ABSTRACT

If Sub-Saharan Africans understand the value of waste and handle it correctly and introduce "political hygiene" in governance, the issue of a filthy environment, unemployment, hunger, malnutrition and poverty will be greatly minimised.

Waste Management as a Correlate of Environmental Sustainability in Sub-Saharan Africa: The example of Imo State, Nigeria

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(The quotation "political hygiene" was used by the Kenyan Professor - Patrick Loch Otieno Lumumba in Tanzania on June 29, 2017).

(Cover picture: Oldest waste picker at the Old Road Landfill besides Nwaorie River Owerri, Imo State, Nigeria on February 9, 2017).

“Africa must do her own growing, no matter how tall her neighbours are.”

This work was completed with the assistance of the
“DAAD STIBET Abschlussbeihilfe”

I dedicate this work to waste pickers and waste users.

Summary

Introduction. Rapid and uncontrolled industrialisation and urbanisation in most developing countries are resulting in land, air and water pollution at rates that the natural environment cannot fully renew. These contemporary environmental issues have attracted local, national and international attention. The problem of urban garbage management is associated with rapid population growth in developing countries. These are pertinent environmental crises of sustainability and sanitation in Sub-Saharan Africa and other Third World countries. Despite efforts of the various tiers of government (the case of Nigeria with three tiers: Federal, State and Local governments) in managing solid waste in urban centres, it is still overflowing open dumpsites, litters streets and encroaches into water bodies. These affect the quality of urban living conditions and the natural environment.

Sub-Saharan and other developing countries are experiencing an upsurge in the accumulation and the diversity of waste including E-waste, waste agricultural biomass and waste plastics. The need for effective, sustainable and efficient management of waste through the application of 3Rs principle (Reduce, Reuse, and Recycle) is an essential element for promoting sustainable patterns of consumption and production. This study examined waste management in Imo State, Nigeria as an aspect correlated to the sustainability of its environment.

Materials and methods. To analyse waste management as a correlate of environmental sustainability in Sub-Saharan Africa, Imo State, in eastern Nigeria was chosen as a study area. Issues about waste handling and its impact on the environment in Imo have been reported since its creation in 1976; passing through the State with the cleanest State capital in 1980 to a 'dunghill' in 2013 and a 'garbage capital' on October 1, 2016. Within this State, three study sites were selected – Owerri metropolis (the State capital) Orlu and Okigwe towns. At these sites, households, commercial areas, accommodation and recreational establishments and schools, as well as dumpsites were investigated to ascertain the composition, quantity, distribution, handling patterns of waste in relation to the sustainability of the State's environment. This was done conveniently but randomly through questionnaires, interviews, focus group discussions and non-participant observation; these were all heralded by a detailed deskwork. Data were entered using Microsoft Office Excel and were explored and analysed using the Statistical Package for Social Sciences - SPSS.

Data were made essentially of categorical variables and were analysed using descriptive statistics. The association between categorical variables was measured using Cramer's V the Chi-Square that makes the power and the reliability of the test. Cramer's V is a measure of association tests directly integrated with cross-tabulation. The Chi-Square test of equal proportions was used to compare proportions for significant differences at 0.05 levels. The statistical package - the Epi Info 6.04d was also used since a contingency table had to be created from several sub-outputs and determine the extent of association between the row and column categories.

The scale variable 'quantity of waste generated' was described using measures of central tendency. It was screened for normality using the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality; in all context, the normality assumption was violated ($P<0.05$). Five null hypotheses were tested using Logistic Regression model. The explanatory power of individual conceptual component was calculated using the Cox & Snell R^2 and that of individual indicators was also appraised using the Likelihood Ratio test.

In the context of this work, the significance of the variability explained by the model (baseline model) was appraised using the Omnibus Tests of Model Coefficients, the magnitude of this variability explained by the model using the Cox & Snell R^2 and the effects of individual predictors using the Likelihood Ratio test.

Qualitatively, data from open-ended items, observations and interviews were analysed using the process of thematic analysis whereby concepts or ideas were grouped under umbrella terms or keywords. The results were presented using tables, charts, graphs, photos and maps.

Findings and discussions. The total findings and analyses indicated that proper waste handling in Imo State, Nigeria has a positive impact on the environment. This was assessed by the community's awareness of waste management via sources like the radio and the TV, their education on waste management and schools' integration of environmental education in their program. Although most community members perceived the State's environment as compared to it about 10 years' back has worsened, where they were conscious of proper waste handling measures, the environment was described to be better. This influence of environmental awareness and education on environmental sustainability appraised using Logistic Regression Model, portrayed a significant variability (Omnibus Tests of Model Coefficients: $\chi2=42.742$; $P=0.014$), inferring that environmental awareness and education significantly predict environmental sustainability.

The findings also revealed that organic waste generation spearheaded amongst other waste types like paper, plastic, E-waste, metal, textile and glass. While waste pickers always sorted paper, plastics, aluminium and metal, some of them also sorted out textile and glass. Statistically ($P<0.05$), in situations where waste was least generated (i.e., 1-2kg per day), community members maintained that the environmental quality was better in comparison to 10 years' back. Waste items like broken glass and textile as well as the remains of E-waste after the extraction of copper and brass were not sorted for and these contributed more to environmental degradation.

Similarly, the influence of wealth on environmental sustainability was appraised using Logistic Regression Model including development index related indicators like education, occupation, income and the ability to pay for waste disposal. Harmonising the outcome, farmers, who were mostly the least educated claimed to notice more environmental improvement. In addition, those who did not agree to pay for waste disposal who were mostly those with low income (less than 200,000 Naira, i.e. about 620 Euros monthly) perceived environmental improvement more than those with income above 200,000 Naira. This irony can be attributed to the fact that those with low educational backing lack the capacity to appreciate environmental sustainability pointers well as compared to those with a broader educational background with critical thinking.

The employment and poverty reduction opportunities pertaining to waste management on environmental sustainability was appraised using qualitative thematic analysis. All community members involved in sorting, buying and selling of waste items had no second job. They attested that the money earned from their activities sustained their livelihood and families. Some expressed love for the job, especially as they were their own masters. Waste picking and trading in waste items are offering employment opportunities to many communities around the world. For instance, in the waste recycling, waste composting, waste-to-energy plants and *die Stadtreiniger* in Würzburg city. The workers in these enterprises have jobs as a result of waste.

Waste disposal influence on environmental sustainability was appraised using the Binary Logistic Regression Model and the variability explained by the model was significant. The validity was also supported by the Wald statistics ($P<0.05$), which indicates the effect of the predictors is significant. Environmental sustainability was greatly reliant on indicators like the frequency at which community members emptied their waste containers; how/where waste is disposed of, availability of disposal site or public bin near the house, etc. Imolites who asserted to have public waste bins or disposal sites near their houses maintained that the quality of the State's environment had worsened as such containers/disposal sites were always stinking as well as had animals and smoke around them. Imolites around disposal sites complained of traits like diarrhoea, catarrh, insect bites, malaria, smoke and polluted air.

Conclusions. The liaison between poor waste management strategies and the sustainability of the Imo State environment was considered likely as statistically significant ineffectiveness, lack of awareness, poverty, insufficient and unrealistic waste management measures were found in this study area. In these situations, the environment was said to have not improved. Such inadequacies in the handling of generated waste did not only expose the citizenry to health dangers but also gave rise to streets and roads characterized by filth and many unattended disposal sites unleashing horrible odour to the environment and attracting wild animals. This situation is not only prevalent in Imo State, Nigeria but in many Sub-Saharan cities.

Future Perspectives. To improve the environment in Sub-Saharan Africa, it is imperative to practice an inclusive and integrated sustainable waste management system. The waste quantity in this region is fast growing, especially food/organic waste. The region should aim at waste management laws and waste reduction strategies, which will help save and produce more food that it really needs. Waste management should be dissociated from epidemic outbreaks like cholera, typhoid, Lassa fever and malaria, whose vectors thrive in filthy environments. Water channels and water bodies should not be waste disposal channels or waste disposal sites.

Résumé

Introduction. L'industrialisation et l'urbanisation rapides et incontrôlées dans la plupart des pays en voie de développement entraînent une pollution des sols, de l'air et de l'eau à un rythme que l'environnement naturel ne peut pas entièrement renouveler. Ces questions environnementales contemporaines ont attiré l'attention locale, nationale et internationale. Le problème de la gestion des déchets urbains est associé à une croissance démographique rapide dans les pays en voie de développement. Il s'agit des crises environnementales pertinentes de la durabilité et de l'assainissement en Afrique subsaharienne et dans d'autres pays du tiers monde. Malgré les efforts des différents paliers de gouvernement (le cas du Nigeria avec trois niveaux : gouvernement fédéral, État et collectivités locales) dans la gestion des déchets solides dans les centres urbains, il déborde toujours de décharges ouvertes, de petites rues et empiète sur les plans d'eau. Celles-ci affectent la qualité de la vie urbaine et l'environnement naturel.

L'Afrique subsaharien et les autres pays en voie de développement connaissent une recrudescence de l'accumulation et de la diversité des déchets, notamment les déchets électroniques, les déchets de biomasse agricole et les déchets plastiques. La nécessité d'une gestion durable et efficace des déchets grâce à l'application du principe des 3R (réduire, réutiliser et recycler) est un élément essentiel pour la promotion des modes de consommation et de production durables. Cette étude a examiné la gestion des déchets dans l'État d'Imo, au Nigéria, en tant qu'aspect corrélé à la durabilité de son environnement.

Matériaux et méthodes. Pour analyser la gestion des déchets en tant que corrélat de la durabilité environnementale, en Afrique subsaharienne, l'État d'Imo, dans l'est du Nigéria, a été choisie comme zone d'étude. Depuis sa création en 1976, des problèmes liés à la gestion des déchets et à leur impact sur l'environnement ont été signalés. Passant par l'État avec la capitale la plus propre en 1980 jusqu'à une « colline de fumier » en 2013 et une « capitale des déchets » le 1er Octobre 2016. Dans cet État, trois sites d'étude ont été sélectionnés - la métropole d'Owerri (la capitale de l'État), Orlu et Okigwe villes. Sur ces sites, les ménages, les zones commerciales, les établissements d'hébergement et de loisirs, les écoles ainsi que les dépotoirs ont été examinés afin de déterminer la composition, la quantité, la distribution, les types de traitement des déchets en relation avec la durabilité de l'environnement de l'État. Cela s'est fait de manière pratique mais aléatoire au moyen de questionnaires, d'entretiens, de discussions de groupe et d'observation non-participants ; ceux-ci ont tous été annoncés par un travail de bureau détaillé. Les données ont été entrées à l'aide de Microsoft Office Excel et ont été explorées et analysées à l'aide du progiciel statistique pour les sciences sociales – SPSS.

