KADUNA JOURNAL OF GEOGRAPHY
2025, VOL. 7, No. 1, 127-133
https://doi.org/10.47514/kjg.2025.07.01.014

SPECIAL ISSUE: CELEBRATING 20 YEARS OF GEOGRAPHY IN KADUNA STATE UNIVERSITY - ADVANCES AND FRONTIERS IN GEOGRAPHY

Assessing Environmental Sustainability of the Built Environment in Kano Metropolis, Nigeria

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ABSTRACT

Kano Metropolis is undergoing rapid urbanization, resulting in a high urban growth rate that is a major challenge for urban environmental sustainability. This study evaluates the environmental sustainability of the built environment in Kano Metropolis, Nigeria, with a view to providing solutions to the increasing pressures from population expansion, infrastructural strain, and environmental degradation. Using a descriptive research design, a five-point Likert-scale questionnaire was administered for data collection by employing the Delphi technique; 23 experts across multiple environment-related disciplines were selected purposively for the study. The key indicators of the built environment include housing, infrastructure, and aesthetics. The responses were subjected to descriptive statistical analysis in the SPSS environment using mean values, standard deviation, and percentage, as well as consensus level, to determine the availability and quality of these indicators. Results show that Housing, Infrastructures, and Aesthetics have considerably low means and SD that range from 1.91 to 2.70 and 0.90 to 1.36, 2.13 to 2.74 and 0.76 to 1.36, 2.04 to 2.48 and 0.93 to 1.30, respectively. Housing was found to be poorly designed, unaffordable, and lacked basic amenities. Infrastructure such as road networks, drainage, and waste management systems was inadequate, while Aesthetic components, including green spaces, recreational areas, and structure spacing, were notably deficient. These deficiencies reflect broader issues of weak urban planning, over-exploitation of natural resources, and ineffective environmental governance. Hence, there is a need to adopt sustainable construction practices using local and agro-based materials, policy-driven urban densification, and the protection of green and open spaces.

ARTICLE HISTORY
Submitted 24 October 2025
Accepted 20 December 2025
Published 22 December 2025

GUEST EDITOR
A. M. Ahmed

KEYWORDS
Environmental quality; Urban sustainability; Built environment; Delphi technique; Kano Metropolis

1 Introduction

Environmental sustainability is a serious concern in recent times due to the realization of the profound consequences of human activities on the present and future health and well-being of the planet. Its main concern is to ensure basic living standards, foster economic growth, preserve environmental health, and effectively manage social and ecological systems (Halla & Binder, 2020). It is a fundamental principle within the broader concept of sustainability and asserts that meeting the needs of the present does not endanger environmental quality and preserves the ecosystem for future benefits (Kaswan et al., 2019). Although there are lots of disagreements regarding the most suitable and efficient approaches for the realization of these goals (SDG) (Fisher al., 2021).

Rapid urbanization and intensified human activities have placed increasing pressure on natural and built environments, resulting in deforestation, depletion of water resources, pollution, biodiversity loss, and climate-related risks such as flooding and rising temperatures (Edo et al., 2024). These challenges have heightened global concern for environmental sustainability, which emphasizes meeting present human needs while safeguarding environmental systems for future generations (Halla & Binder, 2020; Kaswan et al., 2019).

United Nations sustainable development frameworks like the SDG recognize the importance of environmentally sound cities, especially in relation to housing quality, infrastructure provision, energy efficiency, and access to green spaces (UN, 2015). However, translating these global aspirations into effective local urban management remains a major challenge in many developing countries (Fisher et al., 2021; Goh et al., 2023). In Nigeria, limited adoption of sustainable construction practices and weak urban governance have contributed to environmental degradation, infrastructural deficits, and declining livability in urban areas (Okoye et al., 2023).

The built environment, comprising housing, infrastructure, and associated green and open spaces, plays a critical role in shaping urban environmental quality and human well-being. While urbanization can drive economic growth and social development, poorly planned expansion often leads to unsustainable development patterns, resource overexploitation, and declining environmental quality (Khan et al., 2021; Bao et al., 2023). Projections indicating substantial global urban population growth further underscore the urgency of promoting sustainability in urban development,

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particularly in rapidly growing cities of the Global South (Passer et al., 2020).

