Received: 6 February 2024 | Revised: 25 June 2024 | Accepted: 15 July 2024 | Published online: 5 August 2024

RESEARCH ARTICLE

Journal of Comprehensive Business Administration Research
2024, Vol. 00(00) 1–12
DOI: 10.47852/bonviewJCBAR42022589

BON VIEW PUBLISHING

Sustainable Waste Management and Service Quality Delivery in Nigeria

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Abstract: Waste disposal, collection, and treatment are an indispensable facet in the developmental phases of rural and urban cities across the globe. The accumulation, disposal, and treatment of waste in urban centers have become a predicament to both private and public stakeholders in Uyo metropolis, Akwa Ibom State, Nigeria. The objective of this study is to examine sustainable waste management and service quality delivery in Nigeria. The issues to be addressed by this study include attitude of residents toward waste disposal, non-conformity with modern waste collection/treatment processes, and the waste management infrastructural gaps. The study adopted the "9 Development Band global theory" of waste management and development, using Integrated Sustainable Waste Management (ISWM) approaches. Descriptive survey technique was adopted in which questionnaire was administered to 384 respondents in the metropolis and the conduct of in-depth interview to obtain additional information on issues that were not clarified in the structured questionnaire. Data collected from the field were collated and analyzed using Pearson's correlations analysis technique, to ascertain the relationship between the dependent and independent variables. The findings of the study revealed unwholesome and unsustainable approaches in waste disposal/management and suggest effective service delivery approaches in line with the 9DB model ISWM. The study recommends that residents should dispose waste in line with established waste disposal procedures, and waste management authorities should adopt efficient and sustainable waste collection and treatment approaches. If these suggestions are implemented, it could reduce the metropolis environmental footprint, mitigate on the current global climate change challenges, and promote the UN Sustainable Development Goals-11 which anchors on the need for sustainable cities and communities.

Keywords: service quality delivery, sustainability, integrated and sustainable waste management, development band, environmental footprint, infrastructural gap, Nigeria

1. Introduction

The management of waste includes all forms of human activities involved in the collection/conveying of waste from the point of collection, to the disposal of waste. Ineffective waste management processes result in the following issues; proliferation of solid waste on land with health and environmental consequences [1], issues involved in transportation of solid waste from land to affect the marine ecosystem [2], and unhealthy emission of gaseous element through uncontrollable waste burning, as well as ineffective regulatory policies within the region where the waste is generated and disposed [3, 4]. Documented evidence has shown that over 2 billion people globally are not accessible to waste collection facilities, and an estimated 3 billion people have no access to sustainable waste management resources [5, 6]. In developing countries, the issue of waste management and environmental degradation is quite a huge challenging factor due to ineffective planning/regulatory issues. The transformation of cities from rural communities to urban centers comes with an increasing multiple challenges, one of which is effective waste management [7]. The preservation of human health and the environment is the basis for a global effort towards effective waste management [8]. In Uyo metropolis, Nigeria, managing waste has been quite challenging due to attitude of the residents towards waste disposal, non-conformity with modern waste collection/treatment processes, and gap in waste management infrastructures.

1.1. Sustainable waste management

Sustainable and effective waste management approaches means that authorities in the metropolis must explore global best practices and efficient waste management processes, such as E-Waste systems which have built in devices to recycling and reuse of waste materials [9]. According to United Nations Global E-Waste Monitor 2020, global E-waste is estimated at 74metric tons by 2030, and expected to double by 2050, though reports of inconsistencies in handling of E-waste have been reported in some developing nations [10]. But E-waste has been argued as an efficient approach in urban waste management based on its sustainability potentials [11] and capacity to reduce in greenhouse gas emission [12, 13], other options include transforming waste to wealth generating resource [14], exchanging household waste for money, and imposing taxes on waste generated by households as a control measure [15]. The waste management situation is made complex by consistent

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urbanization drift from rural areas in wants of "better life and livelihood", and this has increased pressure on existing waste management infrastructures (collection and disposal facilities), initially planned to cater for a reduced number of residents.

1.2. Service quality delivery

Service quality (SQ) is a voguish marketing concept with its derivation from the disconfirmation-expectancy model [16], and this concept juxtaposes perceived customers' expectation of a service on one hand and how that service is executed/performed on the other hand [17]. In service delivery, higher levels of service delivery are assumed to be actualized when any organization exceeds customers' expectation in service delivery profitably [18, 19]. Consistent enhancement in service delivery is achievable when firms constantly upgrade their functional procedures and swiftly and comprehensively acknowledge challenges through customers' complaints, creating dependable service delivery procedures, based on customers' encounters and experience [20]. The extant challenge of service quality delivery in waste management in Uyo metropolis is the capacity of service providers, Government operators, and Public-Private Partnership (PPP) agents to meet or exceed customers' expectation in solid waste management [21]. Previous studies have confirmed some negative aspects of unsustainable waste management experiences such as inefficient control of solid waste products [22, 23], coupled with the activities of unskilled waste management personnel [24]. It is quite necessary for waste management operators to harness professionalism in its team, for the purpose of effective handling of the metropolis waste products [25], by optimizing waste delivery trucks to reduce carbon emission [26], and to mitigate on possible pollution, by reducing waste export to the channels of the metropolis water system [27].