Les données ont été constituées essentiellement de variables catégorielles et ont été analysées à l'aide de statistiques descriptives. L'association entre les variables catégorielles a été mesurée à l'aide de Cramer's V, le Chi-carré qui assure la puissance et la fiabilité du test. Cramer's V est une mesure de tests d'association directement intégrée à la tabulation croisée. Le test du Chi carré de proportions égales a été utilisé pour comparer les proportions des différences significatives à 0,05. Le paquet statistique - Epi Info 6.04d a également été utilisé, car il fallait

créer un tableau de contingence à partir de plusieurs sous-sorties et déterminer l'étendue de l'association entre les catégories de rangées et de colonnes.

La variable d'échelle « quantité de déchets générée » a été décrite à l'aide de mesures de tendance centrale. Il a été testé pour la normalité à l'aide des tests de Kolmogorov-Smirnov et Shapiro-Wilk ; dans tous les contextes, l'hypothèse de normalité a été violée ($P<0,05$). Cinq hypothèses nulles ont été testées à l'aide du modèle de régression logistique. Le pouvoir explicatif de la composante conceptuelle individuelle a été calculé à l'aide du Cox & Snell R^2 et celui des indicateurs individuels a également été évalué à l'aide du test du ratio de vraisemblance (Likelihood Ratio test).

Dans le cadre de ce travail, l'importance de la variabilité expliquée par le modèle (modèle de base) a été évaluée à l'aide des tests Omnibus des coefficients du modèle, l'ampleur de cette variabilité expliquée par le modèle utilisant le Cox & Snell R^2 et les effets de prédicteurs utilisant le test du ratio de vraisemblance.

Sur le plan qualitatif, les données d'éléments ouverts, des observations et les entretiens ont été analysées à l'aide du processus d'analyse thématique consistant à regrouper les concepts ou les idées sous des termes génériques ou des mots clés. Les résultats ont été présentés sous forme de tableaux, graphiques, photos et cartes.

Constatations et discussions. L'ensemble des résultats et des analyses indique qu'une gestion appropriée des déchets dans l'État d'Imo, au Nigéria, a un impact positif sur l'environnement. Cela a été évalué par la sensibilisation de la communauté à la gestion des déchets via des sources telles que la radio et la télévision, son éducation sur la gestion des déchets et l'intégration de l'éducation à l'environnement dans son programme. Bien que la plupart des membres de la communauté aient perçu la détérioration de l'environnement de l'État par rapport à celui-ci environ 10 ans en arrière, alors qu'ils étaient conscients de la nécessité de prendre des mesures adéquates pour la gestion des déchets, l'environnement a été décrit comme étant meilleur. Cette influence de la sensibilisation et de l'éducation environnementales sur la durabilité environnementale, évaluée à l'aide du modèle de régression logistique, traduit une variabilité significative (tests Omnibus des coefficients de modèle : $\chi 2 = 42,742$; $P = 0,014$), ce qui en déduit que la sensibilisation et l'éducation environnementales prédisent de manière significative la durabilité environnementale.

Les résultats ont également révélé que la génération de déchets organiques était le fer de lance des autres types de déchets tels que le papier, le plastique, les déchets électroniques, le métal, le textile et le verre. Alors que les ramasseurs de déchets triaient toujours le papier, les plastiques, l'aluminium et le métal, certains d'entre eux triaient également le textile et le verre. Statistiquement ($P <0,05$), dans les situations où la production de déchets était la plus faible (1 à 2 kg par jour), les membres de la communauté ont affirmé que la qualité de l'environnement était meilleure par rapport à 10 ans en arrière. Les déchets tels que le verre brisé et le textile ainsi que le reste de déchets électroniques après l'extraction du cuivre et du laiton n'étaient pas triés et ceux-ci contribuaient davantage à la dégradation de l'environnement.

De même, l'influence de la richesse sur la durabilité de l'environnement a été évaluée à l'aide du modèle de régression logistique, notamment des indicateurs liés à l'indice de développement, tels que l'éducation, la profession, le revenu et la capacité de payer pour l'élimination des déchets. En harmonisant les résultats, les agriculteurs, qui étaient pour la plupart les moins scolarisés, ont affirmé qu'ils remarquaient une amélioration de l'environnement. De plus, ceux qui n'acceptaient pas de payer pour l'élimination des déchets et qui étaient pour la plupart ceux ayant un faible revenu (moins de 200 000 nairas, soit 620 € par mois) percevaient une amélioration de l'environnement davantage que ceux ayant un revenu supérieur à 200 000 naira. Cette contradiction peut être attribuée au fait que ceux qui ont un faible niveau d'éducation n'ont pas la capacité d'apprécier les indicateurs de durabilité environnementale ainsi que ceux qui ont une formation plus approfondie avec une pensée critique.

Les opportunités d'emploi et de réduction de la pauvreté liées à la gestion des déchets sur la durabilité environnementale ont été évaluées à l'aide d'une analyse thématique qualitative. Tous les membres de la communauté impliqués dans le tri, l'achat et la vente de déchets n'avaient pas de second emploi. Ils ont attesté que les revenus de leurs activités ont permis de maintenir leurs moyens de subsistance et leurs familles. Certains ont exprimé leur amour pour le travail, d'autant plus qu'ils étaient leurs propres maîtres. La collecte et le commerce des déchets offrent des possibilités d'emploi à de nombreuses communautés du monde entier. Par exemple, dans le recyclage des déchets, le compostage des déchets, usines d'incinération des déchets (les installations de valorisation énergétique des déchets) et 'die Stadtreiniger' dans la ville de Würzburg. Les travailleurs de ces entreprises ont des emplois grâce aux déchets.

L'influence de l'élimination des déchets sur la durabilité de l'environnement a été évaluée à l'aide du modèle de régression logistique binaire et la variabilité expliquée par le modèle était significative. La validité était également étayée par les statistiques de Wald ($P < 0{,}05$), qui indiquent que l'effet des prédicteurs est significatif. La durabilité environnementale dépendait en grande partie d'indicateurs tels que la fréquence à laquelle les membres de la communauté vidaient leurs poubelles ; comment / où les déchets sont éliminés, disponibilité de dépotoirs ou de poubelles publiques à proximité de la maison, etc. Les habitants qui prétendaient avoir des poubelles publiques ou des dépotoirs à proximité de leurs maisons ont dit de leur qualité de l'environnement que celle-ci se détériorait, car ces sites étaient nauséabonds, avaient des animaux et de la fumée autour d'eux. Ces habitants se sont également plaints de diarrhée, (de) catarrhe, (de) piqûres d'insectes et (de) morsures d'animaux, de paludisme et d´air puant.

Conclusions. La liaison entre les stratégies de gestion des déchets médiocres et la durabilité de l'environnement de l'État d'Imo a été jugée probable : inefficacité statistiquement significative, manque de sensibilisation, pauvreté, mesures de gestion des déchets insuffisantes et irréalistes ont été trouvées dans cette zone d'étude. Dans ces situations, l'environnement ne s'est pas amélioré. Ces insuffisances dans la gestion des déchets générés exposaient non seulement les citoyens à des risques pour la santé, mais donnaient également lieu à des rues et à des routes caractérisées par la saleté et à de nombreux dépotoirs sans surveillance, dégageant une odeur désastreuse pour l'environnement et attirant des animaux sauvages. Cette situation prévaut non seulement dans l'État d'Imo, au Nigéria, mais dans de nombreuses villes d'Afrique subsaharienne.

Perspectives d'avenir. Pour améliorer l'environnement en Afrique subsaharienne, il est impératif de mettre en œuvre un système de gestion des déchets durable et inclusif. La quantité de déchets dans cette région augmente rapidement, en particulier les déchets alimentaires / organiques. La région devrait viser des lois sur la gestion des déchets et des stratégies de réduction des déchets, qui contribueront à économiser et à produire plus d´ aliments dont elle a réellement besoin. La gestion des déchets doit être dissociée d'épidémies telles que le choléra, la typhoïde, la fièvre de Lassa et le paludisme, dont les vecteurs se développent bien dans des environnements immondes. Les canaux et les plans d'eau ne doivent pas être des canaux d'évacuation de déchets ou des sites de décharge d´ ordures.

Zusammenfassung

Einführung. Die rasante und unkontrollierte Industrialisierung und Verstädterung in den meisten Entwicklungsländern führt zu Boden-, Luft- und Wasserverschmutzung in einem Ausmaß, das die natürliche Umwelt nicht vollständig ausgleichen kann. Diese gegenwärtigen Umweltprobleme haben lokale, nationale und internationale Aufmerksamkeit erregt. Das Problem der städtischen Abfallbewirtschaftung ist mit einem rasanten Bevölkerungswachstum in Entwicklungsländern verbunden. Daraus resultieren relevante Umweltkrisen in Bezug auf Nachhaltigkeit und Hygiene in Subsahara-Afrika und in anderen Ländern der Dritten Welt. Trotz der Bemühungen der verschiedenen Regierungsebenen (im Fall von Nigeria mit drei Regierungsebenen: Bundes-, Landes- und Kommunalregierungen), feste Abfälle in städtischen Zentren zu entsorgen, dominieren immer noch offene Mülldeponien, Straßenabfälle und Einträge in Gewässer. Dies wirkt sich auf die Qualität der städtischen Lebensbedingungen und auf die natürliche Umwelt aus.

In den Subsahara Ländern und in anderen Entwicklungsländern nehmen sowohl die Abfallmenge als auch die Arten von Abfällen zu, darunter Elektroschrott, landwirtschaftliche Biomasse und Kunststoffabfälle. Die Notwendigkeit für eine effektive, nachhaltige und effiziente Bewirtschaftung von Abfällen durch die Anwendung des 3R-Prinzips (Reduzieren, Wiederverwenden (Reuse), Recyceln) ist ein wesentliches Element, um nachhaltigen Konsum und nachhaltige Produktions zu fördern. Diese Studie untersucht die Abfallbewirtschaftung im nigerianischen Bundesstaat Imo als einen Aspekt, der mit der Nachhaltigkeit seiner Umwelt zusammenhängt.