Kano Metropolis, one of the fastest-growing urban centers in Nigeria and a major economic hub in the northern region, exemplifies many of the urban challenges being experienced all across the developing cities. Rapid population growth and urban densification have exerted considerable pressure on housing, infrastructure, and land resources, leading to overcrowding, inadequate services, loss of green spaces, and environmental degradation (Barau et al., 2015; Idris et al., 2021). These dynamics threaten the long-term sustainability and livability of the Metropolis. It is for this reason that this study assesses the environmental sustainability of the built environment in Kano Metropolis using three key indicators: housing, infrastructure, and aesthetics. By providing an integrated evaluation of these components, the study seeks to generate empirical evidence to support sustainable urban planning and environmental management strategies in Kano and similar rapidly urbanizing cities.

2 Materials and Methods

2.1 Study Area

Kano Metropolis is the administrative centre of Kano State in Nigeria, located between latitude 11° 55′ 23.93" N and 12° 3′ 53.10" N and between longitude 8° 27′ 42.26" E and 8° 36′ 41.62" E. Figure 1 shows the map of Kano Metropolis with its eight Local Government areas (Dala, Fagge, Nassarawa, Tarauni, Gwale, Kano Municipal, Kumbotso, and Ungogo). Kano Metropolis is the second largest commercial and industrial centre in Nigeria (Mustapha et al., 2013; Abdu et al., 2014). The metropolis is experiencing population increase and rapid urbanization from 295,432 in 1963, 760,000 in 1973, 1.6 million in 1991, and 2.84 million in 2006, with a growth rate of 5.5% per annum (Mustapha et al, 2013; Dankani, 2013). The World Urbanization Prospect report for 2024 has an estimated population of 4,348.481 people, depicting an increase of 2.83% increase in 2021 and 3.06% in 2022.

Urban expansion of Kano metropolis is attributed to natural population increase, rural–urban migration, commercial growth, and industrialization (Maiwada, 2000; Barau et al., 2015). Over the years, the spatial structure of the Metropolis has evolved from a compact traditional form to a concentric form and later on a multi-nuclei urban form, with expansion intensifying from the late twentieth century onwards. Extensive land use and land cover changes, with continuous increase in built-up areas at the expense of green and open spaces is seen through the rapid conversion of agricultural land, and wetlands in Kano metropolis (Idris et al., 2021; Idris, 2022). This growth is evident as population pressure increases housing demand, resulting in outward expansion beyond planned urban boundaries, with no access to basic infrastructures like drainage systems, road networks, and waste management facilities. Thus, urban sprawl in the Kano metropolis reflects the broader challenges of rapid urbanization and limited integration and implementation of sustainable urban development plans.