1.3. Environmental footprint

Environmental footprint is a terminology that originates from The United Nations (UN) 2030 Agenda for Sustainable Development, based on The UN Sustainable Development Goals (UNSDG) which details 17 outstanding "people-centered and planet-sensitive agenda" that guarantees dignity of humanity, equitability, environmental protection, flourishing economic activities, guaranteed security, and a determination for global collaboration to deliver on Sustainable Developmental Goals (SDGs) (UN General Assembly 2014). In specific terms, environmental footprint has become synonymous with the term "ecological footprint' which measure human activities or ecological accounting for human impacts on the environment [28, 29], this measurement involves a standardized metric that is used in evaluating how impactful is human activities on the environment [30]. Unsustainable urban planning and resource management have been identified as a key index responsible for increasing environmental footprint in urban centers; according to the UN Secretary-General report on "Progress towards the Sustainable Development Goals", an estimated 10 percent rise in rural-urban movement results in 5.7% increase in CO_2 emissions and a 9.6% increase in environmental pollution and the prevailing devastations resulting from the effects of climate change [31].

Previous research in this field of study has demonstrated the diverse impacts of waste management on increasing environmental footprints. For example, indiscriminate burning of waste increases the carbon footprint of the metropolis [32], inappropriate dumping of waste without following due processes in waste disposal, present a huge challenge and is unsustainable [33], moreover, when evaluating the direct and indirect CO_2 emissions resulting from electricity generation/transmission from gas turbines [34], in addition to offshore oil production activities prevalent in the study domain [35], consistent deforestation of urban areas to provide space for construction and industrialization [36], and uncontrollable discharge of CO_2 from vehicles fumes and industrial activities [37]. The resultant effect is blockages along drainage channels, flooding, health hazards, and even death, and this issue has led to serious threat to a safe and sustainable environment. Based on ISWM framework, the metropolis lies between DB1 and DB4, that links current technology with societal values, for the improvement of livelihood of the residents [14]. Hence, strategic steps should be taken by residents and waste management authorities to augment the metropolis up the ladder, and this could be achieved by efficient supervisory roles by waste management regulators, control of incessant waste burnings, and dumping of refuse in drainage channels as a way of reducing the metropolis environmental footprint.

In conceptualizing this study, previous research has shown cases unprofessional/unsustainable management of waste across Nigeria such as recurring issues of unsustainable environmental management by oil and gas industry firms [38], integrating environmental sustainability in organizational culture [39], negative effect of waste management on health and environmental pollution; solid waste management Challenges in Federal Capital Territory-FCT, environment as our destiny and management policy, households' willingness-to-pay for private solid waste management [33], and Commercialization Policy of Solid Waste Management [40]. Several studies have examined far-reaching aspects of sustainable waste management and environmental performance. These include the leadership role in sustainable environmental performance [41], effective and sustainable municipal solid waste management that enhances economic opportunities and reduces carbon footprint [42], firms adopting environmental sustainability as a corporate social responsibility (CSR) [43, 44], sustainable environmental ethics, performance, and competitive advantage [45, 46], it is also worthwhile to note the negative effect of digitization (4.0 revolution) on the ecosystem [47]. Retrospectively, none of the foregoing studies articulated on the need for service quality delivery as approach; hence, this study fills the literature gap on sustainable approaches in waste management within the metropolis, and by extension, Nigeria. The use of open dumpsite in waste management adopted in Uyo metropolis is hazardous and unsustainable.

The proliferation of an open dumpsites has adverse effects on the health of the citizens. This includes disgusting odour from decomposed waste, blockages of drainages by refuse due to leading to unnecessary flooding, attraction of rodents and other pests to the sites, erosion, and degradation of the ecosystem. The essence of this study is to suggest the need for service quality delivery in waste management through the adoption of sustainable approaches that will increase residents' confidence in the government as well as preserve the environment sustainably. A thorough assessment of the Uyo metropolis refuse waste management program revealed that commercial waste bins should be deployed at every dumpsite for waste collection; the size of the waste bin will depend on the quantity and frequency of waste dumped in each site; a total of thirty garbage compactor trucks could be suitable for this exercise, with each stationed at strategic locations for waste collection, processing, and delivery. The samples of waste bin and trucks are shown in Figure 1.