Materialen und Methoden. Um die Abfallbewirtschaftung als Aspekt der Nachhaltigkeit und des Umweltmanagements in Subsahara-Afrika zu analysieren, wurde der Bundesstaat Imo im Osten Nigerias als Untersuchungsgebiet ausgewählt. Aus diesem Bundesstaat wurden seit seiner Gründung im Jahr 1976 Probleme in Bezug auf die Abfallbehandlung und deren Auswirkungen auf die Umwelt gemeldet. Imo State zeigt mit Owerri die sauberste Landeshauptstadt Nigerias im Jahr 1980 die Entwicklung zu einem „dunghill“ (Misthaufen) im Jahr 2013 und zu einer „Müllhauptstadt“ am 1. Oktober 2016 auf. Innerhalb dieses Staates wurden drei Untersuchungsgebiete ausgewählt: Owerri-Metropole (die Landeshauptstadt) und die Städte Orlu und Okigwe. An diesen Standorten wurden Haushalte, Gewerbegebiete, Unterbringungs- und Freizeiteinrichtungen sowie Schulen befragt und Untersuchungen an Mülldeponien vorgenommen. Damit wurde exemplarisch die Zusammensetzung, Menge, Verteilung und die Behandlung der Abfälle in Bezug auf das Nachhaltigkeitsmanagement in der städtischen und staatlichen Umwelt ermittelt.

Dies geschah durch „convenient random sampling“… mit Fragebögen, Interviews, Fokusgruppendiskussionen und „non-participant observation“. Alle Zielgruppen wurden vorab kontaktiert. Die im Zuge der Untersuchung erhobenen Daten wurden in Microsoft Office Excel eingegeben und mit dem Statistical Package for Social Sciences - SPSS - untersucht und analysiert.

Die Daten bestanden im Wesentlichen aus kategorialen Variablen und wurden unter Verwendung deskriptiver Statistiken analysiert. Die Assoziation zwischen kategorialen Variablen wurde mit Cramers V, dem Chi-Quadrat, gemessen, das die Leistungsfähigkeit und Zuverlässigkeit des Tests ausmacht. Cramers V ist ein Maß für Assoziationstests, die direkt in die Kreuztabelle integriert sind. Der Chi-Quadrat-Test mit gleichen Anteilen wurde verwendet, um die Anteile auf signifikante Unterschiede bei 0,05 Niveaus zu vergleichen. Das Statistikpaket - Epi Info 6.04d - wurde zur Erstellung einer Kontingenztabelle aus mehreren Unterausgaben und zur Bestimmung der Zuordnung zwischen den Zeilen- und Spaltenkategorien verwendet.

Die Skalenvariable „Menge des anfallenden Abfalls" wurde anhand von Maßnahmen zentraler Tendenz beschrieben. Es wurde unter Verwendung der Kolmogorov-Smirnov- und Shapiro-Wilk-Tests auf Normalität untersucht; in allen Zusammenhängen wurde die Normalitätsannahme verletzt ($P < 0{,}05$). Fünf Nullhypothesen wurden unter Verwendung des logistischen Regressionsmodells getestet. Die Aussagekraft der einzelnen konzeptionellen Komponenten wurde mit dem Cox & Snell R-Square berechnet, und die der einzelnen Indikatoren wurde auch mit dem Likelihood Ratio-Test bewertet.

Im Rahmen dieser Arbeit wurde die Bedeutung der vom Modell erklärten Variabilität (Baseline model) anhand der Omnibus-Tests der Modellkoeffizienten, die Größe dieser Variabilität anhand des Modells mit Cox & Snell R^2 und die Auswirkungen des Individuums unter Verwendung von Prädiktoren, die den Likelihood Ratio-Test bewertet.

Qualitativ wurden Daten aus offenen Items, Beobachtungen und Interviews unter Verwendung des Prozesses der thematischen Analyse analysiert, wobei Konzepte oder Ideen unter Oberbegriffen oder Schlüsselwörtern gruppiert wurden. Die Ergebnisse wurden anhand von Tabellen, Diagrammen, Grafiken, Fotos und Karten dargestellt.

Erkenntnisse und Diskussionen. Die Gesamtheit der Untersuchungen hat ergeben, dass sich eine ordnungsgemäße Abfallbehandlung im nigerianischen Bundesstaat Imo positiv auf die Umwelt auswirkt. Dies wurde anhand des Bewusstseins der Gemeinschaft für die Abfallbewirtschaftung über Quellen wie Radio und Fernsehen, ihrer Aufklärung über die Abfallbewirtschaftung und der Einbeziehung der Umwelterziehung der Schulen in ihr Unterrichtsprogramm bewertet. Obwohl die meisten Befragten die Umweltsituation im Staat im Vergleich zu vor etwa 10 Jahren als verschlechtert empfanden und sich der Notwendigkeit einer ordnungsgemäßen Abfallentsorgung bewusst waren, wurde die aktuelle Umweltsituation als besser beschrieben. Dieser Einfluss des Umweltbewusstseins und der Umweltbildung auf die Umweltverträglichkeit, die mithilfe des logistischen Regressionsmodells bewertet wurden, zeigen eine signifikante Variabilität (Omnibus-Tests der Modellkoeffizienten: $\chi 2 = 42{,}742$; $P = 0{,}014$). Dies lässt darauf schließen, dass das Umweltbewusstsein und die Umweltbildung die Umweltverträglichkeit signifikant vorhersagen lassen.

Die Ergebnisse zeigten auch, dass organische Abfälle häufiger als andere Abfallarten wie Papier, Kunststoff, Elektroschrott, Metall, Textil und Glas anfallen. Während die Müllsammler immer Papier, Plastik, Aluminium und Metall sortierten, sortierten einige von ihnen auch Textil und Glas. Statistisch gesehen (P <0,05) stellten die Befragten in dem Umfeld, in dem am wenigsten Abfall erzeugt wurde (d. h. 1 bis 2 kg pro Tag), fest, dass die Umweltqualität im Vergleich zu vor 10 Jahren besser war. Abfälle wie zerbrochenes Glas und Textile sowie die Reste von E-Abfällen nach der Gewinnung von Kupfer und Messing nicht sortiert wurden und diese mehr zur Umweltzerstörung beitrugen.

In ähnlicher Weise wurde der Einfluss des Wohlstands auf die Umweltnachhaltigkeit mithilfe eines logistischen Regressionsmodells bewertet, das entwicklungsindexbezogene Indikatoren wie Bildung, Beruf, Einkommen und die Zahlungsfähigkeit für die Art der Abfallentsorgung umfasste. Bei der Harmonisierung des Ergebnisses gaben die Landwirte, die größtenteils am wenigsten ausgebildet waren, an, mehr Umweltverbesserungen zu bemerken. Darüber hinaus sahen diejenigen, die sich nicht bereit erklärten, für die Abfallentsorgung aufzukommen, bei denen es sich hauptsächlich um Personen mit niedrigem Einkommen handelte (weniger als 200.000 Naira, das heißt, 620 € monatlich), eine stärkere Verbesserung der Umweltbedingungen als diejenigen mit einem Einkommen von mehr als 200.000 Naira. Diese scheinbar widersprüchliche Wahrnehmung kann auf die Tatsache zurückgeführt werden, dass Menschen mit geringem Bildungshintergrund nicht in der Lage sind, ökologische Nachhaltigkeitsaspekte richtig einzuschätzen, verglichen mit Menschen mit einem breiteren Bildungshintergrund und eher kritischem Denken.

Die Beschäftigungs- und Verdienstmöglichkeiten im Zusammenhang mit der Abfallbewirtschaftung im Hinblick auf die Umweltnachhaltigkeit wurden anhand einer qualitativen thematischen Analyse bewertet. Alle Befragten, die mit dem Sortieren, Kaufen und Verkaufen von Abfällen befasst waren, hatten keine zweite Beschäftigung. Sie bescheinigten, dass das Geld, das sie mit ihren Aktivitäten verdient hatten, ihren Lebensunterhalt und den ihrer Familien sicherte. Einige gaben an, ihre Arbeit sehr gerne zu machen, besonders, wenn sie selbständig arbeitend waren. Die Müllsammlung und der Handel mit Abfällen bieten vielen Gruppen auf der ganzen Welt Beschäftigungsmöglichkeiten. Dies reicht vom Abfallrecycling, der Abfallkompostierung und der Beschäftigung bei der Müllverbrennung in Entwicklungsländern bis zur Tätigkeit bei den „Stadtreinigern“ in der Stadt Würzburg. Die Mitarbeiter und Mitarbeiterinnen in diesen Unternehmen haben durch Abfall-(Behandlung) Arbeitsplätze.

Der Einfluss der Abfallentsorgung auf die Umweltnachhaltigkeit wurde mithilfe des binären logistischen Regressionsmodells bewertet, und die durch das Modell erklärte Variabilität war signifikant. Die Validität wurde auch von der Wald-Statistik (P <0,05) gestützt, die anzeigt, dass die Wirkung der Prädiktoren signifikant ist. Die Umweltnachhaltigkeit ist stark abhängig von Indikatoren wie der Häufigkeit, in der die Befragten ihre Abfallbehälter entleerten; wie / wo Abfälle entsorgt werden, der Verfügbarkeit von Abfalldeponien oder öffentlichen Abfalleimern in der Nähe des Hauses usw. Nach Ansicht von Imolites, die behaupteten, öffentlichen Abfallsammelstellen/-behältern in der Nähe ihrer Häuser zu haben, hat sich die Qualität der staatlichen Umwelt verschlechtert, da sich die Qualität dieser Abfallsammelstellen/-behälter verschlechtert habe. Die Standorte sorgen für ständige Geruchsbelästigung, Rauch und ziehen Tiere/Ungeziefer an. Imolites in der Nähe von

Deponien klagten über Beschwerden wie Durchfall, Katarrh, Insektenstiche, Malaria sowie Atembeschwerden durch Rauch und Gestank.

