2	0	8	0	0	0	0	0	5	0	0	0	0	0	0
58	Nwaniba Road	0	0.1	0.2	0	6	0.1	0	0	0	0.1	14	0	0	0	0	6	0
59	Oron road	0	0.1	0.2	0	8	0.1	0.2	0.1	0	0.3	18	0.1	0	0.1	0	9	0
60	Wellington way	0	0.1	0.3	0	18	0	0	0	0	0.3	12	0	0	0	0	8	0
	Mean	0	0.1	0.23	0.01	13	0.03	0.05	0.03	0	0.17	12	0.02	0	0.03	0	0.6	0.01
	%	0	10	23	1	-	3	5	3	0	17	-	-	0	-	0	-	-

* This value was derived by counting number of facilities and dividing it by the length of the road in kilometres

Appendix B – ANOVA Results

B1- Kaduna

ANOVA

KADUNA Group

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.193	9	1.799	.121	.999
Within Groups	2373.355	160	14.833		
Total	2389.549	169			

B2- Makurdi

ANOVA

MAKURDI Group

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.028	9	1.003	.180	.996
Within Groups	890.441	160	5.565		
Total	899.469	169			

B3 - Yola

ANOVA

YOLA Groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.175	9	3.575	.745	.667
Within Groups	767.434	160	4.796		
Total	799.609	169			

B4 - Ibadan

ANOVA

IBADAN Groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33.159	9	3.684	.440	.911
Within Groups	1338.546	160	8.366		
Total	1371.705	169			

B5 - Aba

ANOVA

ABA Groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28.017	9	3.113	.493	.878
Within Groups	1009.884	160	6.312		
Total	1037.901	169			

B6 - Kaduna

ANOVA
UYO Group

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	58.491	9	6.499	.349	.957
Within Groups	2981.506	160	18.634		
Total	3039.997	169			

B7 – ANOVA for the six cities

ANOVA
ALL SIX CITIES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.800	5	2.360	.301	.911
Within Groups	752.569	96	7.839		
Total	764.368	101			

Appendix C - Kruskal-Wallis H test

Ranks

	Groups	N	Mean Rank
Mean Scores	PWD	23	31.52
	The Elderly	23	34.02
	Students	23	39.46
	Total	69	

Test Statistics a,b

	MeanScores
Chi-Square	1.886
df	2
Asymp. Sig.	.389

a. Kruskal Wallis Test
b. Grouping Variable: Groups

Appendix D – Questionnaire

Usability of road infrastructure for people with mobility impairment

We, researchers from the School of Environmental Sciences, Federal University of Technology Owerri, Imo State, are conducting a study on the above subject, with the goal of providing empirical basis for policy makers to mainstream inclusivity in transport infrastructure provision**.** We humbly solicit your participation in this survey. We assure you that all information will be kept strictly confidential and will only be used for the advancement of knowledge on this topic. Thank You.

Kindly use your personal experience moving around your town to rate the following aspects of your journey using a 5-Point Likert Scale, with 1 corresponding to very low rating; 2 = low rating; 3 = uncertain, 4 = high rating, and 5 = very high rating. Please Tick the appropriate box.						
Code	**Journey Aspects**	**5-Point Likert Scale**				
		1	**2**	**3**	**4**	**5**
Q1	Please rate **how SAFE** your city roads are (generally), in terms of having infrastructure that enhance safety of children, elderly persons, and people with disabilities such as: tactile paving surfaces, zebra crossing, signalled control crossing, speed bumps, street light, guardrails, traffic –officers, etc., and considering how safe you feel each time you cross the roads.					
Q2	Similarly, rate **how ACCESSIBLE** your city roads are (generally), in terms of having infrastructure that promote accessibility for children, elderly persons, and people with disabilities such as: walkways, footpaths, ramps, footbridges, refuges, dropped kerbs, etc., and in terms of how easy it is for you to move around.					
Q3	Please rate **how RELIABLE** your city roads are (generally), in terms of ease of movement, timeliness, travel convenience, and comfort afforded by infrastructure like bus-stop with roof-shade, waiting seats, boarding platforms, and rest-rooms, and availability of traffic officers to guide road users.					
Q4	Please rate the **AFFORDABILITY** of your travel on city roads in terms of transport fares, effects of discrimination by drivers other passengers, subsidies available to school children, and persons with disabilities, etc.					
Q5	Kindly rate the availability/condition of the following:					
	SAFETY: Tactile paving surfaces Zebra crossing Signalled control crossing Speed bumps					

