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ARTICLE

Perception of the Residential Environmental Quality of Yenagoa Metropolis, Nigeria

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ABSTRACT

Residential environmental quality (REQ) affects human health and quality of life (QoL). Therefore, this study assessed residents' perception of the REQ of the Yenagoa metropolis. Data for the study were sourced from the 400 administered questionnaires, which required respondents to rate their REQ based on seven selected indicators (air quality, drinking water quality, housing location, sanitation, waste management, housing accessibility and noise pollution). The respondents were sampled using the multistage sampling technique. The data were analyzed using frequency, percentage, t-test, ANOVA and REQ model. The findings show that the overall calculated REQ of Yenagoa was classified as "good quality". The best-rated indicator was drinking water quality, while the least-rated was noise pollution. Ratings based on respondents' sex, income and educational status recorded similar results. Also, the respondents' perception of the REQ across the four zones was similar as the calculated ratings of all the zones fell under the "good quality" classification. Furthermore, the hypotheses tested revealed that there were no significant differences in the perception of the REQ by sex and income status, while significant variation exists by education status. Despite the general "good quality" rating, there is still room for improvement, especially in the areas of noise pollution, sanitation and housing location, which received relatively low ratings.

Keywords: Air quality; Drinking water quality; Noise pollution; Residential environmental quality; Waste management

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1. Introduction

The rate of population growth and urbanization has been increasing in recent decades. It has been projected that by 2050, the world's urban population would be 68%, as against the 55% in 2018 [1]. This accounts for a 13% increase for a period of 32 years. The report also asserts that 35% of this growth will take place primarily in Nigeria, China and India. These countries are expected to add 189, 255 and 416 million people to their respective urban populations by 2050. Unfortunately, the higher the population of an urban area, the higher the density, which in turn exerts stress on the environment, leading to urban deterioration with negative effects on the population. The most common effects include air, water and noise pollution, waste management challenges, building in flood-prone and poorly accessible areas amongst others.

The linkage between residential environmental quality (REQ) and human health, quality of life (QoL) and standard of living has been established by several studies [2-6]. This is so because, human health and well-being are influenced by some of the environmental quality indicators such as clean air, safe drinking water, adequate sanitation and proper waste management. Hence, the incorporation of residents' perceptions would lead to a better understanding of environmental pollution problems and enhance local planning for the sustainability of the urban area [7].

Studies on REQ are usually carried out based on some selected indicators, which are used to assess the prevailing environmental quality of the area of interest. Assessment of REQ may involve an array of indicators, ranging from air, water, residential location, town planning to social services. Hence, environmental quality studies are usually considered as multidimensional constructs, which are conducted using either objective or subjective approaches [8]. The objective environmental quality assessment is usually based on the adoption of technical measurement systems, which can give precise quality values of the indicator being measured based on the design of the measuring instrument and its calibration. This method is considered objective because it is not influenced by the bias and prejudices of the assessor. On the other hand, the subjective method is based on people's perception of their REQ, based on selected environmental quality indicators, using some kind of Likert scale, which may range from "very good to very poor", with assigned weight values based on their perceived importance in contributing to the assessment of the overall quality of the environment. This study adopted the subjective method in the assessment of the REQ of Yenagoa metropolis because the residents can relate their perceived REQ with their residential satisfaction, perceived health status and QoL.

The resident's rating of environmental quality drivers or indicators can constitute reliable information in gauging the capacity of the environment to support human health and wellbeing. They can also help in providing early warning signs of impending environmental stress and shocks, which can enhance the abilities of environmental practitioners, regulators and policymakers to respond proactively to impending environmental threats. Hence, the continuous evaluation and monitoring of the major residential quality drivers could help to facilitate achieving sustainable residential environmental quality by the timely implementation of appropriate measures to forestall any impending environmental problem [9]. In a similar vein, a study asserts that "environmental health indices that can capture the multiple dimensions of healthy housing are important tools for characterizing the risk of exposure as well as evaluating the effectiveness of interventions" [10].

In spite of the linkages between REQ and residents' perceived health and QoL, there is a dearth of reliable information and baseline data on residents' PREQ of most cities in Nigeria, especially Yenagoa. This situation has made it difficult to proactively deal with impending environmental threats and shocks that the residents are exposed to. Therefore, it is imperative to conduct studies to continuously monitor and appraise the quality of the residential environment to ensure that the capacity of the environment is not overstretched but capable of sustainably maintaining the health of the residents. Hence, the aim

of this study is to assess the residents' perception of REQ of the Yenagoa metropolis.

2. Literature review

Studies have established that the quality of the residential environment largely influences human health, QoL and mental well-being [6,11,12]. Hence, a higher perceived REQ is linked with better well-being [11] and a poorly perceived REQ is linked with poor well-being [13].

For this reason, it is imperative to continuously monitor the residential environment to ensure that its quality does not deteriorate to levels that would pose serious threats to human life and well-being. The measurement or monitoring of the environment can be done either through objective or subjective means. However, there have been increases in the number of studies that have adopted the subjective approach, which is based on the perception of residents on their REQ [12,14,15]. One of the reasons for opting for subjective approach is that residents' perception of REQ could provide dependable stock of information that could guide policymakers, environmental regulators and other relevant stakeholders on the development of policies and environmental regulations, which could directly address the concerns of the people thereby enhancing good government and people relations, which may lead to less resistance to government policies and environmental regulations. Secondly, since the residents are the ones directly affected by the quality of the residential environment, and policies to improve the REQ are designed for the benefit of the same residents, it is only logical and imperative that the residents' perception of the environmental quality be sought before embarking on any improvement strategies.