Schlussfolgerungen. Der Zusammenhang zwischen schlechten Abfallbewirtschaftungsstrategien und mangelnder Nachhaltigkeit im Umweltmanagement im nigerianischen Bundestaat Imo wurde als wahrscheinlich angesehen, da in diesem Untersuchungsgebiet statistisch signifikante Ineffektivität in der Abfallbehandlung, mangelndes Bewusstsein, Armut sowie unzureichende und unrealistische Abfallbewirtschaftungsmaßnahmen festgestellt wurden. In diesen Situationen habe sich die Umwelt lt. Umfrageergebnis in den letzten ca. 10 Jahren nicht verbessert. Solche Unzulänglichkeiten im Umgang mit anfallenden Abfällen gefährden nicht nur die Gesundheit der Bürger und Bürgerinnen, sondern führen auch zu Straßen und Wegen, die von Schmutz und vielen unbeaufsichtigten Deponien gekennzeichnet sind. Diese verursachen eine starke Geruchsbelästigung und ziehen wilde Tiere und Ungeziefer an. Diese Situation ist nicht nur im nigerianischen Bundesstaat Imo, sondern auch in vielen Städten in Subsahara-Afrika verbreitet.

Zukunftsperspektiven. Um die Umwelt in Subsahara-Afrika zu verbessern, ist ein integratives und integriertes nachhaltiges Abfallmanagementsystem unabdingbar. Die Abfallmenge in dieser Region wächst rasant, insbesondere Lebensmittel- und Bioabfälle. Die Region sollte auf Gesetze zur Abfallbewirtschaftung und Strategien zur Abfallreduzierung abzielen, um nur die tatsächlich benötigten Lebensmittel bereit zu stellen. Die Abfallbewirtschaftung sollte außerdem auf die Vermeidung von epidemischen Ausbrüchen von Cholera, Typhus, Lassafieber und Malaria abzielen, deren Überträger in schmutzigen Umgebungen gedeihen. Wasserkanäle und Gewässer sollten keine Abfallentsorgungskanäle sein.

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Table of Contents

List of Figures

List of Tables

Acronyms and abbreviations

APHA	American Public Health Association
APME	Association of Plastics Manufacturers in Europe
AWWA	American Water Works Association
BAN	Basel Action Network
BCCC	Basel Convention Co-ordination Centre
BFJ	Bundesamt für Justiz
BICC	Bali International Convention Centre
BMJV	Bundesministeriums der Justiz und für Verbraucherschutz
C2C	Cradle-to-cradle
CBOs	Community Based Organisations
CDWs/C & D	Construction and demolition waste
CEWEP	Confederation of European Waste-to-Energy Plants
CIO	Christabell International Organization
CUP	Cambridge University Press
DEFRA	Department for Environment, Food and Rural Affairs
DSD	Duales System Deutschland
DTIE	Division of Technology, Industry and Economics
EAP	East Africa and Pacific
ECA	Europe and Central Asia
ECCAS	Economic Community of Central African States
ECCDE	Early childcare development and education
ECCP	European Climate Change Program
ECOWAS	Economic Community of West African States
ed.	Edition
Ed.	Editor
Eds.	Editors
EEA	European Economic Area
EEC	European Economic Community
e.g.	For example
EEE	Electrical and electronic equipment
EKC	Environmental Kuznets curve

EMAS	Eco-management Audit Scheme
EMS	Environmental Management System
ENGO	Environmental Non-Governmental Organisation
ENTRACO	Environmental Transformation Commission
Env.	Environment
EoW	End of Waste
EPA	Environmental Protection Act
ESDAC	European Soil Data Centre
EU	European Union
FCE Ltd	Fichtner Consulting Engineers Limited
FEPA	Federal Environmental Protection Act
FGN	Federal Government of Nigeria
FMANR	Federal Ministry of Agriculture and Natural Resources (Nigeria)
FME	Federal Ministry of Education (Nigeria)
FMHE	Federal Ministry of Health and Environment (Nigeria)
FMP	Federal Ministry of Power
FORMECU	Forest Management Evaluation and Coordinating Unit
FUTO	Federal University of Technology Owerri
GAIA	Global Alliance for Incineration Alternatives/Global Anti Incinerator Alliance
GAWP	Global Alliance of Waste Pickers
GCE A/L	General Certificate of Education Advanced Level
GCE O/L	General Certificate of Education Ordinary Level
GEI	Green economy initiative
GHG	Greenhouse gases
GWMO	Global Waste Management Outlook
HDPE	High-density polyethylene
HWRCs	Household waste recycling centres
HWSD	Harmonized World Soil Database
i.e.	That is
ICCM2	Second Session of the International Conference on Chemical Management
IETC	International Environmental Technology Centre

IGE	Inclusive Green Economy
IMSU	Imo State University
INSC	Institut National de la Statistique du Cameroun
IRIN	Integrated Regional Information Networks
ISUA	Imo Scrap Union Association
ISWA	International Solid Waste Association
IUCN	International Union for Conservation of Nature
IWMA	Imo Waste Management Agency
JAMB	Joint Admissions and Matriculation Board
JMU	Julius-Maximilians-Universität
JSCE	Junior Secondary Certificate Examination
KrWG	Kreislaufwirtschaftsgesetz
KWB	Kreislaufwirtschaftsbau
LAC	Latin America and the Caribbean
LACW	Local Authority Collected Waste
LDPE	Low density polyethylene
LG	Local Government
LGA	Local Government Area
LGAs	Local Government Areas
LIC	Low Income Countries
LMIC	Lower Middle Income Countries
LWMA	Lagos State Waste Management Agency
MCFG	Motor City Free Geek
MDGs	Millennium development goals
MENA	Middle East and North Africa
MHKW	Müllheizkraftwerk
Min.	Minister
MSW	Municipal solid waste
₦	Naira (Nigerian currency)
na	Not available
NAFDAC	National Agency for Food and Drug Administration and Control
NAN	News Agency of Nigeria
NBCCC	Nigerian/National Basel Convention Coordination Centre

NBS	National Bureau of Statistics
n.d.	No date
NDDC	Niger Delta Development Commission
NDLEA	National Drug Law Enforcement Agency
NECO	National Examination Council
NEDS	Nigeria Education Data Survey
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NETW	North East Trade Winds
NHA	Nigerian Hotel Association
NIMBY	Not in my backyard
NIMET	Nigerian Meteorological Agency
NIMH	Not in my house
NIMS	Not in my shop
NNPC	Nigerian National Petroleum Corporation
NNPCASB	Nigerian National Petroleum Corporation Annual Statistical Bulletin
NOA	National Orientation Agency
NPC	National Population Commission
NRGI	National Resource Governance Institute
NTDCA	Nigerian Tourism Development Corporation Act
OAU	Organisation of African Unity
OND	Ordinary National Diploma
OPEC	Organisation of Petroleum Exporting Countries
OPECASB	Organisation of Petroleum Exporting Countries' Annual Statistical Bulletin
OTH	Orlu Teaching Hospital
PDWD	Packaging and Packaging Waste Directive
PET	Polyethylene terephthalate
PP	Polypropylene
PPC	Pollution Prevention and Control
PS	Polystyrene
PVC	Polyvinyl chloride

RDF	Refuse derived fuel
RIC	Resin identification code
SAICM	Strategic Approach to International Chemicals Management
SAR	South Asia Region
SCERP	Sixth Community Environment Action Program – 2002
SCP	Sustainable Consumption and Production
SPI	Society of plastic industry
SRF	Solid recovered fuel
SSA	Sub-Saharan Africa
SSCE	Senior Secondary Certificate Examination
StEP	Solving the E-waste Problem
SWTW	South West Trade Winds
TC	Tropical Continental air mass
TM	Tropical Maritime air mass
UBEC	Universal Basic Education Commission
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Conference on Sustainable Development
UNEA	United Nations Environmental Assembly
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UN HABITAT	United Nations human settlements' program
UNICEF	United Nations International Children's Emergency Fund
UNITAR	United Nations Institute for Training and Research
UNSD	United Nations Statistics Division
UNVDA	Upper Nun Valley Development Authority
US EIA	United States Energy Information Administration
VES	Veolia Environmental Services
WAEC	West African Examination Council
WBHE	World Bank Housing Estate
WCA	Waste Collection Authority
WEEE	Waste Electrical and Electronic Equipment
WEF	Water Environment Federation

WFD	Waste Framework Directive
WIEGO	Women in Informal Employment Globalizing and Organizing
WMH	Waste management Hierarchy
WRAP	Waste and Resource Action Program
WTE	Waste-to-Energy
WVV	Würzburger Versorgungs- und Verkehrs-GmbH
WWF	World Wildlife Fund
ZVAWS	Zweckverband Abfallwirtschaft (Raum Würzburg)

Acronyms of sampled schools at the study sites

Acronyms of sampled schools in Owerri metropolis

APS	Aladinma Primary School
CANPS	Claret Academy Nursery and Primary School
CASS	Claret Academy Secondary School
CDSS	Comprehensive Development Secondary School
CNPSUN	Claret Nursery and Primary School Umualum Nekede
CSSN	Claret Secondary School Nekede
DMRCNPS	D'Marcie Royale Crèche, Nursery and Primary School
FCNPS	Fair Child Nursery and Primary School
FGGC	Federal Government Girls' College (Owerri)
GSS	Girls' Secondary School (Ikenegbu, Owerri)
LSHS	Lighthouse Startright High School
MACNPS	Maria Assumpta Cathedral Nursery and Primary School
MHS	Methodist High School
MMSS	Madonna Model Secondary School
MNPS	Madonna Nursery and Primary School
MSPS	Mann Saint Primary school
Rosy Kids	Rosy Kids Nursery and Primary School
SOEDSS	School of Education Demonstration Secondary School
Sts. MJSSUN	Sts. Mary and Joseph Secondary School Umualum Nekede
UPS	Umualum Primary School

Acronyms of sampled schools in Orlu

APS Amaike	Aladinoba Primary School Amaike
BSC Orlu	Bishop Shanahan College Orlu
CPS Amaike	Central Primary School Amaike
CS Eziachi	Central School Eziachi
ESS Amaike	Eziachi Secondary School
GSS Orlu	Girls' Secondary School Orlu
HRSS Ihioma	Holy Rosary Secondary School, Ihioma, Orlu (*Ihioma Girls*)
ISS Orlu	International Secondary School

OMSS	Ojike Memorial Secondary School
OPS Ihioma	Onymiri Primary School Okuabala, Ihioma
TCHS	Township Comprehensive High School
USS Amaike	Umueze Secondary School Amaike

Acronyms of sampled schools in Okigwe

CCNPSS	City College Nursery, Primary and Secondary School
FGC Okigwe	Federal Government College Okigwe
Mercy GSS	Mercy Government Secondary School
QASS	Queen of Apostles Secondary School
SMNPS	Santa Maria Nursery and Primary School

St. Peter’s Seminary Okigwe

Urban Primary School Okigwe

1 INTRODUCTION

1.1 Littering and garbage patches on the streets and in water bodies in cities of Sub-Saharan Africa (SSA)

Waste in human communities is age old. Before recorded history, waste decomposed in small quantities according to the capacity of the natural environment to recycle. A simultaneous consumption of the resources and amenities from urbanization and industrialization, with severe implications on how to collect, store and dispose of waste emerged as a worrisome issue considering the current level of urban technology for these crises in SSA. Humanity has experienced numerous negative effects of waste disposal within its environment.