Figure 1
Samples of sustainable waste bins and trucks

Figure 2
The Integrated Sustainable Waste Management (ISWM) framework [54]

2. Literature Review

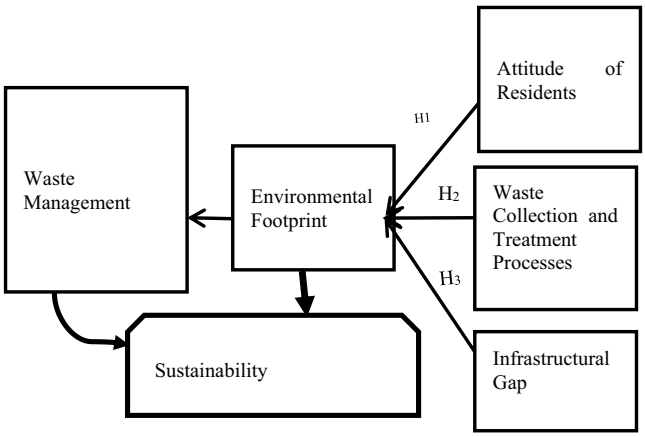
2.1. Global theory of waste and development – ISWM framework

One of the key indices of Sustainable Development (SD) is effective waste management, this phenomenon became pronounced nationally and internationally in the 1970s, and until in recent years, various strategies have been deployed on how to integrate waste management as a key factor in environmental management [48], city planning, and devastating effect of climate change [49]. This theory delineates waste management processes into nine categories (tagged 9DBs – Development Band conceptual framework), with each country identified based on its social developmental paradigm as it relates to provision of waste management resources as benchmark for measurement. Low-and-medium-income-countries (LMICs) are also subdivided into bands, and this fits into the study on hand [5]. The theory posits that for LMICs to which Uyo metropolis belongs, the transformation into ISWM involves series of successive steps [50], which involves concentrating on how to perfect the process of physical Waste management [6], before transiting into a flexible waste management process, which incorporate the 3Rs of waste management – Reduce, Reuse, and Recycle.

The conceptual framework in Figure 2 (9DBs) has been tested and confirmed to be very relevant for application in Integrated Sustainable Waste Management (ISWM) in many countries both developed and Low and Medium Income Countries (LMICs) [51]. The development band (DB1-DB4) is a representation of countries that are making progress in mitigating global waste/bush burning, prohibition of open refuse dumping through a well-organized and systematic refuse collection process, DB5 is a step forward in performance through transmutation from control measures to full control measures in waste management and control [52]. DB6 ensures that the cost of waste collection and disposal is operated at the least cost, competitive, while upholding sustainable standards environmentally [53]. DB7 involves converting waste to economically usable products with strict adherence to a sustainable ecosystem; DB8-DB9 is the process at which the 3Rs (Reduce, Reuse, Recycle) of waste management are optimized. Retrospectively, the Uyo metropolis is between DB1-DB4; strategic steps must be taken by residents and waste management authorities to move the metropolis up the ladder through ISWM approaches.

The ISWM framework focuses on the management of waste as conglomeration of network of system that is multilateral, multidimensional, and an interrelationship between technology and society. ISWM adapts itself to the enhancement of livelihood of the vulnerable in the society [14]. In Figure 2, ISWM is divided into three facets, collaborators (street cleaners, waste collectors, local waste management authorities, waste pickers, waste contractors, waste structure components). This include issues of waste collection, transportation to dumpsite, recycling, commercialization of waste, and protecting the health of the residents [55], preservation of the ecosystem during the process of waste management [41], and sustainability based on an integrated approach that includes; political will, legal framework, socio-cultural facet of the residents, governance process [56], funding, infrastructural facilities [19], health provisions [41], and the general economic effects of waste management. The adaptation of a process such as ISWM in Uyo metropolis could proffer sustainable solution on how to address issues on managing of waste in the metropolis. Therefore, establishing a link between sustainable waste management and service quality delivery in Uyo metropolis, with replicate effect of human activity on the environment, Figure 3 therefore hypothesizes the relationship between waste management and the need to adopt sustainable approaches in guaranteeing environmental safety based on the model in Figure 3 with the following variables such as (i) the attitude of residents towards sustainable waste management, (ii) waste collection/treatment processes by service providers, and (iii) existing waste management infrastructural gap.

Figure 3
Research model



2.2. Research model

The research model in Figure 3 shows that Uyo metropolis environmental footprint could be mitigated through sustainable waste management where there is positive attitudinal change of resident towards waste disposal, effective waste collection and treatment processes, and filling existing waste management infrastructural gap in the following;

2.3. Attitude of residents

Residents' attitude is a key index in ensuring that waste produced by households and business organizations is disposed within the framework of the policies guiding waste disposal within the metropolis. The tendency at which unethical attitude of residents involved in the indiscriminate dumping of waste has become quite challenging and unsustainable [33], this has resulted in blocking of drainages, flooding, health hazards, and even death, and this issue has led to serious threat to a safe and sustainable environment [55], encouraging residents on behavioral change towards sustainable waste management [57], using appropriate feedback mechanism [58], training, and engaging hospitality industry personnel on change in attitudinal dimensions, based on waste generated by this sector [59], exploring technical behavioral dimensions of sustainable waste management [60], and integrating sustainability waste management approaches into organizational culture of firms operating in the metropolis [61]. Furthermore, regulators should discourage the indiscriminate burning of waste by residents as observed in the city recently. This will further increase the carbon footprint of the metropolis, and accordingly, worsen the current global climate change issues [13]. Hence, the proposition for H_1 residents' attitude towards sustainable waste management is stated as:

Proposition H1: Attitude of residents has no significant effect on sustainable waste management in Uyo Metropolis.