A review of the literature has shown that different proxy indicators have been adopted in studies of REQ with different outcomes. For example, Bonaiuto et al. [16] adopted 11 proxy indicators as follows: Three focused on spatial aspects, one on human aspects, four on functional aspects and three on contextual aspects. The findings confirm the factorial structure of the indicators and show an improved extent of reliability in relation to past studies. A study on the "perception of the residential environment in cities: A comparative study" by Hanák et al. [9] adopted 22 proxy residential environmental indicators to compare three cities-Brno, Prague and Ostrava. The findings indicated that generally the indicators affecting the quality of life in the three cities were similar and they considered safety and noise as major quality indicators impacting their QoL. Another study adopted the "facility adequacy index (FAI), environmental risk factor index (ERFI) and safety perception index (SPI)". The study concluded that the environmental quality of the assessed area was very high, with housing quality showing the highest rating, while water supply was the least rated indicator [14].

The use of different proxy environmental quality indicators discussed above clearly shows that researchers have not come to a general consensus on the acceptable indicators for studying REQ. The reason for the adoption of diversity of indicators is not farfetched, as the residential environment can be defined and conceived from different perspectives because the concept seems to be relatively vague and loose [17]. In addition, the scale of the studies also varies; with some focusing on macro levels (a city) while others on the micro level (a neighbourhood in a city or town). It should be stressed at this point that irrespective of the used REQ indicators, its major purpose is to assess the current state of the environment to support ecological and human health and well-being. Having this information, regulators and policymakers could be well armed with impending environmental challenges and better prepared to resolve and manage them more efficiently. Since no generally agreed indicators have been developed for the study of REQ, this study proposed and used seven proxy indicators to assess the REQ of Yenagoa.

3. Methodology

3.1 Description of the study area

The study was carried out in Yenagoa, the capital of Bayelsa State, Nigeria. It is situated "within

latitudes 4°55' and 5°02' North of the Equator and longitudes 6°15' and 6°25' East of the Greenwich Meridian" (see **Figure 1**) [18]. Yenagoa is located in southern Nigeria, specifically in the Niger Delta, which is characterized by flood plains, tidal flats and beach ridge barriers. The entire area is low-lying and hardly rises above 15 metres. The climatic type of the area is "tropical monsoon climate, with two distinct seasons-rainy and dry" [19]. The rainy season is usually experienced from the month of April to October, while the dry season occurs from November to March. The mean monthly temperature ranges between 27-28 °C, with an annual mean rainfall ranging between 2500 mm to 4000 mm and relative