In Nigeria, like in many Sub-Saharan African countries, old and new cities that have become State, regional, provincial, divisional, district, counties and departmental capitals[1] have expanded in surface area and population with the attendant need for similar expansion in infrastructural facilities and other resources to sustain the growing need of its population. In urban areas of Imo State, Nigeria, commercial, industrial and household activities have brought about phenomenal increase in the daily volume and diversity of garbage. Ayeni (1978), Mabogunje (1968) and Sada (1977, 1980, 1984) considered this to be a result of rapid urbanization in the country without corresponding rapid provision of needed resources to sustain the ever-increasing population, especially in the cities. Garbage heaps are common sights in State capitals and urban areas.

Waste management has been of environmental and moral concern to urban public and private stakeholders. Waste generation, accumulation, collection and evacuation thus remain a serious environmental nuisance and challenge in most towns and cities in Sub-Saharan Africa. Perhaps, because the schemes for collection, evacuation and disposal of wastes have not been sufficient, realistic or effective (Parnham & Rispin, 2001, pp. 291-298; Uchegbu, 1998). Perhaps also because the rate of collection, evacuation and disposal often lag behind the rate of generation and accumulation of waste. Of recent, commercial cities like Onitsha in Anambra State, Aba in Abia State and State capitals like Owerri in Imo State produce large amounts of waste such

[1] In West Africa, countries have different administrative divisions. Republic of Benin is divided into 12 Departments, Burkina Faso into 13regs, Guinea 7 Regions, Côte D'Ivoire 12 Districts, The Gambia 5 Divisions, Guinea Bissau 9 Regions, Ghana 10 Regions, Liberia 15 Counties, Mali 8 Regions, Mauritania 15 Regions, Nigeria 36 States, Togo 5 Regions, Senegal 14 Regions, Sierra Leone 3 Provinces, Cape Verde 22 Municipalities.

that their street and roadsides are littered with disgusting amounts solid waste and odour-emitting garbage heaps.

Though the term 'waste' is easily understood, the precise, globally accepted definition is probably difficult to make. In this work, waste embraces all wanted or unwanted, useable or unusable (by-) products, which have been generated and discharged with or without economic significance. It involves all other matters, which in turn, alter the aesthetic value of the environment. The notion of waste as explained by the European Council (1997) is relative in two main respects. First, something becomes waste when it loses its primary function for the user. Therefore, a waste material is relative to this primary function. Secondly, what is considered waste to this primary function may be useful for a secondary function. In other words, somebody's waste material or substance is someone else' (secondary) raw material (Bontoux & Leone, 1997).

Waste has been classified into different categories by various authors. Although there is the issue of what to choose as a foundation for categorization, most nomenclatures classify waste either by state. For example, (Savas, 1976) waste is usually considered in three main categories: solid, liquid, and gaseous. Some classify waste by origin: processing, household, packaging, or cleaning waste; CDWs or C & D; emissions treatment waste; and energy conversion waste. Others are classified by some of their characteristics, such as inert waste, combustible waste, bio-degradable waste, hazardous and/or nuclear waste (Pongrácz & Pohjola, 2004).

Solid waste generation according to Goddard (1975) is as old as man's activities. He further stated that living inescapably results in the production of waste, which are unwanted residue. Solid waste, according to him then, were food remnants, which were not in large quantities and concentration in a particular place because of few dispersed natures of the population.

The accumulation, uncontrolled disposal and evacuation of solid waste tend to be major public health issues and vital factors affecting the quality of the environment in towns and cities of West Africa (Afon, 2007a, 2012; Anarfi, 2012). The issue of solid waste handling has become one of the most intractable environmental aspects facing the inhabitants of Imo State (Emelue et al., 2013; Ikpeama et al., 2016). The health implication of this trend cannot be far-fetched. There has been a phenomenal increase in the volume and range of solid waste generated and accumulated daily in the urban areas of Imo State with an ever-increasing pace of urbanization, rate of population growth, industrialization and expanding economic activities. The above picture is likely to get bleaker especially in a situation of ineffective performance by various waste management authorities and agencies.

The incidences of typhoid and malaria fever attacks among the residents in urban Imo can be attributed largely to the growing squalid nature of the immediate environment. Waste of all categories can pollute and degrade the environment if not properly handled. They can cause economic and social problems in the environment affecting negatively the quality of life of urban dwellers. No doubt the accumulation of (solid) waste creates health problems, pollution, global warming and climate change due to the release of greenhouse gases (Yegbemey, 2014); increased disease incidence such as malaria, cholera, diarrhea, dysentery, respiratory tract infection and other filth-related diseases (Anunonwu et al., 2009; Nwankwo, 2008). Due to improper management, waste accumulates on the streets and open spaces in urban areas of Imo State, Nigeria. Waste materials are scattered along roads/areas like Douglas, Ikenegbu, World Bank housing estate and Nekede old road as well as Orlu and Okigwe roads and towns.

The mere sight is nauseating and spoils the beauty of the place. Besides, the piled heaps of waste serve as food and habitat for insects, flies, rodents and reptiles, which invade the population in the vicinity causing various diseases sometimes of epidemic dimensions Ikpeama et al. (2016). Traffic bottlenecks and sometimes total cut-off of traffic result from waste heaps on the streets. (See Figure 1.1). When it rains, some of the waste materials are washed into nearby water bodies, thereby rendering them unfit for human consumption. The teeming population that depends on such water bodies is put at great risk. The efficiency of a city as a functional entity is very much dependent on the excerpt of environmental quality.

Figure 1.1: Traffic cut-off and street blocked by waste because of floods after* rainfall *in Lagos.
(Photos retrieved from Nairaland, 2015)

Furthermore, the primary focus of the first component of the MDGs, adopted by the UN in 2000, is to solve the problems associated with diseases. The aim of this first item of the MDGs is to halt, and, afterwards, begin to reverse the incidence of malaria and other major diseases by 2015. In SSA, especially, malaria is a major cause of morbidity and mortality, especially among children below the age of five (Alaba, 2007). Besides this aim, there is the need to ensure a sustainable environment since we live in a defined globe. The Anopheles mosquito finds a suitable breeding ground in filthy, moist and warm environment. Hence, the indiscriminate and unsanitary accumulation, spread and disposal of waste in Imo State give this insect and many others a breeding ground for them to increase and infest the population.

The managing of waste in the context of this research would refer to the practice applied in the techniques and ways of waste deposit, collection, transportation and (hygienic) disposal in, and removal from our environment. This four-phase approach to waste management are complimentary in nature.

1.2 Waste mishandling in Nigeria: the two sides of waste

The handling of waste appears to be a major issue and a vital factor affecting urban living standards and environment in Nigeria generally and Imo State specifically. As the population grows, and as the pace of urbanization and modern living upsurges, the rate at which waste is generated and accumulated tends to increase. This poses a burden to the population and the administrative authorities alike. It appears that proportional to the increase in urban population is the rate of generation of urban waste and environmental pollution. In this view, Onibokun (1974) ranked waste generation highest on the scale of urban environmental problems. This could be attributable to rapid urbanization rate with some of its determinants being human over population, increased domestic and industrial activities, as it appears to be the situation in Imo State.

Solid waste lies en masse along the roads and streets especially in Imo State indicative of perhaps the possibility that the rate of removal does not keep pace with the rate of generation. It is thus observed that large heaps of waste contain a range of materials such as broken glass, plastics, old and scrap metal, old and used electronic and electrical equipment, food residue, human waste, and others (Onykakeyah, 2013). These constitute breeding grounds for flies, mosquitoes, rodents, reptiles and other microorganisms, which cause disease to the adjacent population (Kofo & Bola, 2012).

In urban areas of Imo State, waste management by the administration seems ineffective and insufficient with apparent problems and hazards to the people and the environment. Along some streets and roadsides where waste has been dumped, traffic is slow. Traffic in such areas may be impassable for several days, weeks or even months. It could take days to completely evacuate the heaps of solid waste that are piled up by the roadsides. An example was the 'Owerri waste saga' of October 1, 2016 (Punch, 2016a). Solid waste could also pose great potential fire hazard in the dry season and block surface water channels in the rainy season.

In Imo State, households and firms appear to collect their refuse in different ways. Most families invariably tend to use baskets, metal cans, plastics, old bags (especially of imported and local rice as well as flour), cartons and all sorts of unsanitary containers, which are accessible to insects and larger animals. Transportation of solid waste appears to be done manually and mostly by children or even adults from homes. Refuse is moved by seemingly unconventional manners.

Increasingly the waste generated is a source of employment to some individuals. It was observed that there was recovery of materials, especially from solid waste, if organized properly can generate a livelihood for unskilled workers in the developing country environment. This may further propagate the concept 'waste is money' when citizens begin to perceive waste materials as recyclable materials (Kaseva & Gupta, 1996; Kaseva & Mbuligwe, 2000; Kaseva et al., 2002). The individuals or unskilled workers (waste pickers) are people who sort "valuables" from the waste and sell to earn money and a living (UNEP, 2013). Therefore, there is an overall association between waste (especially solid waste) generation, urbanization and wealth creation (Sinha-Khetriwal D. , 2010; Snow & Dickinson, 2011; Spiegelman, 2006; VES, 2006).