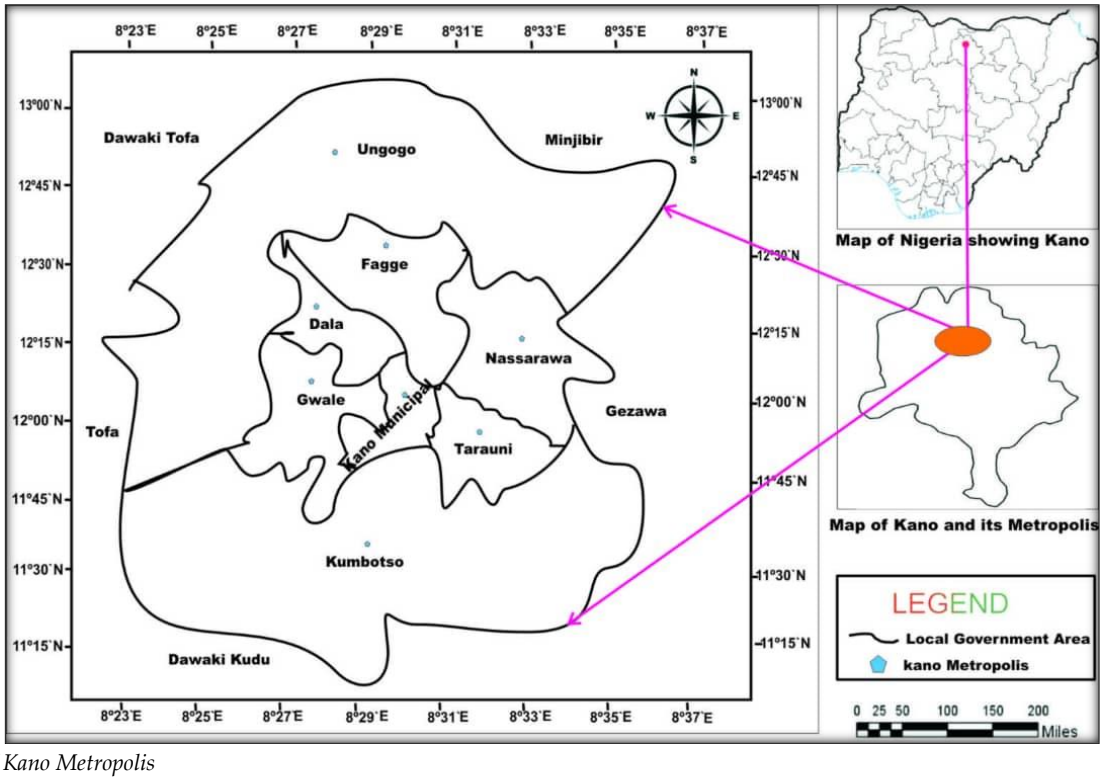

Figure 1: Map of Kano Metropolis
Source: Adapted from Kano Ministry of Land and Physical Planning (2023)

2.2 Data Sources

The built environment and environmental sustainability are concepts that require a multi-disciplinary approach, which is being used globally in urban development. Therefore, the primary source of data for this study was the responses from the questionnaire administered to the experts from different fields. To obtain the information needed for this research, a respondent will require being an expert in any of the fields of the built environment and environmental sustainability therefore purposive sampling was employed to include professions such as Architecture, Building, Civil Engineering, Urban and Regional Planning, Environmentalist, Estate Surveyor, Quantity Surveyor, GIS, Geographer in the Academia or a practioner with over 5 years of experience and a minimum of a Diploma certification in the field of expertise (Table 1).

For this reason, the Delphi technique was employed for data collection. A common feature in purposive sampling and the Delphi Technique is the selection of experts in the areas of interest, the size or number to be used, and their profile, which depends on the subject and aim of the study. Consent was sought from the participants, with anonymity and confidentiality of responses ensured. As reiterated by Stewart et al. (2017), the selection of an appropriate and willing expert is crucial in ensuring robust and valid research.

Table 1: Demographic Characteristics of Respondents

Demographic Variable		Frequency	Percentage (%)
Institution	Academics	7	30.43
	Practitioners	16	69.57
Field of Expertise	URP	8	30.78
	Architecture	4	7.39
	Civil Engineer	2	8.70
	Estate Survey	1	4.35
	Quantity Survey	1	4.35
	Geographer	1	4.35
	Building Engineer	1	4.35
	GIS	2	8.70
	Environmentalist	3	13.04
Education Level	Degree	7	30.43
	Masters	11	47.83
	PhD	5	21.74
Years of Experience	5 < 10	2	8.70
	10 <15	5	21.74
	15< 20	5	21.74
	>20	11	47.83

Three basic indicators of the built environment- housing, infrastructure, and aesthetics were assessed. The Delphi technique was used to gather information from selected experts in a two-round survey using a structured five-point Likert-scale questionnaire, which was distributed electronically via Email and WhatsApp. The questionnaire, divided into 2 sections – A & B, was used to gather the required information for descriptive statistical analysis. Demographic information to determine the qualifications of the experts is depicted in section A. Section B contains questions on the usefulness of the indicators of the built environment (housing, infrastructures, and aesthetics) in describing the quality of the built environment, with the options of 1- "Not available", 2- "Available", 3- "Not sure", 4- "Highly available" and 5- "Most available".

2.3 Data Analysis

Data collected from the questionnaire were analyzed in the Statistical Package for the Social Sciences environment. Descriptive statistical tools: the mean values, standard deviation, and percentage were used to evaluate expert responses. The level of agreement or consensus among the respondents was used to assess the sustainability status of the indicators of the built environment. The agreement level is determined using the consensus criterion adapted from Chuenjitwongsa (2017) as shown in Table 2. The criteria classified responses into agreement, disagreement, or neutrality based on mean scores and standard deviation thresholds. This approach enables an objective interpretation of expert consensus regarding the sustainability of housing, infrastructure, and aesthetic components in Kano Metropolis.