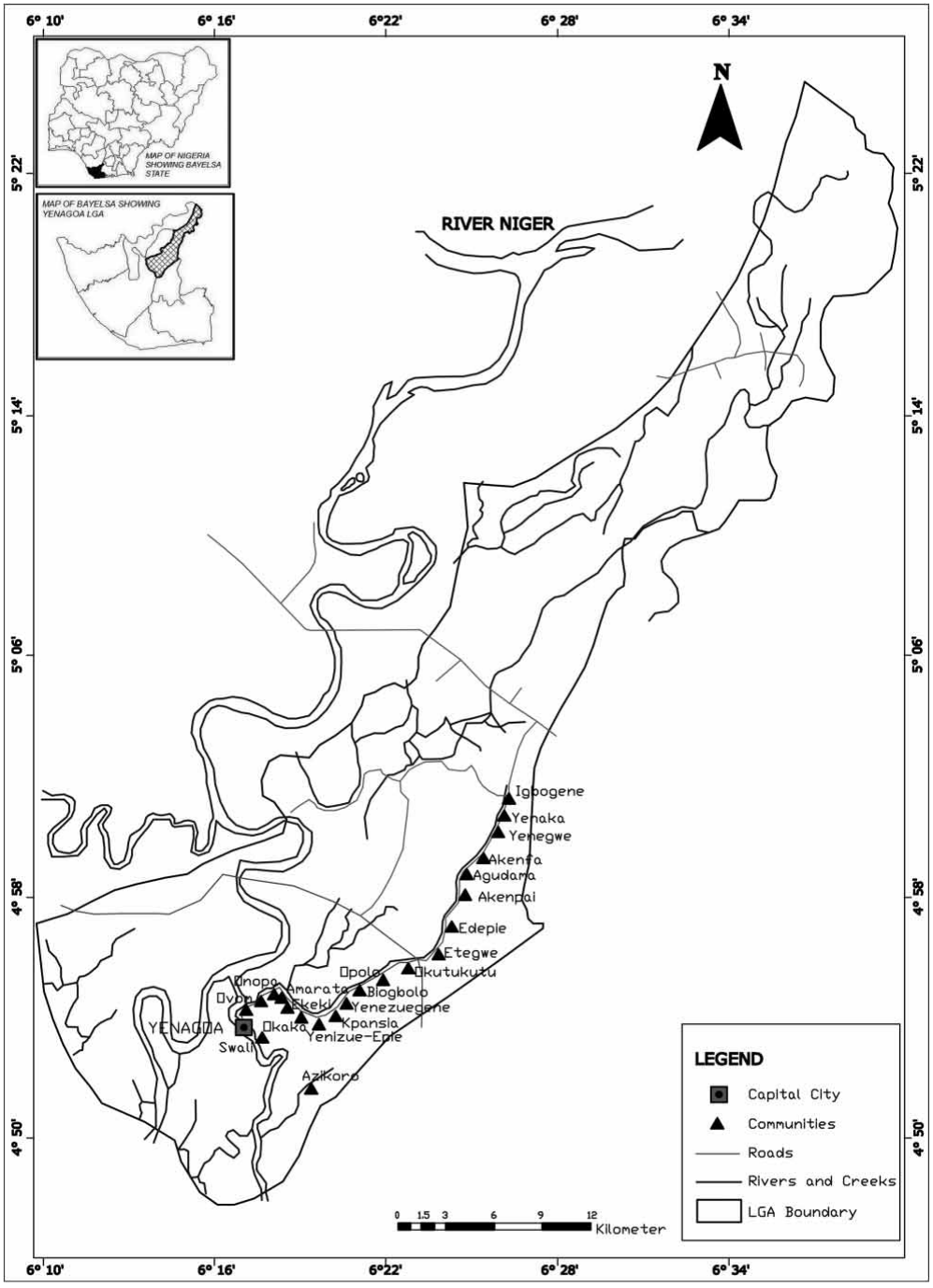

Figure 1. The study area in Yenagoa local government area.

Source: [18].

humidity of about 70% [19].

Yenagoa has been experiencing a rapid rate of population growth since it was named the capital of Bayelsa State in 1996. The population of the city has progressively grown "from about 50,000 people in 1991 to about 300,000 in 2006" [20]. Unfortunately, the growth in population is not commensurate with infrastructural provisions [20]. This has created developmental gaps with adverse effects on the livability index of the city and QoL of the people. The developmental gaps manifest in various ways—insufficient decent housing accommodations, road networks, waste management challenges, insufficient safe drinking water, air and noise pollution and poor urban development control. These challenges have adverse effects on productivity and human health. Hence, this study was carried out to assess the residents' perception of their REQ, which could provide baseline data for future environmental planning and management of the Yenagoa metropolis.

3.2 Methods of data collection

The cross sectional survey research design was used for this study, which involved physical field observation of residential environmental settings and direct field administration of a structured questionnaire. Data for the study were obtained from the administered questionnaire. The questionnaire comprises two parts—A and B. Part A, focused on the respondents' demographic characteristics, while part B focused on the respondents' perception of their environmental quality through responses to seven selected REQ indicators or drivers (air quality, drinking water quality, housing location, sanitation, waste management, housing accessibility and noise pollution). Each of the seven indicators had five options, which were rated on a Likert scale format and were assigned quality weight values based on their assumed contributions to REQ. The scale adopted was very good quality—5 points; good quality—4 points; moderate quality—3 points; poor quality—2 points and very poor quality—1 point.

The population for the study was 125,000 households, based on an average household size of four persons per household [19]. In order to obtain a representative sample, the table for estimating sample size from a given population was used to obtain a sample size of 400 [21]. To ensure that the 400 samples were a true representation of the population, the multistage sampling technique was adopted. Firstly, Yenagoa was classified into four zones based on the 20 communities that make up the metropolis. Each of the zones comprises five communities, which were assigned alphabets (A-D). The communities in each of the zones were as follows: Zone A (Igbogene, Yenegwe, Akenfa, Agudama & Akenpai); Zone B (Edepie, Etegwe, Okutukutu, Opolo & Biogbolo); Zone C (Yenezuegene, Kpansia, Yenizue-Epie, Ekeki & Amarata); Zone D (Onopa, Ovom, Okaka, Swali & Azikoro). The respondents were later sampled using the systematic random sampling technique at every six housing intervals. The designed questionnaire was then administered to the sampled respondents directly by hand to fill and return.

3.3 Methods of data analysis

The responses from the administered questionnaire constituted the data for the study, which were analyzed using percentages, frequencies, t-test, analysis of variance (ANOVA) and a REQ arithmetical model that was adapted from the waterborne diseases vulnerability (WDV) model by [11]. Frequencies and percentages were used to analyze the data on respondents' demographic characteristics and responses to the REQ indicators; while the REQ model was used to assess the perceptual rating of the REQ indicators by the respondents. The model integrates the various responses of the respondents to the seven selected REQ indicators to arrive at a single value, which shows the REQ rating of the metropolis. Apart from the general rating by all respondents, a cross tabulation rating was also carried out to determine the ratings based on sex, education, income status and residential zones. The t-test statistic was used to determine whether there was a significant difference between male and female perception of the REQ indicators; while the ANOVA was used to determine whether there was a significant variation in the rating

of REQ indicators by education and income status. The REQ model is stated as follows:

$$REQ = \frac{reqi}{hq} \times \frac{100}{1} \quad (1)$$

where:

$$reqi = \sum_{i=1}^{n} \frac{q(f)}{TR}; i = 1, 2, 3, 4.5 \quad (2)$$

REQ = residential environmental quality; reqi = residential environmental quality index; q = quality unit weight, a number between 1-5; hq = highest quality unit weight, 5; f = number of responses to a quality unit weight (1-5) of each ith indicator, a number between 1-7; TR = total number of responses to all quality unit weight values (1-5) of all ith indicators (1-7) and ∑ = summation.

The calculated rating of the REQ is presented in percentage; where the higher the calculated value the better the REQ of the area under consideration. The interpretation scale of the model is as follows: Very good quality = above 70%; Good quality = 60-69%; Moderate quality = 50-59%; Poor quality = 40-49%; Very poor quality = below 40%.