In Nigeria, particularly in Imo State, the scavenging and waste trading activities as well as waste picking appear to be carried out mostly by the Muslim male youths from Northern Nigeria who, in most cases flew from the insurgency[2] going on in Northern Nigeria. According to Pickford (1984), the storage, collection, treatment and disposal of waste can lead to short term risks; in the long run, there may be dangers arising particularly from the chemical pollution

[2] It is fruit of the '*Boko Haram*' sect, founded in 2002 by a group of Islamic clerics in Bornu, under the leadership of Mohamed Yusuf. Radical at the beginning, the sect's aim was to Islamize Nigeria and impose the Sharia Law. Being opposed, they, from 2009 resorted to violence, kidnapping, terrorist and insurgent activities, devastating the country especially the North. Thus, the inhabitants have to flee and are still doing so.

of water, soils (Ikpeama et al., 2016) and the general environment (Emelue et al., 2013). Insufficient solid waste management can lead to disease transmission, fire outbreak, atmospheric pollution, water pollution, odour, accidents and general degradation of the environment.

This Doctoral piece was performed with the aim of methodically exploring waste handling techniques as a correlate of the sustainability of the Imo, State's environment. Considering waste from generation and going through the stages as outlined on the waste management ladder (prevention, reduction, recycle, recovery and disposal), we had to specifically verify the following on the environmental sustainability of the State:

- the influence of environmental awareness and education;
- the quantity of waste and its distribution;
- the influence of wealth;
- the employment and poverty reduction opportunities pertaining to waste management and their effects and
- the effects of waste disposal.

The above intents were guided and substantiated by the following research questions:

- How do environmental awareness and education affect environmental sustainability in Imo State, Nigeria?
- In what way does waste quantity and its distribution affect environmental sustainability in Imo State, Nigeria?
- To what extent does wealth affect environmental sustainability in Imo State, Nigeria?
- What are the effects of employment and poverty reduction opportunities on environmental sustainability in Imo State, Nigeria?
- To what extent does waste disposal affect environmental sustainability in Imo State, Nigeria?

1.3 Research hypotheses

General Research Hypothesis

H_0 Waste management has no significant relationship with environmental sustainability in Imo State, Nigeria.

H_a Waste management has a significant relationship with environmental sustainability in Imo State, Nigeria.

Specific Research Hypotheses

i. H_0 Environmental awareness and education do not affect environmental sustainability in Imo State, Nigeria.

   H_a Environmental awareness and education affect environmental sustainability in Imo State, Nigeria.

ii. H_0 Waste quantity and its distribution have no significant relationship with environmental sustainability in Imo State, Nigeria

   H_a Waste quantity and its distribution have a significant relationship with environmental sustainability in Imo State, Nigeria.

iii. H_0 Wealth has no significant relationship with environmental sustainability in Imo State, Nigeria.

   H_a Wealth has a significant relationship with environmental sustainability in Imo State, Nigeria.

iv. H_0 Employment and poverty reduction opportunities pertaining to waste management have no significant relationship with environmental sustainability in Imo State, Nigeria.

   H_a Employment and poverty reduction opportunities pertaining to waste management have a significant relationship with environmental sustainability in Imo State, Nigeria.

v. H_0 Waste disposal in Imo State, Nigeria has no significant relationship with environmental sustainability.

   H_a Waste disposal in Imo State, Nigeria has a significant relationship with environmental sustainability.

1.4 Position and location of Nigeria

Located in West Africa, the Federal Republic of Nigeria is named after its longest and most important River - the Niger. The country as noted by the Central Intelligence Agency (CIA World Factbook, 2019a) has a total area of 923,768 km^2, with 910, 768 km^2 being land and the rest water. It has a total land boundary of approximately 4,477 km[3] and is bordered by the Republic of Benin to the west (809 km). To its north is the Niger Republic about 1,608 km, the northeast by the Republic of Chad (across Lake Chad) about 85 km. The Republic of Cameroon is to its east about 1,975 km extending to the southern limits opening up to the Atlantic Ocean. The country has a coastline of about 853 km (Aregheore, 2009) along the Gulf of Guinea (Figure 1.2).

Nigeria is the fourth largest in West Africa in terms of surface area after Niger (1,267,000 km^2), Mali (1,240,192 km^2) and Mauritania (1,030,700 km^2). It is approximately 923,768 km^2 [4] (356,669 mi^2) (Amosun & Adedoyin, 2010; CIA World Factbook, 2019a; Iloeje, 2001). Aregheore (2009) and NBS (2010b) put the same area to be 923,769 km^2 or 91.07million hectares (Cleaver & Shreiber, 1994). The longest distance from east to West is about 767 km while from north to south is 1,605 km (NBS, 2010b)[5]. The country is precisely located between latitudes 4° to 14° north and Longitudes 3° to 14° east[6] (NBS, 2010b). The Federation is divided into 36 States, including Abuja the Federal Capital Territory (FCT); the country has 774 Local Government Areas. The States are further grouped into six geo-political zones. The country operates three tiers of government: Federal, State and Local governments.

[3] Nigeria's total land boundary according to Aregheore (2009) is 4,047km; but we use that of the CIA World Factbook because it is actually near impossible to get on land and measure this distance; and because all the countries that border Nigeria have the same dimension recorded in the CIA Factbook.

[4] Records consulted show a slight difference in the total surface area of the country; but we choose 923,768km^2 because it is the widely used figure.

[5] The longest distance from east to west of Nigeria according to Aregheore (2009) is about 800 km while from north to south is about 1450 km; Iwena (1996, 2012) opined 1,300km is the longest distance from west to east and about 1,100km from north to south. We use the estimates of National Bureau of Statistics (2010b) because it is the country's national statistics' body.

[6] Aregheore (2009) and FAO (2009) stated that the same territory Nigeria is located between Longitudes 2° 2' to 14° 30' east. The differences in these figures are observed because these are estimates not actual practical or physical measurement. Nevertheless, they refer to the same political and geographical entity - Nigeria.

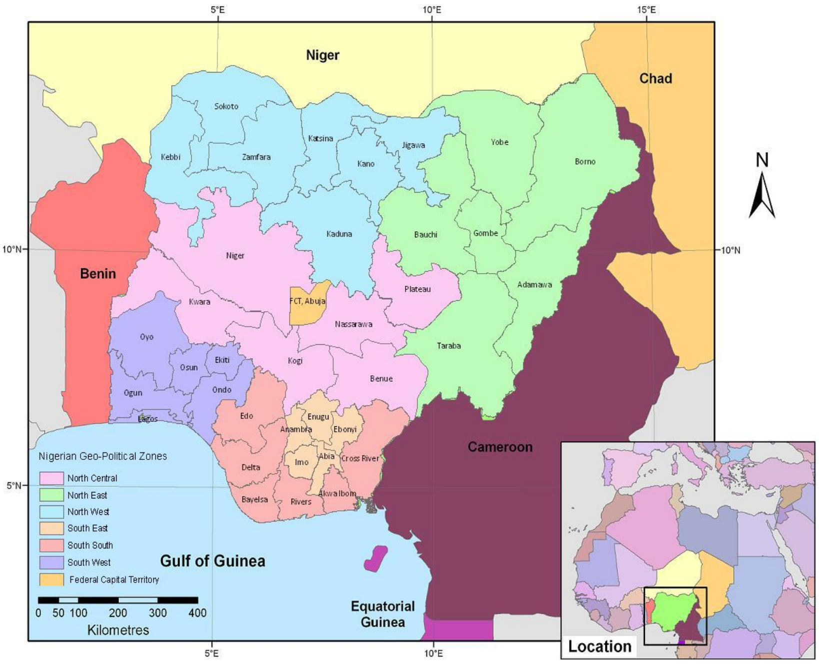


Figure 1.2 Federal Republic of Nigeria showing its localization, 36 States and 6 geo-political zones.

(Naibbi and Healey, 2014).

1.5 Position and location of Imo State, Nigeria

Imo state, found in the southeast geo-political zone occupies the area between east of River Niger and the Basin of River Imo from which it got its name (Udo, 1970). The State's eastern location, almost at the centre of the eastern part of Nigeria gave it the acronym "Eastern Heartland". Imo State is bounded to the north and north-west by Anambra State and to the northeast and east by Abia State, to the south and south west by Rivers State. The State was created when the former East-Central State of Nigeria split into Anambra and Imo States on February 3, 1976. The State is in the rain forest region of West Africa and lies between latitudes 4° 45' to 7° 15' north; and between longitudes 6° 50' to 7° 25' east. The State has a total land area of 5,530 km^2 (2,140 mi.^{2}) (Aregheore, 2009). Imo State has three distinct senatorial zones: Owerri, Orlu and Okigwe; these three headquarters are the main towns in the State. Imo State is further delineated into twenty-seven Local Government Areas (Figure 1.3). Owerri is the State's capital and is known to be the centre of commercial, administrative and industrial activities. The State has a three-tier administrative structure: State, Local and (Autonomous) Community levels.

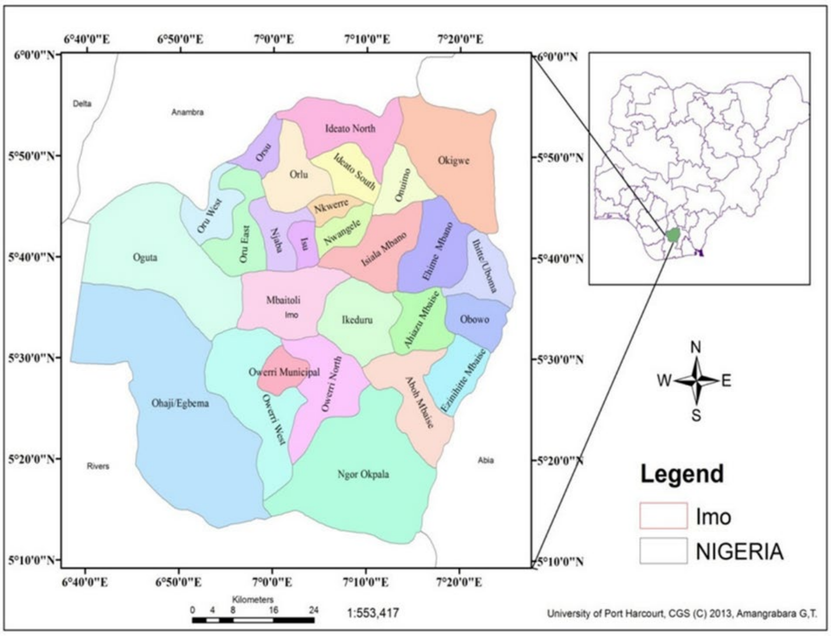


Figure 1.3 The 27 Local Government Areas of Imo State, Nigeria.
(Amangabara et al., 2015).