	Street light Guardrails Traffic –officers					
	ACCESSIBILITY Walkways Footpaths Ramps Footbridges Refuges Dropped kerbs					
	RELIABILITY Timeliness of journey travel convenience bus-stop with shelter Bus-stops with waiting seats Boarding platforms Restroom (toilets)					
	AFFORDABILITY Transport fares Effects of discrimination by drivers/passengers subsidies available Cost for additional aid (e.g. wheelchair)					
	RESPONDENT'S DETAILS					
Q6	What is your sex? A. Male B. Female					
Q7	What is your age grade? A. below 18; B. 18 – 40; C. 41 – 60; D. 61 – 80;					
7B.	**For those above 80 years**. What is your age? A. 81 – 85; B. 86 – 90; C. 91 – 95; D. 96 – 100					
7C.	**For Students.** What is your age? A. 5 – 6; B. 7 – 8; C. 9 – 10; D. 11 – 12					
Q8.	What type of disability do you have? Visual impairment (blind or partially blind) Hearing impairment (deaf and/or dumb) Using Wheelchair Using clutches Others					

Appendix E – Openstreetmaps of the 6 studied cities

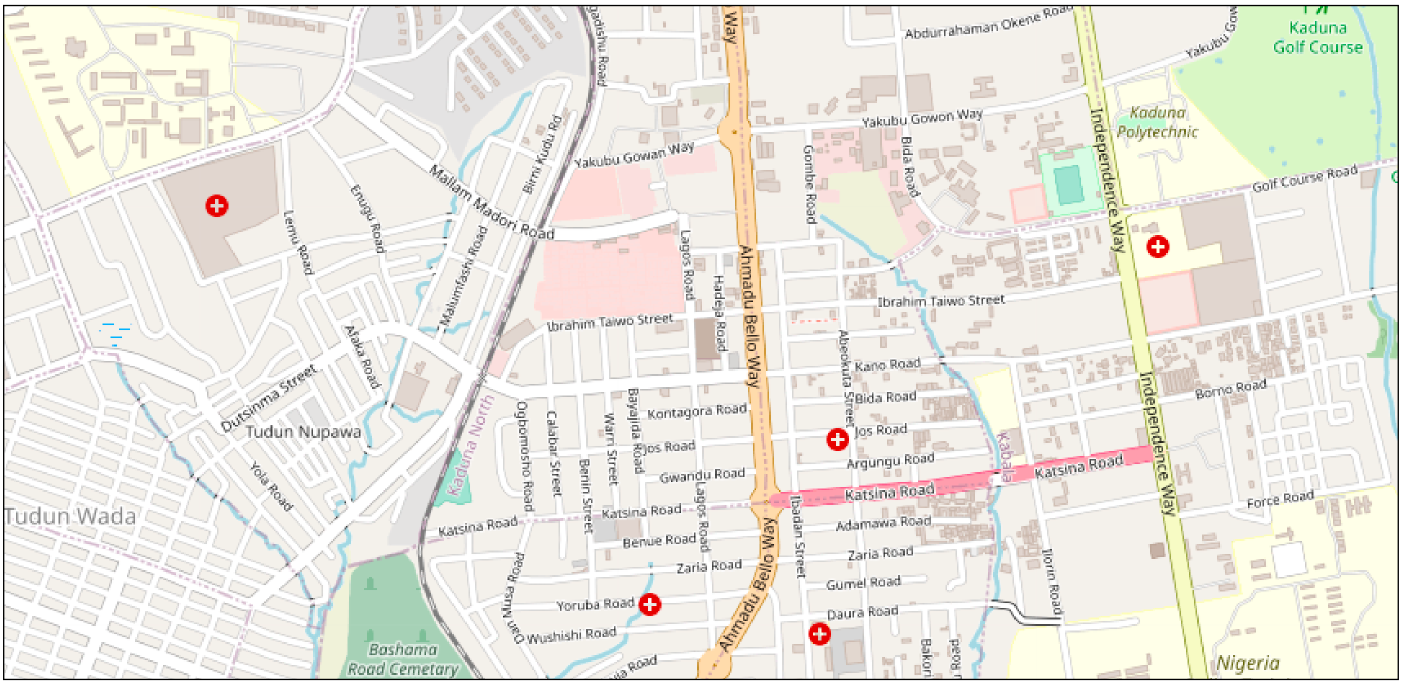

Fig.4. Openstreetmap of Kaduna.