4. Results and discussion

4.1 Respondents' demographic characteristics

A total of 392 (97.5%) of the 400 sets of the administered questionnaire were filled and returned. The responses to the questionnaire are presented in **Table 1**. The data showed that there were 222 (56.6%) males and 170 (43.4%) females, which adequately represents the views of both sexes. The age bracket with the highest frequency was 25-40 years, which accounts for 179 (45.7%) respondents, while above 65 years accounts for the lowest number (17) of respondents, which represents 3.8%. This shows that the age structure is youthful. However, the views of the various age strata of the population were accommodated. The data on marital status show that 185 (47.2%) respondents were married, while 160 (40.8%), 42 (10.7%) and 5 (1.3%) were single, divorced and widowed, respectively. The educational status showed that the majority (45.9%) of the respondents had tertiary education, while 42.9% and 11.2% had secondary and no formal/primary education, respectively. The income status of the re-

Table 1. Demographic characteristics of respondents.

Questionnaire variable	Response variable	Number of respondents	Percentage response
Sex	Male	222	56.6
	Female	170	43.4
Age	Below 25 years	100	25.5
	25-40 years	179	45.7
	41-65 years	98	25.0
	Above 65 years	15	3.8
Marital Status	Married	185	47.2
	Single	160	40.8
	Divorced	42	10.7
	Widow/Widower	5	1.3
Educational Status	No formal/Primary	44	11.2
	Secondary	168	42.9
	Tertiary	180	45.9
Monthly Income	Low (below N100,000)	247	63.0
	Middle (N100,000-N250,000)	120	30.6
	High (above N250,000)	25	6.4

Source: Authors' fieldwork, 2023.

spondents indicated that the majority of the population belongs to the low- and middle-income class; as 247(63%), 120 (30.6%) and 25 (6.4%), respondents earned below N100,000 (low income), 100,000-250,000 (middle income) and above N250,000 (high income), respectively. The data have shown that the sampled respondents adequately represented the various socioeconomic strata of the population.

4.2 Residential environmental quality indicators

In order to determine the REQ of Yenagoa metropolis, seven proxy indicators (air quality, drinking water quality, housing location, sanitation, waste management, housing accessibility and noise pollution) were selected and used for the assessment. Each of the seven indicators was graduated into a five-point Likert scale for respondents to rate accordingly as shown in **Table 2**. A quality weight value ranging from 1-5 was assigned to each of the sub-items of the respective seven indicators, based on their assumed importance in contributing to the REQ. Value 1, represents very poor quality and 5 very good quality. The integration of the ratings of the seven REQ indicators by the respondents produced the PREQ of the Yenagoa metropolis. The calculated REQ is presented in percentage as indicated in the method of study. The higher the percentage value the higher the PREQ.

Air quality

Air quality (AQ) was selected as one of the indicators for the assessment of the REQ of Yenagoa because it constitutes serious environmental threats to human health, which could increase the burden of diseases such as respiratory tract infections, lung cancer and asthma. In fact, air pollution was estimated to be responsible for the premature death of 4.2 million people globally in 2016 [22]. The assessment of residential AQ by the respondents was done based on five sub-elements, which were assigned quality weight values ranging from 1-5. Five, represents very good quality, while 1 represents very poor quality as shown in **Table 2**. The response shows that the majority (28.1%) of the respondents perceived the environmental AQ as acceptable but with moderate risk for people who are usually sensitive to air pollution, which was rated moderate, with a quality weight value of 3. However, 12 (3%) of the respondents perceived the air quality as very unacceptable, as the risk of health effects is increased for everyone, hence, it was assigned a quality weight of 1 (very poor quality). In all, only 44.7% of the respondents perceived the air quality as either good or very good. This may indicate that the majority of the population is exposed to the threat of air pollution. This response is not surprising because it has been reported that in 2019, about 99% of the global population lived in areas that failed to meet the WHO guidelines on air quality [22]. This assertion confirms a 2009 study of the "concentrations of air pollutants in Yenagoa and environs," which reported that the concentration of all the studied pollutants except hydrogen sulphide exceeded the permissible thresholds recommended by the Federal Ministry of Environment and therefore constitute serious health threats [23].

Drinking water quality

Drinking water quality (DWQ) was selected as one of the REQ indicators because it is a major component of the environment and is needed for the sustenance of life. Several studies have established the role of safe drinking water in the prevention of different types of diseases, especially diarrhea, which has been identified as one of the major killers of children below the age of 5 [24]. The perception of the DWQ was based on the major source of drinking water used by the respondents. As earlier noted in the method of study, this indicator was classified into five categories and was assigned quality weight values. The data as shown in **Table 2** revealed that the highest responses (40.6%) had access to drinking water from safe sources, which were accessible on premises and whenever needed. This was considered the best water source and was assigned a 5-point quality weight; while the lowest response of 4.5% was recorded for those who still obtain their drinking water from surface sources such as rivers, dams, lakes, ponds, canal or irrigation canal, which is the worst supply source for drinking water. This figure is

Table 2. Response to residential environmental quality indicators.