Table 2: Consensus Criteria

Consensus	Parameters (M: Mean and SD: Standard Deviation)
Agreement (A)	M≥3.5, SD <1.24
Disagreement (DA)	M≥3.0≤3.4, SD ≥1.25<1.5
Neutral (N)	M>0≤2.9. SD≥1.5

Adopted from Chuenjitwongsa (2017)

3 Results

3.1 Housing

Housing (structure and design, plan and layout, affordability and accessibility, energy and water availability), infrastructure (road network, parking spaces, water distribution and drainage systems), and aesthetics (green and open spaces, recreation and structure spacing) were assessed to give an insight into the sustainability of the built environment in Kano Metropolis. Housing is a key component of the built environment that entails residential and business complexes. The results show that houses in Kano Metropolis are of poor quality and not sustainable. Table 3 shows that experts unanimously agreed that houses in Kano Metropolis do not meet the desired qualities as they are generally not well structured or designed with poor planning and layout; they are neither affordable nor accessible, with no energy or water available for use.

This corroborates the findings that urban growth in Kano metropolis is majorly due to an increase in population growth (natural birth, rural-urban migration, rural-rural migration). This results in illegal, increasingly built-up areas and unplanned settlements in the form of substandard dwellings with poor physical state, and a degraded environment. This is spread across different residential densities- High Density Residential Areas (HDRA) like Bachirawa, Rijiyar Lemu in Ungogo, and Gwammaja in Dala, Medium Density Residential Areas (MDRA) like Gandun Albasa in KMC and Rijiyar Zaki in Ungogo, and Low density Residential Areas (LDRA) like Dan Agundi in KMC and Badawa Layout and GRA in Nassarawa (Barau et al., 2015; Idris, 2022; 2024).

Table 3: Housing as an Environmental Quality Indicator

Housing	Availability			
	M	SD	A (%)	Consensus
Houses have good structures, are well-designed, and are in very good condition	2.7	1.36	53.91	DA
Located in a properly planned and well-laid-out area	2.22	1	44.35	DA
They are affordable and easily accessible	2.3	1.26	46.09	DA
Have an assigned energy source with a proper distribution system	2.3	1.22	46.09	DA
Have no accessible and clean water source for drinking and sanitation purposes	1.91	0.9	38.26	A

3.2 Infrastructure

Infrastructure entails basic facilities that make living easier were unanimously agreed to be of low quality in Kano Metropolis. The increasing population growth of Kano metropolis is accompanied by an increasing need for more physical infrastructure, like roads and other services (water, drainage, and waste management system). Analysis of findings on infrastructure in Kano metropolis (Table 4) indicates that accessibility (road networks, parking spaces, and pedestrian walkways) is in poor condition and not available for use. There is no well-structured water distribution, drainage, and waste management system within the metropolis, resulting in recurring flooding, disease outbreak and loss of aesthetic values.

Studies by Idris (2022) and Idris et al. (2024) showed continuous expansion of the built-up index in Kano metropolis through infrastructural development (roads, houses, schools, etc.) with no consideration for the sustainability of the environment using sustainable construction strategies. Thus, the findings of this study corroborate the works of Kazemi et al. (2023) and Regúlez et al. (2023), which highlight sustainability as looking ahead while meeting the needs of the present and future generations, especially for the built environment. Accordingly, the need for sustainable construction has become a major concern for the future of the built environment to reduce environmental degradation and mitigate global warming.

Table 4: Infrastructure, as an Environmental Quality Indicator

Infrastructure	Availability			
	M	SD	A (%)	Consensus
Good road networks that are accessible and in very good condition	2.74	1.36	54.78	DA
No designated and spacious parking structures (for bicycles, motorcycles, cars, buses, trucks) to complement the roads and reduce traffic congestions	2.35	1.15	46.96	A
Safe pedestrian walkways are available for use	2.3	1.26	46.09	DA
No well-structured water distribution system for both domestic and industrial use	2.43	1.16	48.7	A
There are no laid-out drainage systems that are in good condition and accessible for clean-ups	2.13	1.18	42.61	A
No proper waste management system for both domestic and industrial wastes	2.13	0.76	42.61	A

3.3 Aesthetics

The findings showed that all the elements that make aesthetics qualitative for a sustainable built environment are below expectation, having low means, standard deviations, and percentage frequencies as shown in Table 5. The overuse of generic resources like land, water, air, and energy in constructing the built environment has resulted in the loss of aesthetic components of the environment in Kano Metropolis.