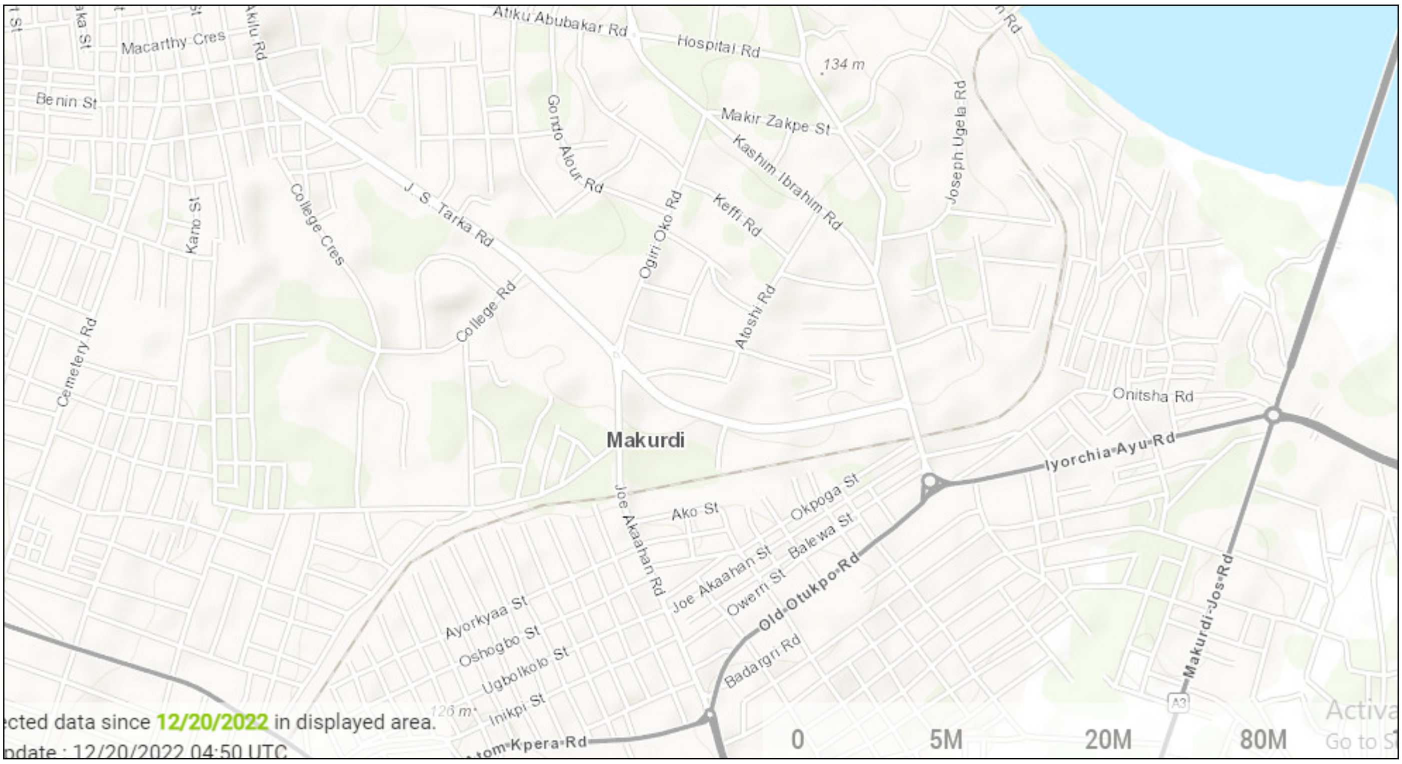

Fig.5. Openstreetmap of Makurdi.