S/N	Environmental quality indicator	Quality weight (q_{1-5})	Response (f)	Percentage (%)
1	**Air Quality**			
A	Air quality is satisfactory, and air pollution poses no risk	5	72	18.4
B	Air quality is acceptable but with little risk for people who are unusually sensitive to air pollution	4	103	26.3
C	Air quality is acceptable but with moderate risk for people who are usually sensitive to air pollution	3	110	28.1
D	Air quality unacceptable as some members of the general public may experience health effects; while sensitive groups may experience more serious health effects.	2	95	24.2
E	Air quality very unacceptable, as the risk of health effects is increased for everyone	1	12	3.0
2	**Drinking Water Quality**			
A	Drinking water from safe sources, accessible on premises and whenever needed	5	159	40.6
B	Drinking water from safe sources but not accessible on premises, provided collection time is not more than 30 minutes	4	89	22.7
C	Drinking water from safe sources but not accessible on premises and collection time is more than 30 minutes	3	96	24.5
D	Drinking water from unsafe sources such as unprotected dug well or spring	2	30	7.7
E	Drinking water from surface water sources such as river, dam, lake, pond, stream, canal or irrigation canal	1	18	4.5
3	**Housing location**			
A	Free from all kinds of floods	5	46	11.7
B	Low flood risk	4	139	35.5
C	Moderate flood risk	3	111	28.3
D	High flood risk	2	61	15.6
E	Severe flood risk	1	35	8.9
4	**Sanitation facility**			
A	Safely managed sanitation facility that is not shared, disposed in situ or treated off-site	5	32	8.2
B	Use of improved sanitation facility that is not shared with other households	4	180	45.9
C	Use of improved sanitation facility that is shared with two or more households	3	134	34.2

Table 2 continued

S/N	Environmental quality indicator	Quality weight (q_{1-5})	Response (f)	Percentage (%)
D	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines	2	41	10.5
E	Open defecation	1	5	1.3
5	**Waste Management**			
A	All forms of waste are adequately disposed safely in a designated place and evacuated promptly	5	44	11.2
B	All forms of waste are adequately disposed safely in a designated place but not promptly evacuated.	4	11	28.1
C	Some forms of waste are inadequately disposed due to insufficient disposal facilities and are poorly evacuated.	3	15	39.3
D	Most forms of waste are very inadequately disposed due to poor disposal facilities and are poorly evacuated.	2	64	16.3
E	Indiscriminate disposal of all forms of waste on wetlands, bushes, roads or rivers.	1	20	5.1
6	**Housing Accessibility**			
A	Adequately accessible to all forms of road transportation	5	86	21.9
B	Fairly accessible to all forms of road transportation	4	173	44.1
C	Poorly accessible to some forms of road transportation	3	96	24.5
D	Not accessible to some forms of road transportation	2	27	6.9
E	Not accessible to most forms of road transportation	1	10	2.6
7	**Noise Pollution**			
A	Environment is quiet, serene and free from any form of noise pollution	5	30	7.7
B	Environment is fairly quiet with very low risk of noise pollution	4	94	24.0
C	Environment is moderately quiet with low risk of noise pollution	3	140	35.7
D	Environment is disturbed with high risk of noise pollution	2	86	21.9
E	Environment is disturbed with severe risk of noise pollution.	1	42	10.7

* Quality weight: 5 = Very good; 4 = Good; 3 = Moderate; 2 = Poor; 1 = Very poor.

Source: Authors' fieldwork, 2023.

in line with the 6% estimates for Nigeria in 2020 [25].

In spite of the global efforts toward achieving the sustainable development goals (SDGs), target 6.1, it was observed that 12.2% of the respondents still used unimproved sources of drinking water, which exposes those using these sources to serious health challenges and pose some problems to the actualization of the SDG 6.1 target. Although 87.8% of the respondents had access to safe drinking water sources, however, 24.5% still spent more than 30 minutes on a return journey for fetching drinking water from their major sources, which is beyond the WHO and UNICEF thresholds of less than 30 minutes. **Plate 1** shows a typical water vending point in Yenagoa.

Plate 1. A typical water vending point at Okutukutu.

Source: Authors' fieldwork, 2023.

Plate 2. Poorly spaced houses and location at Agudama.

Source: Authors' fieldwork, 2023.

Housing location

Responses to housing location (HL) show that only 11.7% of the respondents live in houses that were free from all kinds of floods; while the remaining 88.3% experience one form of flood or the other. Of this number, 24.5% experience either high or severe flood risk as revealed in **Table 2**. The responses agreed with the recent flood episodes (2012 & 2022) experienced in Yenagoa, where over 50% of the built up areas were affected. This assertion agrees with the study that reported that about 48% of Yenagoa experiences moderate to high risk of flooding [26].

The location of a residential building to a large extent influences human health, QoL and socio-economic activities [27]. Those whose houses are located in flood-prone areas are usually subjected to untold hardships, occasioned by frequent floods that cause serious dislocation to their normal lifestyle, health and well-being. In fact, floods in Yenagoa have led to the loss of lives, properties, and farmlands, disruption of academic activities, social functions and economic livelihoods of the people [28]. In spite of the impact of floods in the city, people still build on flood plains and poorly reclaimed wetlands due to scarcity of land, poor economic status of the people, high population growth rate and poor development control [20]. This situation has led to the development of slums in part of the city, which has created congestion with little spaces between houses. This congestion could result in the rapid spread of infectious diseases in the city in case of an outbreak. **Plate 2** is an example of some of the poorly located houses in Yenagoa.

Sanitation

Sanitation is an important component of the Sustainable Development Goal 6, which has been recognized as an important factor in promoting good health [25,29,30]. The responses to sanitation as presented in **Table 2** showed that 88.2% of the respondents either have access to improve or safely managed sanitation facilities (see **Plate 3**). However, 34.2% of this proportion used shared facilities with two or more families, which is classified as limited sanitation [18]. In spite of the global efforts to end open defecation (OD), 1.3% of the respondents still practice this worst form of sanitation. This is however better than the 18% average for sub-Saharan Africa (SSA) in 2020. The ultimate goal of SDG target 6.2a is to ensure that everyone has access to safely managed sanitation facilities. This goal is still far from being achievable in Yenagoa by 2030, as only 8.2% of the respondents had access to safely managed sanitation services.