2.4. Waste collection and treatment processes

The collection and treatment of waste processes within the metropolis are crucial factors determining ISWM – DB phase ranking in the 9DB waste management model (see Figure 2). The process of collecting waste from open dump points, with open/rickety trucks without safety cover, is completely unsustainable, and this could further result in polluting virgin areas as the truck transports waste to the dumpsite. One of the key functions of the metropolis waste management authority is to provide effective service quality delivery to the metropolis, the continuous use of obsolete collection and treatment processes and procedures is unsustainable and environmentally hazardous to the lives of residents; hence, sustainable and technologically driven waste management approaches could be adopted to optimize the collection and treatment processes (see Figure 1), and by extension, augmenting the metropolis along the 9DB ISWM, other approaches such as the "waste to wealth" initiative could be adopted by the waste management operators to encourage residents to see waste generation as an avenue for transforming waste to profitable wealth creation venture. The waste treatment process of open burning of waste at the dumpsite as a means of waste treatment is unsustainable and could add to the existing environmental footprint of the metropolis [38, 39], thereby complicating the existing global climate change imbroglio [13, 31, 49].

Hence, this research examines the significant effect of adopting effective and technologically driven waste collection/treatment processes as panacea to sustainable waste management in Uyo metropolis. In essence, the hypothetical proposition for H_2 – waste collection and treatment processes – was formulated from the model in Figure 3.

Proposition H2: Non-conformity with modern waste collection and treatment processes has no significant relationship with sustainable waste management in Uyo metropolis.

2.5. Infrastructural gap

Waste management infrastructural gap adds to the long list of gaps in infrastructural requirements needed for responsible life and livelihood as citizens, such as huge gap in energy generation, transmission and distribution [19], myriads of challenging issues in the educational sector [19], online shopping and retail marketing [17], and in sustainable waste management [38, 39]. It is quite obvious while driving to see open/rickety trucks without safety cover polluting the environment with waste as the truck transports waste to the official dumpsite, and this study intends to encourage the use of efficient sustainable waste trucks such as waste compactor trucks (see Figure 1), the installation of dumpster bins to aid resident disposal of waste (see Figure 1), to ease the process of waste collection by waste management operators.

The adoption of the 21st century 9DB-ISWM ranked model in waste collection and treatment could be of positive value addition to Uyo metropolis waste management processes, this process has been tested and affirmed as necessary for application in both developed and LMICs [51]. The process involves a two-phase evaluation of countries which are making progress in waste management processes, that is, augmentation from 3Rs to 7R – Refuse, Reduce, Reuse, Repair, Repurpose, Recycle, and Recover [51], countries are ranked based on their Developmental Band Performance This research has affirmed by filling the gap in literature; Uyo Metropolis is ranked within the DB1–DB4 phase which shows countries that are gradually making progress in global mitigation in waste/bush burning [62], and not close to DB7–DB8–9, which is for countries that operates the ISWM (3R–7R) rankings. Hence, government and donor agents could augment the ranking of the metropolis, by acquiring necessary waste management infrastructural facilities, that could impact positively on the lives and livelihood of the residents within the metropolis. In essence, the hypothetical proposition for H_3 infrastructural gap was formulated from the model in Figure 3.

Proposition H3: Waste management infrastructural gap has no significant effect on sustainable waste management in Uyo metropolis.

2.6. Uyo metropolis

The present Uyo metropolis was established between 1900 and 1906 by the British colonial authorities to aid the process of provincial administration, and the area coordinate is 5°02′00″N 7° 55′39″E of the Greenwich Meridian, with density of 1,200/ km^2 (3,100/sq m), and area city of 362 km^2 (140 sq mi) [63]. According to official census statistics of 2006, the estimated population of Uyo greater Urban area (including Uruan and Itu) was at 554,906, now projected in 2024 at 1,393,000, with an increase of 48.2% from 2023 [64], this shows the fast rate of growth within the metropolis, which should be matched with effective and sustainable waste management system. The official dumpsites of Uyo metropolis are located at Uyo Village Road [65], waste management in the metropolis is not managed in line with the 3Rs –neither is it in line with the augmented 7Rs [66], it presupposes that effective and sustainable process of waste management is not applicable in Uyo Metropolis.