Table 5: Aesthetics, as an Environmental Quality Indicator

Aesthetics	Availability			
	M	SD	A (%)	Consensus
There are adequate green areas to reduce pollution	2.17	1.3	43.48	DA
There are no designated recreational facilities or public parks	2.48	1.16	49.57	A
There are little or no available open spaces to reduce run-offs/for infiltration	2.04	0.93	40.87	A
There is no adequate spacing between structures for ventilation	2.22	1.17	44.35	A

4 Discussions

The continuous increase in the rates of urban growth in Kano Metropolis has brought about the need for more built-up areas to meet the socio-economic demand of its population. A study on urban densification and environmental quality in the area posits that more land is allocated for the built environment while neglecting other critical aspects of the environment (Mshelia, 2025). This will most likely result in a multiplier effect on the sustainability of the built environment since urban development is largely unplanned. Increase in demand for housing (residential and commercial) has rendered the available infrastructure insufficient, and aesthetics have been continuously encroached upon. Weak integration and implementation of sustainable urban plans has resulted in the poor condition of key indicators of a sustainable built environment- where and how to build, leaving vulnerable areas unprotected (EPA, 2013, 2023). These actions have severe consequences, as seen in biodiversity depletion, recurring floods, and modification of urban microclimate.

Hence, sustainable construction strategies like the use of compressed earth blocks and clay materials that enhance indoor environments and mitigate the release of greenhouse gases, as used in Burkina Faso and the ancient Kano city walls (Almusaed et al., 2023; Assoumou et al., 2023), can be reintroduced in Kano Metropolis. Municipal waste (plastic, glass, paper, and incinerated ash), Agro-waste (rice husk ash, sugarcane bagasse ash, and bamboo leaves ash) are potent building material solutions towards the development of sustainable construction materials (Maraveas, 2020). Adopting a policy-driven urban densification strategy is another solution that can enhance a sustainable built environment. Alongside emphasis on where to build and how to build, as adopted by the Environmental Protection Agency (2013), will further protect fragile ecosystems and preserve environmental resources like the green and open spaces in any developmental project.

4.1 Limitation

The limitations of this study are that it was mainly based on expert opinion using the Delphi technique, which may not fully capture on-ground realities experienced by residents of Kano Metropolis. Additionally, the study

focused mainly on physical indicators of the built environment and did not incorporate social and behavioral dimensions of sustainability that may influence how environmental sustainability is perceived within the built environment.

5 Conclusion

Kano Metropolis faces significant challenges as rapid urban expansion undermines environmental sustainability. The findings reveal that the majority of residential structures are inadequately designed, financially inaccessible, and lack essential utilities such as clean water and energy. Infrastructure remains insufficient, characterized by substandard road networks, inadequate drainage systems, and ineffective waste management. Additionally, the urban environment lacks sufficient aesthetic features, including green spaces and public recreational facilities. The ongoing degradation of green spaces, rising pollution levels, and inadequate infrastructure planning collectively indicate a broader crisis in urban management. Promoting sustainable construction practices through the use of locally sourced and agro-based materials, implementing policy-driven urban densification strategies, improving waste management systems, and prioritizing the conservation of green and open spaces are essential for enhancing the quality of the built environment. Bridging the gap between urban development and environmental sustainability requires the enactment of robust policies that support sustainable construction. Recommended measures include incentivizing the use of eco-friendly construction materials, enforcing strict energy efficiency standards, and integrating green spaces into urban planning. Raising awareness among construction industry stakeholders and the general public is another critical area that needs to be given priority. While this study assesses the environmental sustainability of the built environment, there is a need for research to understand the viability of sustainable construction materials and sustainable construction projects using local resources in the Kano metropolis.

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