Plate 3. A safely managed sanitation facility at Onopa.

Source: Authors' fieldwork, 2023.

Waste management

Waste of different types and compositions could have adverse effects on people if not well disposed of or managed. Several studies have reported that poor waste management (WM) could lead to water, soil and air pollution, poor QoL and health challenges, such as diarrhea, cholera and cancer [4,31,32]. It can also constitute both social and psychological effects on people as it is unsightly and produce an offensive odour; hence its inclusion as an indicator in the assessment of REQ of Yenagoa. The responses to WM (**Table 2**) revealed that 11.2% of the respondents indicated that all forms of waste are adequately disposed of safely in a designated place and evacuated promptly (see **Plate 4**). However, the majority (39.3%) of the respondents indicated that some forms of waste are inadequately disposed of due to insufficient disposal facilities and are poorly evacuated. Sadly, 5.1% of the respondents reported indiscriminate disposal of all forms of waste on wetlands, bushes, roads or rivers. This agrees with the submission that in some local government areas of Ogun State there was a lack of waste disposal facilities in some of the communities [33]. This situation encourages indiscriminate disposal of waste, which may pose a serious threat to human life.

Plate 4. Solid waste evacuation at Yenizue-Epie.

Source: Authors' fieldwork, 2023.

Housing accessibility

Good accessibility is fundamental to a quality residential home because it facilitates social interactions, easy rescue and evacuations of households during emergencies and freedom to move in and out freely. Response to housing accessibility (HA) showed that the majority (44.1%) of the respondents indicated that their homes were fairly accessible to all forms of road transportation, while 21.9% indicated that their houses were adequately accessible to all forms of road transportation. However, 34% of the respondents live in houses that are either poorly or not accessible to some forms of road transportation or not accessible to most forms of road transportation (see **Plate 5**). This is a clear manifestation of poor urban control and planning in Yenagoa. From physical observation in the field, it could be seen that buildings are erected in some locations indiscriminately, with some buildings blocking the right of way to other buildings. In some cases, the buildings are so close to each other that there is hardly enough space for even a motorcycle to pass through easily. These findings agree with the submission that houses in parts of Yenagoa are built haphazardly leading to overcrowding in spite of existing building laws [34].

Plate 5. Earth road linking residential neighbourhood off Imirigi Road.

Source: Authors' fieldwork, 2023.

Noise pollution

Noise pollution (NP) has been known to constitute serious problems such as hearing impairment; high blood pressure; cognitive difficulties; mental health and insomnia [35-38]. However, it has not received much attention compared to other forms of

pollution (air, water & soil). Because of the impacts of noise pollution, it was selected as one of the indicators for REQ. **Table 2** reveals that 32.6% of the respondents are exposed to high or severe risk of noise pollution; while only 7.7% indicated that their environment was quiet, serene and free from any form of noise pollution. Furthermore, 59.7% indicated that their environment was either fairly or moderately quiet with a very low or low risk of noise pollution. The major sources of noise pollution in Yenagoa from the direct field observation are music stores, vehicular movement, generators, construction works and religious activities. This finding agrees with that of Oguntunde et al. [39].

4.3 Calculated rating of REQ of Yenagoa

In order to determine the overall rating of the REQ of Yenagoa based on the respondents' perception, the data in **Table 2** and the REQ model, defined in the method of the study were used and the calculated values were presented in **Table 3**. From the table, the calculated total weighted quality rating of the seven indicators ranged from 1160 to 1517 points. The indicator with the best rating was drinking water quality, while noise pollution had the worst rating. This implies that noise pollution constitutes a serious environmental threat to the residents. Unfortunately, noise pollution has not received much attention compared to other forms of pollution in Yenagoa. Following closely to noise pollution were sanitation and housing location, which had 1270 and 1276 points, respectively. The calculated total weighted quality rating value of the seven indicators was 9370 points, with a total response (TR) of 2744. Based on the model specification, the calculated residential environmental quality index (reqi) was 3.41 points. Substituting this value into the model, the overall rating of the REQ of Yenagoa was 68.2%. Based on the interpretation scale, the respondents have rated the REQ of Yenagoa as "good quality".

$$\mathrm{REQ} = \frac{\mathrm{reqi}}{\mathrm{hq}} \times \frac{100}{1} = \frac{3.41}{5} \times \frac{100}{1} = 68.2\%$$

Rating of REQ by sex, income and education status

In order to assess the influence of respondents' sex, income and education statuses on their rating of the REQ indicators, separate analyses were conducted for each of these three factors. The sex analysis revealed that the calculated reqi of each of the seven indicators ranges from 2.96 to 3.85 points with a mean value of 3.40 points; while that of the female ranges from 2.90 to 3.75 points with a mean value of 3.38 points. For the male respondents, waste management had the best rating and noise pollution was the worst. For the females, both air quality and

Table 3. Calculated rating of residential environmental quality of Yenagoa.