3. Methodology

3.1. Research design

The descriptive survey technique was adopted for the study; prior to questionnaire administration, initial field work was conducted around the metropolis in two phases between 2020–2021 and 2022–2023 to ascertain at different times the process of interviewing residents at random on the management of street dump points by the authorities [67], and in-depth interviews were conducted to enhance the procedural analysis of waste management in the metropolis [68]. The study adopts a 21st-century sustainable waste management ranked model of ISWM through "the 9DBs" of 3Rs, augmented to 7Rs; this theory encourages countries to acquire sustainable waste management infrastructural facilities as a means of enhancing sustainability in waste management services [51]. The respondents consist of residents from various streets in the metropolis, in addition to households, waste pickers, truck loaders, scavengers, and employees of the Akwa Ibom State Waste Management Authority (AKSWMA) who were also interviewed. It was quite necessary to gain access to these respondents based on their experience, for the successful conduct of this study [69].

The population considered for the study was 305,961 based on the national census population figure for Uyo Local Government 2006, gazette 2009. The sample size of 315 was determined with at 95% confidence interval with a margin error of 5. This sample size determination was based on reference [70], and computed from the population of 1,700, which is an estimated 5.56% of the census population of Uyo Local Government Area. Random sampling technique was adopted to ensure that respondents had equal opportunity to be selected from the metropolis, and residents were given equal opportunity to participate (such as state and federal civil servants, waste management officials, market and stall owners, students and households). The validity and reliability of the research instrument were attested by marketing professionals and scholars; they were deployed for data collection, to ensure it is in line with set standards [71].

3.2. Participants

Data collection for the research work was conducted through questionnaire administration and in-depth interviewing of respondents, for the purpose of obtaining additional information, to affirm the relationship between the independent and dependent variables. A breakdown of the data collation in Table 1 showed that a total of (384) questionnaire was administered to the respondents, 315 (82%) were valid, 42(11%) were not returned, while 27(7%) of the questionnaire was rejected due to cancelation, mutilation, and errors by respondents.

Based on the outcome of the respondents' schedule in Table 1, the data collected for the study were carefully screened to enhance the accuracy of the selected variables before analyzing it, and the descriptive statistics in Table 2 was carefully selected to allow for fair demographic representation such as gender, age, marital status, and income level, educational qualification, and respondents' duration in Uyo metropolis.

In Table 3, the detail analyses of respondents' demographic profile are as follows: the breakdown by gender revealed that male respondents were 164(52%), while 141(45%) were female, and those that settled on anonymous were 10(3%); age distribution were as follows; 89(28%) were respondents below 20 years, respondents between 21 and 29 years, were 92(29%), between 31 and 39 years were 78(25%), between 41 and 49 years were 35(11), and above 50 years were 21(7%). For marital status, the analysis showed that single respondents were 149(47%), married were 127(40), divorced were 24(8%), and anonymous were 15(5%). For occupation, respondents categorized as unemployed were 37(12%), self-employed were 175(56%), employed respondents were 88(29%), and anonymous represented 15(4%). For educational qualification, the distribution was as follows: respondents with qualification below high school represented 132(42%), diploma was 83(26%), Bachelors' degree respondents were 72(23%), and those with masters' degree and above were 28(9%). Concerning the key issue of respondents' duration of residing in the metropolis, the profile was as follows: respondents below 3 years were 31(10%), respondents between 4 and 6 years were 104(33%), between 7 and 9 years were 58(18%), and respondent for 10 years and above were 122(39%).

3.3. Instruments

The instrument to be used for data gathering was the questionnaire, and this was based on the 5-point Likert scale ranging between 1 and 5, with 1 = maximum and 5 = minimum. The following acronym and interpretations were also allocated as follows: VS [Very Satisfied]; S [Satisfied]; D [Dissatisfied]; VD [Very Dissatisfied]; and U (Undecided). This research tool has been affirmed as acceptable instrument for data collection in survey research technique [72, 73]. The scale was designed to measure sustainable waste management and service quality delivery in Uyo Metropolis, Nigeria. The preference for structured closed ended questionnaire was informed by the fact that closed-ended questionnaire is efficient, concise and timely with a higher response rate than open-ended questionnaires as it reduces difficulty of data reduction during data analysis [69].