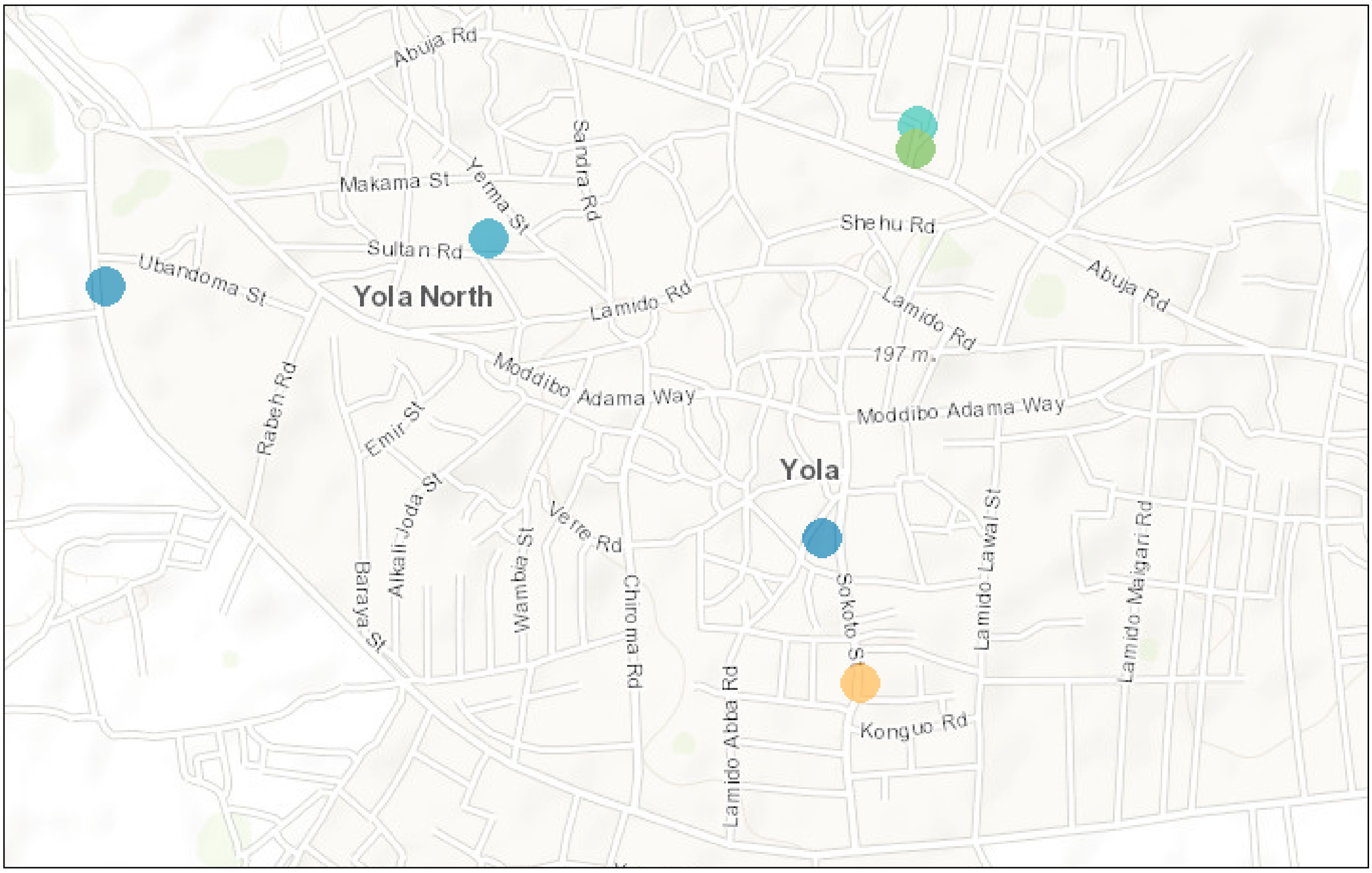

Fig.6. Openstreetmap of Yola.