SN	Environmental quality indicator	Weighted quality rating $q_5(f)$	Weighted quality rating $q_4(f)$	Weighted quality rating $q_3(f)$	Weighted quality rating $q_2(f)$	Weighted quality rating $q_1(f)$	Total weighted quality rating $\Sigma q_{1\text{-}5}(f)$	Total response (TR)
1	Air quality	360	412	330	190	12	1,304	392
2	Drinking water quality	795	356	288	60	18	1,517	392
3	Housing location	230	556	333	122	35	1,276	392
4	Housing Accessibility	160	720	402	82	5	1,369	392
5	Sanitation facility	220	440	462	128	20	1,270	392
6	Waste management	430	692	288	54	10	1,474	392
7	Noise pollution	150	376	420	172	42	1,160	392
8	Total	2,345	3,552	2,523	808	142	9,370	2,744
	Residential environmental quality index (reqi) = 9370/2744 = 3.41							

drinking water quality had the highest rating of 3.75 points each, while noise pollution had the lowest rating just as the male rating. The calculated values of the REQ were 68% and 67.6%, for male and female respondents, respectively (see **Table 4**). The result of the t-test analysis ($t_6 = 0.237$, $p = 0.821$ at $\alpha = 0.05$) clearly shows that there was no significant difference in the perception of REQ of Yenagoa by sex.

The calculated reqi of each of the seven indicators by income status of respondents as shown in **Table 5** revealed that low-income earners' rating ranges from 2.74 to 3.82 points with a mean value of 3.36 points. The highest-rated indicator was drinking water quality, while the lowest-rated indicator was housing location with a mean value of 3.36 points. The range for medium income was 2.77-4.06 points. The highest value was for drinking water quality and the lowest value was housing location, with a mean value of 3.49 points. For high income, it ranged from 2.68 to 4.00 points. The highest value was for air quality, while the lowest was for housing location and a mean value of 3.40 points. The calculated values of the REQ were 67.2%, 69.8% and 68%, for low-income, middle-income and high-income earners, respectively. These results show that middle-income earners had the highest quality rating of their residential environment. However, the result of the ANOVA test ($F = 0.127$, $p = 0.881$ at $\alpha = 0.05$) revealed that there was no significant variation in the perception of REQ of Yenagoa by income status of

Table 4. Calculated residential environmental quality index by sex.

S/N	Rating indicators	Sex	
		Male (n = 222)	Female (n = 170)
1	Air quality	3.48	3.75
2	Drinking water quality	3.81	3.75
3	Housing location	3.06	3.15
4	Housing accessibility	3.34	3.36
5	Sanitation facility	3.29	3.13
6	Waste management	3.85	3.65
7	Noise pollution	2.96	2.90
8	Mean residential environmental quality index (reqi)	3.40	3.38
9	Residential environmental quality (REQ)	68%	67.6%

Source: Authors' fieldwork, 2023.

Table 5. Calculated rating of residential environmental quality by income.

S/N	Rating indicators	Income status		
		Low Income (Below N100,000) n = 247	Medium Income (N100,000-N250, 000) n = 120	High Income (Above N250, 000) n = 25
1	Air quality	3.57	3.80	4.00
2	Drinking water quality	3.82	4.06	3.96
3	Housing location	2.74	2.77	2.68
4	Housing Accessibility	3.45	3.61	3.76
5	Sanitation	3.24	3.01	2.92
6	Waste management	3.77	3.86	3.68
7	Noise pollution	2.95	3.33	2.80
8	Mean residential environmental quality index (reqi)	3.36	3.49	3.40
9	Residential environmental quality (REQ)	67.2%	69.8%	68%

Source: Authors' fieldwork, 2023.

respondents. The insignificant variation was further confirmed by the results of the post hoc test using the Least Square Deviation (LSD) at the 5% level of confidence.

The calculated rating of each of the seven reqi by no formal/primary school respondents as shown in **Table 6** ranges from 2.36 to 3.18 points. Noise pollution was the least rated, while housing location had the highest rating with a mean value of 2.91 points. Rating by those with secondary education ranges from 2.54 to 3.82 points with a mean value of 3.34 points; while the rating by those with tertiary education ranges from 3.31 to 4.01 with a mean value of 3.60. The calculated REQ by education status was 58.2%, 66.8% and 72% for no formal/primary education, secondary education and tertiary education, respectively. This rating is an indication that those with the lowest education status reside in low quality environment. Hence, the ANOVA result ($F = 6.787$, $p = 0.006$ at $\alpha = 0.05$) showed that there was a significant variation in the perception of the REQ of Yenagoa by education status. The post hoc test using the LSD showed that the mean differences were significant at the 5% level of confidence between no formal/primary and secondary, as well as between no formal/primary and tertiary respectively. However, the observed mean difference between secondary and tertiary is insignificant at the 5% level of confidence. From the results of the t-test and ANOVA, it is quite evident that the level of respondents' education exerts a major influence on the perception of the REQ of Yenagoa.

Rating of REQ by zone (Neighbourhood)

In addition to the calculated REQ by sex, income and education status, the REQ of the four classified zones was also calculated. From the results presented in **Figure 2**, the calculated reqi for AQ across the zones were as follows: Zone A, 3.50 points; Zone B, 3.55 points; Zone C, 3.60 points and Zone D, 3.69 points. The calculated reqi for DWQ was relatively high in the four zones but highest in Zone B and lowest in Zone C. The DWQ was the highest-rated quality indicator in each of the four zones. For HL, Zone A recorded the lowest value (2.70), while Zone C recorded the highest (3.19). The probable reason for the low rating in Zone A may be attributed to the fact that large areas of the zone is usually heavily inundated during the annual floods. The level of housing accessibility across the zones ranged from 3.29 (Zone B) to 3.40 (Zone C). The difference between the lowest and highest range was just 0.11 points. This is so because across the zones a large number of the housing stocks are connected with roads that are tarred or not tarred. The rating of sanitation facilities was fairly good across the zones as the range was 3.20 (Zone D) to 3.38 (Zone C). This shows that over half of the population in each zone has access to improved sanitation facilities. This assertion is substantiated by an earlier study in Yenagoa, which reported that 53% of the population in Yenagoa has

Table 6. Calculated rating of residential environmental quality by education status.