Table 1
Respondents' schedule

Questionnaires	Number	Percentage
Valid	315	82%
Invalid	27	7%
Non-remitted	42	11%
Total	384	100%

Table 2
Descriptive statistics

Demography	Classification	Relative frequency	Percentage	Cumulative percentage
Gender	Male	164	52	52
	Female	141	45	97
	Anonymous	10	3	100
Age	Below 20	89	28	28
	21–29	92	29	57
	31–39	78	25	82
	41–49	35	11	93
	50 and above	21	7	100
Marital status	Single	149	47	47
	Married	127	40	87
	Divorced	24	8	95
	Anonymous	15	5	100
Occupation	Unemployed	37	12	12
	Self-employed	175	56	68
	Employed	88	28	96
	Anonymous	15	4	100
Educational qualification	Below High School	132	42	42
	Diploma	83	26	68
	Bachelors	72	23	91
	Masters and above	28	9	100
Respondents' duration in Uyo metropolis	Below 3 Years	31	10	10
	4–6 years	104	33	43
	7–9 years	58	18	61
	10 years and above	122	39	100

Table 3
The correlation analysis for Attitude of residents has no significant effect on sustainable waste management in Uyo Metropolis

		Sustainable waste management	Attitude of the residents
Sustainable waste management	Pearson correlation	1.000	.813
	Sig. (2-tailed)		.000
	N	315	315
Attitude of the residents	Pearson correlation	.813	1.000
	Sig. (2-tailed)	.000	
	N	315	315

**Correlation is significant at the 0.01 level (2-tailed).

4. Results

4.1. Hypothesis one

Attitude of residents has no significant effect on sustainable waste management in Uyo Metropolis.

4.2. Hypothesis two

Attitude of residents has no significant effect on sustainable waste management in Uyo Metropolis.

Table 4 shows that $r = 0.709$ which reveals that non-conformity of waste management service providers with modern waste collection and treatment processes in Uyo metropolis has significant effect on service quality delivery, through sustainable waste management in Uyo metropolis, $N = 315$, while p value $= 0.000$. The summary is presented: [$r = 0.709$; n=315, $p < 0.005$].

Table 4
The correlation analysis for non-conformity with modern waste collection and treatment processes have no significant relationship with sustainable waste management in Uyo metropolis

		Sustainable waste management	Non-conformity with modern waste collection and treatment processes
Sustainable waste management	Pearson correlation	1.000	.709
	Sig. (2-tailed)		.000
	N	315	315
Non-conformity with modern waste collection and treatment processes	Pearson correlation	.709	1.000
	Sig. (2-tailed)	.000	
	N	315	315

**Correlation is significant at the 0.01 level (2-tailed).

4.3. Hypothesis three

Waste management infrastructural gap has no significant effect on sustainable waste management in Uyo Metropolis

The outcome of the coefficient correlation analysis obtained in Table 5, which shows that $r = .704$, this is due to the gap in waste management infrastructures in the municipality, the p value was = 0.000, while $N = 315$. The summary is presented: [$r = 704$; n=315, $p < 0.005$].

5. Discussion

This objective of the study was to examine sustainable waste management in Uyo metropolis, on the effect of the attitude of residents towards disposal of waste, which does not conform with modern waste collection, treatment, and management, based on service quality delivery in Uyo metropolis [74]. The summary of the hypothetical analysis showed this: [$r = .813$, $n = 315$, $p < 0.0005$].

The outcome of 0.813 reveals a higher frequency in unethical attitude of residents towards sustainable waste management (indiscriminate dumping of waste) [33] which is inimical to a sustainable and safe environment; this could result in blocking of drainages, flooding, health hazards, and even death. The result of the analysis revealed a non-conformity with modern waste collection/treatment processes, with significant effect on service quality delivery in Uyo metropolis, this is represented by [$r = 0.709$ $n = 315$, $p < 0.0005$].

This reveals that the authorities in charge of waste management do not conform with modern methods of managing waste [13]. The unsustainable process of surface dumping of waste without adequate provision of waste bin by the authorities is unsustainable, inimical to human health, and could adversely affect the ecosystem [41]. Based on ISWM standard [48], Uyo metropolis is ranked on development band (DB1-DB4), a phase which connotes countries that are making progress in global mitigation in bush burning (Perieira et al., 2020); this is statistically established in a higher positive correlations analysis result of 0.709.

The study outcome reveals that the existing waste management infrastructural gaps has a significant effect on service quality delivery un Uyo metropolis [41], the summary is shown; thus [$r = 0.704$, $n = 315$, $p < 0.0005$]. The outcome shows a very high statistical value of 0.704, which is a proof of the use of obsolete or non-existing infrastructures in managing waste. The increasing population and development in Uyo metropolis call for waste managers to make provision for waste management infrastructures that could match the requirement of the increasing tons of waste generated within the metropolis [12]. Based on the outcome, the infrastructural facilities used in waste management in Uyo are not sustainable and could negatively affect the ecosystem [41].

The global theory of waste and development applied in ISWM, otherwise known as the 9DBs – Development Band conceptual framework, specifically emphasizes on the strategies for integrating waste management as a key factor in environmental management, city planning, the devastating effect of climate change, and the national economic planning [48, 49]. This theory delineates waste management processes into nine categories 9DBs – Development Band and identifies countries based on available social developmental paradigm as it relates to provision of waste management resources as benchmark for measurement. LMICs are also subdivided into bands, and this fits into the study on hand [5].