1.6 Relief and hydrographic system of Nigeria

a) Relief

The scenery of the country is varied consisting of lowlands stretched out mostly in the southern part of the country and plains in the north intertwined by hills and plateaux at the centre. Its mountainous areas are at the southeastern border with Cameroon. Hence, lowland areas in the country are the Sokoto plains in the northwestern part of the country with an altitude of between 150-300m (Udo, 1970). Drained mainly by Sokoto, Rima and Zamfara Rivers, they flood in the rainy season and recede in the dry season leaving behind a coat of alluvial soils termed the "*fadamas*" in Hausa (Iloeje, 2001). There is also the Lake Chad Basin or the Bornu plain in the north-east extreme part (100 – 300 m) on which are found the sand dunes of the *Hadejia* of about 12 – 30 m high and 275 – 365 m wide (Iloeje, 2001; Udo, 1970). In addition, there are the interior lowlands of western Nigeria (100 – 300 m) west of the Niger River and the lowlands and scarp lands of south-eastern Nigeria (100 -300 m) in which Imo state, Cross River plains and south-east coastal plains are found (Aregheore, 2009; Iloeje, 2001). Furthermore, there is the Niger-Benue trough/valley (100 – 300 m), the coastal margins and swamps adjacent to the ocean (0 – 200 m). This is a strip of land stretching from east to west and made up of recent deposits of sand, clays and mud. The Lagos lagoon is part of this strip (Udo, 1970).

A major characteristic of plains in Nigeria is their gentle but undulating nature, which become water logged during the rainy season. Though generally sedimentary rocks are associated with these lowland areas, some of the areas have other rock traits. Imo state is generally a plain found in the Niger Delta region. (Figure 1.3). Waste-blocked water channels, leading to flood and more waste patches on the roads and streets worsen this unembellished nature of the State when it rains.

The highland areas of the country can be grouped into three. Firstly, there is the north-central highlands or plateau that extends around Kano, Kaduna, Bauchi Jigawa and Plateau States. Secondly, there is the western uplands around States like Ondo, Oyo, Kwara and Osun. Most of the area lies between 300 and 600 m above sea level. The Idanre Hills is however about 1,000 m (Iloeje, 2001). Thirdly, there is the eastern and north-eastern highlands found around the borders with Cameroon. This area represents the highest zone in Nigeria and consists of the Mandara Mountains (1200-1500 m), the Biu plateau (800-100 0 m) and the Adamawa Mountain (1800-2300 m). (See Figure 1.4).

b) Hydrology

Nigeria, with a coastline of about 853 km, and a 13,000-km^2 surface area made up of water has four major hydrological centres: the western highlands, the north-central highlands, the eastern highlands and the eastern scarp lands. Two major Basins drain the country: the Niger and Benue Basins. Other River Basins are the Chad Basin, the Cross-River Basin and the South Atlantic Basin. These provide the country with about 8,600 km of waterways.

The main River in the country- the River Niger (from which the Republics of Niger and Nigeria are named) takes its rise from the Fouta Djallon in the Guinea highlands, flows through Mali, Niger, the borders of Benin and enters the country from the north-east flowing southwards almost through the heart of the country (Udo, 1970). It discharges itself into a massive Delta - the Niger Delta. The River with a length of about 4,180km (2,597mi) is the longest in West Africa (NBS, 2010b) and the third longest in Africa (after the Nile and the Congo). The River Benue is the second largest and second most important River in the federation.

The country is endowed with great water bodies and resources capable of improving her environment and energy if properly managed. Nigeria has more than 264 dams/reservoirs for services like water supply, irrigation, hydroelectricity, tourism and recreation. The Federal

Ministries of Environment and Power (FME; FMP, 2014) maintained that the Federal government owns 210, the State government 34 and 20 by private organizations Accordingly, about 70 micro dams, 126 mini dams and 86 small dam sites have been identified. Twenty-three of the dams have the capacity of generating electricity; but only five are functional. This according to Ley et al. (2014) is due to shortage of gas to the thermal plants and water management issues.

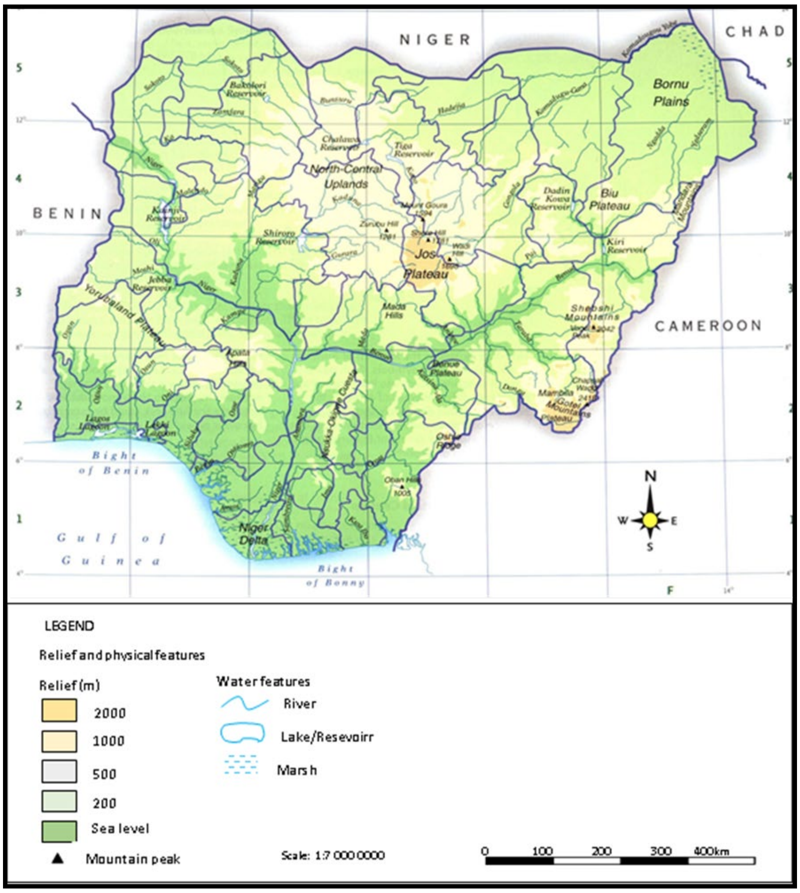


Figure 1.4 Relief map of Nigeria.
(Olayinka 1999).

Despite the great dam resources, power generation in Nigeria is still below 3,500 megawatts giving rise to a 136KW/H per capita electricity usage in the country; this is one of the lowest in the world (Ley et al., 2014). Faced with this back drop, and having major seaports like Bonny inland terminal, Lagos and Calabar, the country amongst the ECOWAS States imports about 1.2 million tons of EEE (making it the highest importer in the sub-region) (Osibanjo, 2012), amongst which is the generator plant to generate electricity. These plants do not only pollute the environment with the noise and odour-laden fumes they produce; the country has been recorded as the highest generator of e-waste amongst five West African States (Ghana, Cote

D'Ivoire, Benin, Liberia and Nigeria). It generates more than 80% (Ogungbuyi et al., 2012; Öko-Institut, 2010; Öko-Institut & BCCC-Nigeria, 2011; Öko-Institut & Green Advocacy Ghana, 2010; Osibanjo, 2012). According to data released by WHO in May 2016, Nigeria is home to four (Onitsha, Aba, Umuahia and Kaduna) of the world's most polluted cities (Parke, 2016; WHO, 2016). There in, Onitsha has the worst PM10 levels in the world; recording more than 30 times above the WHO's recommended PM10 levels. Generally, the high pollution rate stems from the inhabitants' reliance on solid fuels for cooking, burning of waste and traffic pollution from very old cars (Parke, 2016; WHO, 2016).

Major characteristics of Nigerian Rivers just like most tropical rivers is their seasonality and fluctuation of the water volume: rising during the wet season (July to October) and ebbing during the dry season. During the rainy season, this rise in water volume sometimes leads to flooding (especially as most of the riverbeds are characterised by shallowness and full of silt and waste patches) with serious devastating effects on the land and the adjacent population. (See Figure 1.5). A remarkable example is the flood of (October) 2012, considered to be the worst in 40 years (IRIN, 2012). About 1.3 million inhabitants were displaced and 431 reported dead. The flood in Benue resulted not only to loss of houses and properties (Agada & Nirupama, 2015) but also to the release of dangerous and wild animals like crocodiles and hippopotamus (NigerianEye, 2012). More than 200 persons also died from the bites of dangerous and venomous snakes released by the flood in the Duguri District of Bauchi State (Agbo, 2013; Tukur, 2013). However, the devastating effects of these floods would have been greatly reduced or avoided if the inhabitants had consented to the forecast, advice and warning of Nigerian Meteorological Agency - NIMET and the Federal Government (FGN, 2012; NIMET, 2012a, 2012b) to clear drainage systems and water ways blocked by garbage heaps and haphazard construction. Another feature of most of the country's rivers is the change in colour with seasons: having dark colour and muddy in the rainy season. Generally, rivers flowing through urban areas are filthy, stinking and filled of waste material especially plastics (Amangabara et al., 2015). The Rivers and streams in Imo state are a typical example.

Figure 1.5 Flooding caused by rise in water volume in the rainy season
Much plastic and other waste items float, which add to the waste patches on the streets and some in water bodies
(Photo by Ikem, 2017)

Imo state has one major river, the River Imo that is about 225.3 km (NBS, 2010b). This river rises in an area underlined by the Imo shales[7] and whose water is muddy and largely contaminated; the Imo River has about eight (8) tributaries (NBS, 2010b). Other Rivers in the state include Rivers Njaba, Utu, Awbana, Otamiri and Nworie. The Nworie River, a 9.2 km (5.7 miles) tributary of Otamiri (30 kilometers), adjacent to the Old Road Landfill flows through Owerri. Hence, highly polluted as much waste is discharged into it. The Rivers Otamiri and Nworie are well known for their odour, dark colour and filth (Amangabara et al., 2015; Njoku, P. C., (2007). This is because most of the waste from Owerri is dumped at one of the landfill sites (Avu)[8] in Owerri West, along Port Harcourt highway, and, this creates a high concentration of phosphate and nitrate in the Otamiri (Ibe & Njoku, 1999). The State has one natural lake; - the Oguta Lake besides which are hotels, guesthouses, and eateries. These properties mostly empty their waste into the lake.