S/N	Rating indicators	Education status		
		No Formal/ Primary (n = 44)	Secondary (n = 168)	Tertiary (n = 180)
1	Air quality	2.84	3.50	3.90
2	Drinking water quality	3.14	3.70	4.01
3	Housing location	3.18	3.16	3.31
4	Housing accessibility	3.05	3.43	3.57
5	Sanitation facility	2.66	3.26	3.36
6	Waste management	3.11	3.82	3.89
7	Noise pollution	2.36	2.54	3.17
8	Mean residential environmental quality index (reqi)	2.91	3.34	3.60
9	Residential environmental quality (REQ)	58.2%	66.8%	72%

Source: Authors' fieldwork, 2023.

access to improved sanitation facilities [11]. Waste management across the zones received a fairly good rating as the reqi ranged from 3.52 (Zone B) to 3.65 (Zone A). However, during the fieldwork it was observed by the researchers that some waste receptacles were not promptly evacuated, making them constitute a menace in the immediate environment, which flies and rodents have turned into breeding grounds. Such a situation could constitute a serious threat to environmental health. The range of the calculated reqi for NP was 2.98 (Zone A) to 3.10 (Zone B). Compared to the other quality indicators, NP received the lowest rating in Zones B, C and D; while it was the second lowest in Zone A after HL. This shows that the respondents considered NP as a serious environmental threat across the zones. Similar results were also reported in a study of three cities where noise and security were considered major indicators affecting their QoL [9].

In order to have an overall rating of the respective zones based on the seven quality indicators the REQ of each of the zones was calculated and the results were shown in **Figure 3**. From the figure, the REQ of the zones ranged from 66.4% (Zone A) to 68.4% (Zone C). Although based on the interpretation scale, the four zones calculated REQ fell within the "good quality" classification, however, Zone C respondents had the best perception of their environmental quality, while Zone A respondents had the worst perception. These findings could guide policy development by relevant government agencies to further improve the quality of the environment.

5. Conclusions

The study established that the perceived REQ of Yenagoa was high, with an overall calculated score of 68.2%, which was classified as "good quality" based on the model specifications. Drinking water quality was best-rated REQ indicator, while noise pollution was the least-rated indicator. This shows that noise pollution exerts serious environmental

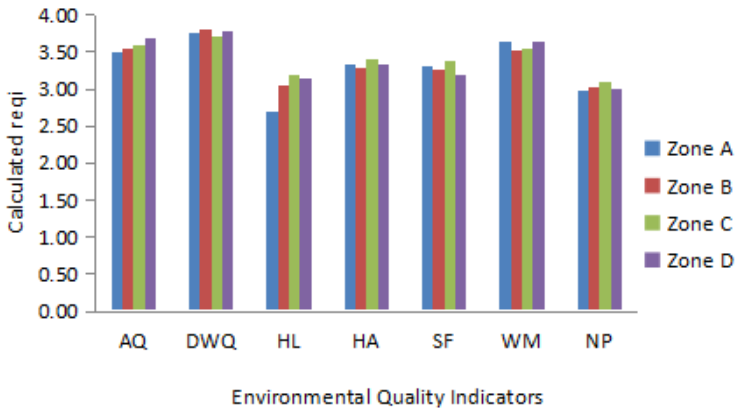

Figure 2. Calculated residential environmental quality index by zone.

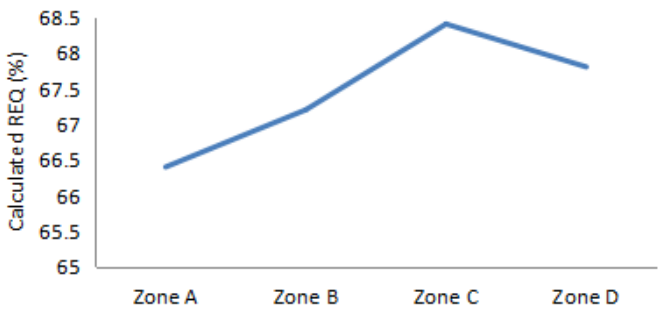

Figure 3. Calculated residential environmental quality by zone.

pressure on the inhabitants, but has received little attention. The REQ rating based on sex, income and education status of the respondents also recorded similar scores. The t-test analysis revealed that there was no significant difference in the perception of the REQ between male and female respondents; while the ANOVA analysis by income status indicated that there was no significant variation in the perception by income status (low, middle & high); while that of education status (no formal/primary, secondary & tertiary) indicated that there was significant variation. However, the post hoc test using the LSD showed that no variation exists between the perception of the REQ by respondents with secondary and tertiary education status. These analyses demonstrate a general consensus that the REQ of Yenagoa was high based on the selected indicators. However, there is still room for improvement especially in the area of noise pollution, sanitation and housing location, which received relatively lower ratings.

Author Contributions

Author OO designed the study, and wrote the first draft; while author DOE conducted the analysis, edited the first draft and both authors read and approved the final draft.

Conflict of Interest

The authors declare that there is no conflict of interest.

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