The theory posits that for LMICs to which Uyo metropolis belongs, the transformation into ISWM involves series of successive steps which involves concentrating on how to perfect the process of physical Waste management (DB1-DB4), before transiting into a flexible waste management process which incorporate the 3Rs of waste management (DB8-DB9) society [50].

Based on the theoretical framework in Figure 2, Uyo metropolis belongs to the DB1-DB4, and as such, sincere and committed effort and resources are required to ensure that sustainability is achievable through the provision of standard waste management infrastructure and processes in order to augment its DB up the ladder based on ISWM theory [53].

5.1. Resident attitude

Poor attitude of unethical dumping of waste by residents could result in blocking of drainages, pollution of water source, health hazards, and outbreak of diseases within the community. Improper attitude of residents in inimical to a safe environment does not guaranty sustainability. The augmentation of processes and procedures as recommended by international, national and regional authorities for sustainable waste management, based on the result of hypothesis 2; Sustainable includes sustainable environmental-friendly measures to be taken.

Timely movement of waste from street dump points to avoid overflow from the bin provided at such point, to avert health hazard on residents. Secondly, the 3Rs and augmented 7Rs should be effectively implemented as this is a globally accepted panacea for sustainable and environmental-friendly waste management process. Thirdly, indiscriminate bush/waste burning should be discouraged as this exposes the land to surface erosion, and by extension worsening the global climate change issues, and finally, skilled personnel and

Table 5
The correlation analysis – Waste management infrastructural gap has no significant effect on sustainable waste management in Uyo metropolis

		Sustainable waste management	Waste management infrastructural gap
Sustainable waste management	Pearson correlation	1.000	.704
	Sig. (2-tailed)		.000
	N	315	315
Waste management infrastructural gap	Pearson correlation	.704	1.000
	Sig. (2-tailed)	.000	
	N	315	315

**Correlation is significant at the 0.01 level (2-tailed).

expert waste managers should be engaged by both private and public waste managers, to ensure that sustainable and environmental waste management approaches are implemented in the metropolis.

5.2. Waste collection and treatment processes

The immediate implication of non-augmentation of waste management processes could result in the carriage of overflowing waste materials by running water into the drainage system, this could cause flooding, outbreak of diseases, and untold suffering to residents. Where waste processes are not augmented, it complicates the existing procedures and could result in health-related issues from constant dumping of environmental waste. Improper waste management process is not sustainable and could alter the balance of the ecosystem [41].

Additional effort required for effective waste management includes aggressive allocation of funding for improvement and provision of urgently required infrastructural facilities required in the 21st century waste management environment. Based on the findings in Hypothesis 3, sustainable environmentally friendly measures should include; the need for increased budgetary allocation and strict implementation based on accountability, probity and transparency. Thirdly, there is need to acquire waste management infrastructures through a well-regulated and transparent bidding system that is void of corruption. Fourthly, the waste management authorities should replace obsolete waste management infrastructures with modern facilities that are sustainable and environmental-friendly. And, effective maintenance of waste facilities to ensure their optimal performance and usage at all times.

Additionally, other waste collection and treatment includes effective implementation of Sustainable Development Goals (SDG 11) on Sustainable cities and Communities, in which one of such goals is effective and sustainable waste management that guarantees healthy and safe livelihood amongst citizens globally. Also, adapting the 'waste to wealth' initiative which ensures the transformation of waste to profitable wealth creative venture for residents. And finally, ensuring that effective service quality delivery is achievable through sustainable and environmentally friendly waste management augmentation along the 9DB ISWM model; Such as augmentation from DB7-DB8-DB9 3Rs and 7Rs of optimized and sustainable waste management.

5.3. Infrastructural gap

The implication of not addressing the infrastructural gap such as the continuous use of rickety trucks to transport waste without appropriate safety covers could lead to pollution of the environment, outbreak of diseases, and avoidable road accidents due to the incessant break down of these old-rickety trucks. The outcome shows lack of sustainable and environmental management friendly waste management process [38, 39]. The use of efficient and sustainable waste trucks, such as waste compactor trucks and installation of dumpster bins to aid resident disposal of waste, could ease the process of waste collection by waste management operators. The adoption of 9DB-ISWM ranked model has been tested and affirmed as necessary for application in both developed and LMICs [51].

Empirically, previous research was an assessment of negative effect of waste management on health and environmental pollution, survey of pilot scheme of waste administration in Abuja Federal Capital territory (FCT), the environment as our destiny and Management policy, determination of household to engage other waste disposal options based on Commercialization Policy of managing Waste [33].

The foregoing information highlights the necessity for a positive shift in the attitude of residents towards adopting more efficient waste management approaches, by ensuring that waste management authorities conforms with modern waste collection, treatment, and processing methods, and addressing the ongoing waste management infrastructural gap by the government, and donor agencies in Uyo metropolis. This study is a complete departure from previous research in its unique approach of focusing on service quality delivery in waste management, and effective, and through sustainable, effective and proactive leadership [64], also by creating social networks with digital content to sustainably and effectively manage waste in the metropolis, and in the long run the entire country [75]. This research augments and fills existing empirical literature gap in this field of study.