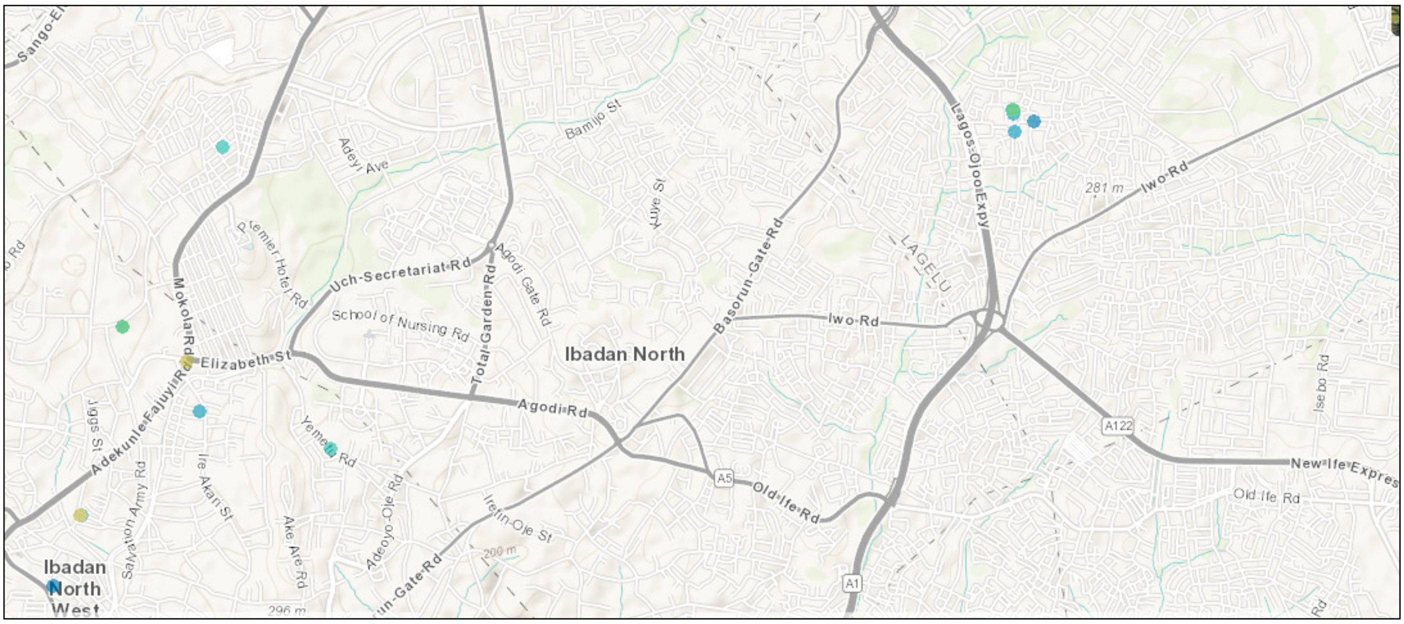

Fig.7. Openstreetmap of Ibadan.