5.4. Sustainability measures

In recent times, fourth quarter of 2023 to the first quarter of 2024, the government has embarked on massive closure of most of the dumpsites, this could help in waste reduction, but the process contravenes the global effort in combating the effect of climate change through consistent carbon emission into the atmosphere by residents burning waste within the precinct of their environment. This approach contravenes global conventions on greenhouse gas emission [3, 76], increasing environmental footprint through incessant waste burnings by households [26], and the encroaching devastation of climate change [49]. Suggested solution to this problem is that households should be given garbage bins to collect generate waste and move them to authorized dump points, assisted by waste managers to sustainably/effectively transfer them to authorized dumpsites.

Other outstanding issues to be addressed include the inability of government and waste management agencies to provide sustainable waste management resources such as eco-friendly dumpster bin, non-provision of garbage compactor trucks to aid the process of sustainable/environmental-friendly waste management. Meanwhile, the current process of household burning of waste within the precinct of their environment further increases the environmental footprint of the metropolis, and by extension, complication of the global climate change issues [13, 77]. Moreover, the current waste-conveying trucks are not environmental-friendly, it is quite common to see these trucks in the metropolis, conveying waste and dropping some of the waste material while in transit to the dump site. However, the state government and waste management regulators are yet to make sustainable provision for the 3R's and augmented 7R's acceptable global waste management process. Also, the sustainable practice of transforming waste to wealth for the benefits of households and the national economy [14], is still not practicable in Uyo metropolis, and finally, the growing practice of using waste resources as a source of energy generation [14] is also not practicable in the metropolis.

6. Conclusion and Policy Recommendations

The objective and findings of this research have revealed that the attitude of residents towards disposal of waste is not inn-conformity with modern waste collection, treatment processes, and management. The non-availability of infrastructural facilities for residents to dispose their waste creates a waste infrastructural gap that has significant effect on service quality delivery by Uyo metropolis.

Data used in conducting the study were obtained from an initial field work of questionnaire administration and in-depth-interview

conducted on residents of the metropolis by the researcher between 2020–2021 and 2022–2023. 315 valid questionnaires collected from respondents were analyzed, and the result showed significant relationship between the variables under study.

Based on the analysis and result obtained, it was significantly interesting to state that the actualization of service quality delivery on sustainable waste management could be achieved by (i) enlightenment campaign by government and donor agents on a shift in attitude of the residents in waste handling and delivery at identified bins, (ii) strict adaptation to modern methods of managing waste by operators, and (iii) provision of "state-of-the-art" infrastructures needed for sustainable waste management in the metropolis.

Additionally, these recommendations become necessary. The results of the findings in hypotheses 1 are a clear proof that residents' attitudinal change is a necessary input required in sustainable waste management. Secondly, to avoid pollution and health hazards, increasing enlightenment and awareness campaign must be done by government and waste management authorities on the need for residents to become sustainable waste management ambassadors through attitudinal change, by adhering strictly to rules and regulation guiding efficient waste and environmental management. Thirdly, residents should ensure that all waste are dumped directly in the waste bin provided by the authority. Fourthly, residents should ensure constant environmental sanitation and de-silting of drainages to ensure the free-flow of water in the drain, ensuring effective policy reforms in waste management at all levels of governance. These measures could guarantee the health of households, create opportunities for economic benefits, and to assure the safety of the ecosystem [63].

Acknowledgements

The authors are grateful to the residents in Uyo metropolis who unreservedly granted us audience at the field work stage and the valid responses provided for the effective completion of this study. Also acknowledged is the effort of Akwa Ibom State Waste Management Authority officials who provided relevant information required for the research.

Funding Support

This work is sponsored by 2019 Project of Humanities and Social Sciences of Henan Provincial Department of Education: "Research on Translation for Overseas Publicity from the Perspective of the Persuasion Theory in Western Rhetoric" (2019-ZZJH-643); 2019 Teaching Reform Project of School of Foreign Studies, North China University of Water Resources and Electric Power: "The Reforming Design and Practice of Mixed Teaching of Online and Offline Course for English Rhetoric"; 2019 Teaching Reform Project of Henan Province: A Research on the "Golden Lesson" of College English from the Perspective of Telling Chinese Stories (2019SJGLX284).

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Idongesit Oto Eshiett: Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Oto Eyamba Eshiett:** Software, Validation, Formal analysis, Resources, Data curation, Writing – original draft, Visualization, Funding acquisition.

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How to Cite: Eshiett, I. O., & Eshiett, O. E. (2024). Sustainable Waste Management and Service Quality Delivery in Nigeria. *Journal of Comprehensive Business Administration Research*. https://doi.org/10.47852/bonviewJCBAR42022589