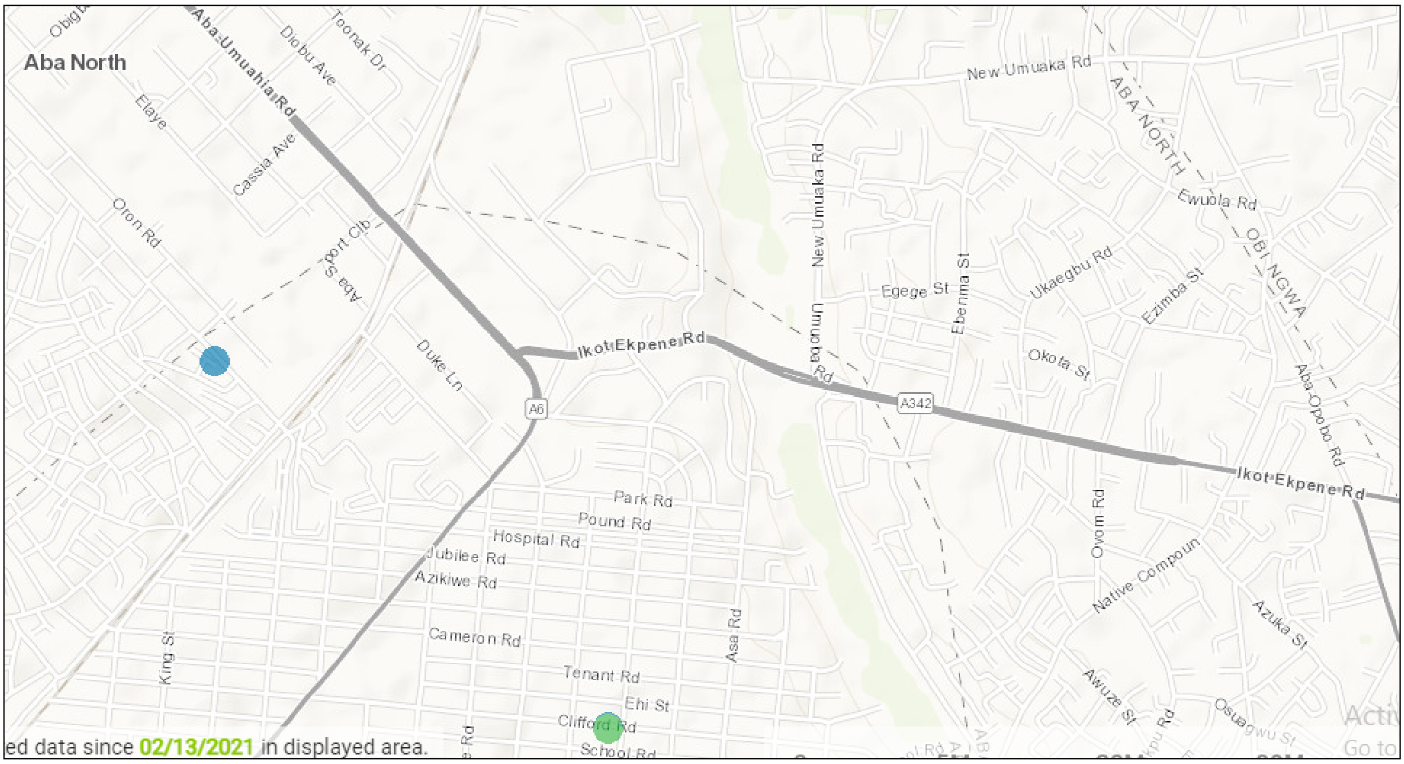

Fig.8. Openstreetmap of Aba.

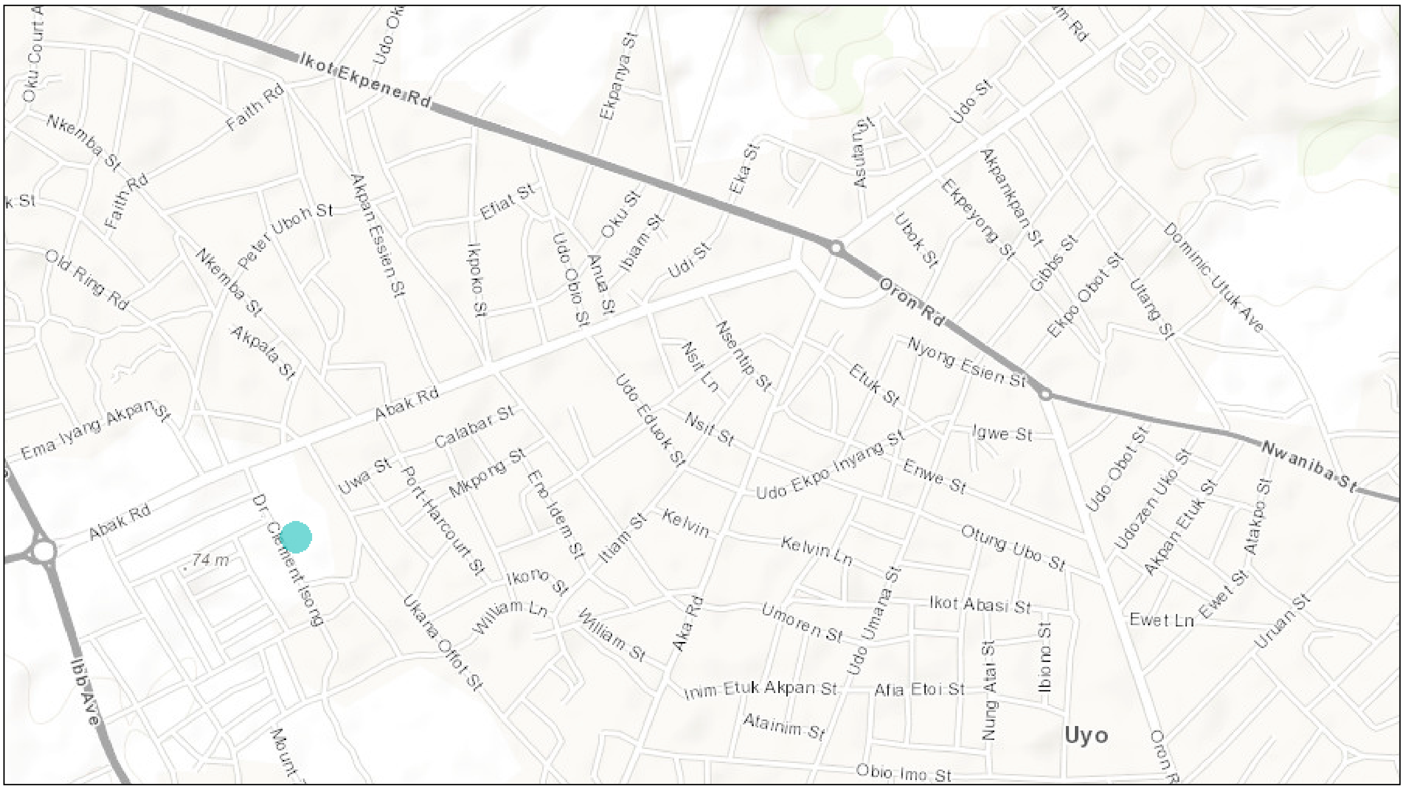

Fig.9. Openstreetmap of Uyo.