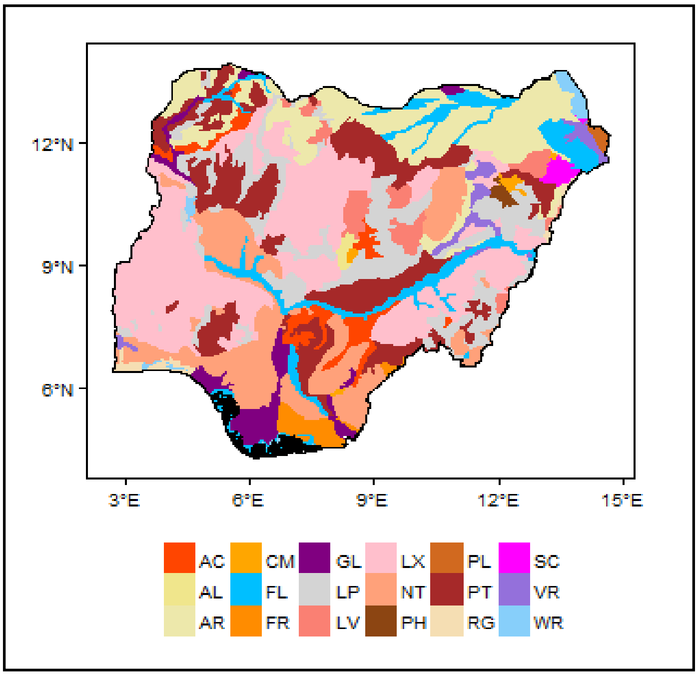
1.7 Soils and vegetation

Soils in Nigeria according to Chude & Odunze (2016) are formed from the screes of weathered basement complex rocks, alluvial sediments derived from humid, mixed alluvium and Aeolian deposits of dry tropical conditions. Soil distribution in Nigeria is influenced by, and aligns broadly with vegetation and climatic belts (Sobulo, 1985). Hence, there is a liaison between

[7] Soft fine-grained stratified sedimentary rock that formed from the compaction or consolidation of silt or clay-size minerals commonly called mud; it can be split easily into fragile plates.

[8] The Avu landfill site is completely filled up and no longer in use since 2014. Construction of residential houses is currently going on, on this site. (Author's findings during fieldwork in February, 2017).

soil moisture content (from climate) and its fertility and productivity rates, thereby giving rise to vegetation. Based on this relationship, which at the same time presents a disparity in soil and vegetation, Oyenuga (1967) explained that humid forests soils are different from those of the drier forests and the savannah zone.



AC	Acrisols	AL	Alisols	AR	Arenosols	CM	Cambisols
FL	Fluvisols	FR	Ferrasols	GL	Gleysols	LP	Leptosols
LV	Luvisols	LX	Lixisols	NT	Nitisols	PH	Phaeozems
PL	Planosols	PT	Plinthososls	RG	Regosols	SC	Solonchaks
VR	Vertisols	WR	Water Body				

Figure 1.6 Soil map of Nigeria
(Dewitte et al., 2013).

The southern belt of forest soils is the zone that represents closely that of the humid tropical forest climatic zones of southern Nigeria where rainy season is long (6-8 months), giving rise to a dense vegetation cover and the dry season is short. The soils are found in the southern part of the country like Ibadan, Akure, Abeokuta, Benin city, Anambra, Imo, Abia and parts of Cross River States. The soils are clayey loam and rich humus due to fallen and decayed leaves. They support the growth of tree crops like cocoa, oil palm, rubber, cashew, kolanut, etc. This belt of soils explains the presence of the Avu palm plantation in Imo state.

Found in the interior zone of Nigeria like Jos, Makurdi, Minna, Enugu, Abuja, etc, the zone of laterite soils is the largest (Iloeje, 2001). The soils here are physically fragile with a low level of organic matter and some with shallow depth overlying hardpan layer (Adeoye & Mohamed-Saleem, 1990; Salako et al., 2002). Though they are heavily leached and reddish in colour due to the presence of iron, they support the growth of tuber crops like yams, cocoyam, cassava, potatoes, etc. This explains the much cultivation of the staple food crop – cassava by Imolites, who harvest and convey them to the households and market areas with the peelings. Thereby generating huge quantities of waste.

1.8 Climate

Nigeria's climate is, as in most of West Africa characterized by strong latitudinal zones: becoming progressively drier as one moves from the coast to the north. As designated by the Köppen Geiger climate classification (Peel et al., 2007), Nigeria has four climatic belts. The Tropical monsoon climate (Am) found in the southern part of the country and this is influenced by the south-west monsoons (warm and humid tropical maritime air masses (TM) referred to as the south west trade winds – SWTW (Adedeji, 2002) from the Atlantic. Also, there is the tropical savannah climate (Aw) or the tropical wet and dry climate, which is experienced from the rainforest climatic boundary, covering most of western Nigeria and extends to its centre. In addition, there is the warm semi-arid climate (BSh) that covers most of north-west and northeast of the country and is characterised by cool, dry and dust laden winds from the Sahara or Tropical Continental air mass – TC, known in Nigeria as the Harmattan or the North East Trade Winds – NETW. Lastly, there is the warm desert climate (BWh) observed mildly in the north of Yobe and Borno States because of their proximity to the Sahara. The TC also influences this zone. (See Figure 1.7).

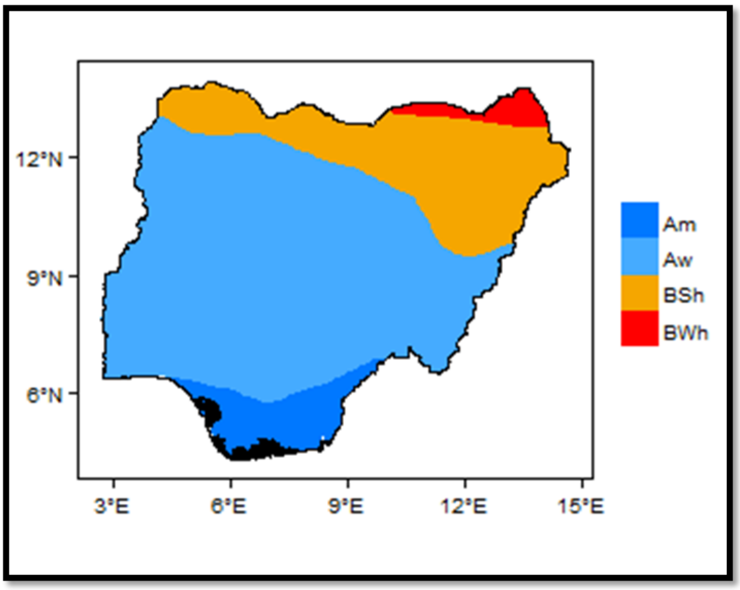


Figure 1.7 Map of Nigeria showing Köppen climate classification
(Peel et al., 2007).

Besides the above classification, (Iloeje, 2001) gives another four-fold climate types in Nigeria. These are: (i) the sub-equatorial climate found in the South around places such as Lagos, Warri, Port Harcourt, Brass, etc. Rainfall is mostly convectional and high (over 2,500 mm per annum), having double maxima (peak) – in June/July and September/October. Mean temperature about 27°C but with low annual range of 2 -3°C and relative humidity is over 90%. At the northern limit of this zone lies Imo State with an annual rainfall variation between 2,000 mm and 2,500 mm.

Generally, the country enjoys a warm and humid tropical West African climate by its location. It has relatively high temperatures with distinct wet and dry seasons (Omotosho, 1988). As noted by Ileoje (2001), the mean monthly temperature figure of above 27°C could be observed, while daily maximum temperatures can reach between 35°C and 38°C depending on the location. The latitudinal zoning of Nigeria presents a progressive dryness as one moves north from south. This entails the northern part of Nigeria is marked by a longer dry season (as compared to the southern part) that spans from October to April (Adedeji, 2002; Aregheore, 2009). In the south, the dry season spans from November to March during which the *Harmattan*[9] is experienced (Aregheore, 2009; Iloeje, 2001). The Harmattan is more common

[9] The *Harmattan* is a very dry and dusty northeasterly trade wind, which blows from the Sahara Desert over the West African sub-continent into the Gulf of Guinea between the end of November and the middle of February. The name comes from or is

in the north but affects the entire country, except for a narrow strip along the south-west coast. However, an occasional strong occurrence sweeps as far as the coast of Lagos, Warri and Brass (Adedeji, 2002).

Data recorded by the Nigerian Meteorological Agency (NIMET, 2014) for a 29-year period (1981 – 2010) support this assertion. Weather stations (Lagos, Port-Harcourt, Calabar) bordering the Gulf of Guinea between Latitudes 4° and 6°N experience in an average 12 months of rainfall. This duration and quantity reduce as the latitude increases to about 9° towards the middle belt of the country. In this zone, an average of 7 or 8 months of rainfall is experienced. As the latitude increases further towards the northern part of the country (12° to 13°N), the rainfall months dwindle to an average of 6 months with intensity just in three months (July, August and September) (Figure 1.8).

The wet season in the coastal and southeastern parts of the country usually begins in late February or March and extends until October. This season in these parts of the country is characterized by two important phenomena: the occurrence of a rainfall dip in August locally referred to as 'August break'[10] (or dry spells (Odunze, 2015) and the experience of a double maxima (peaks) of rainfall around June/July and September/October (Iloeje, 2001). The occurrence of this August break, which actually separates the rainy season into two; together with the dry (Harmattan) season according to some authors leads to a sub-equatorial climate with four seasons (Aregheore, 2009; Kolawolé & Boko, 2012). Imo State, located in this southeastern part therefore experiences these characteristics. However, and specifically, the State records an annual rainfall that varies between 1,500 mm and 2,200 mm (60 to 80 inches). During this season, humidity reaches 90%. The mean annual temperature is above 20°C (68.0°F); creating an annual relative humidity of 75%. Generally, annual rainfall totals in the south range from 2500 mm while in some parts of the extreme north it is less than 400 mm (FME, 2014).

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related to Twi haramata; probably from Arabic haram or harem meaning forbidden thing *https://en.wikipedia.org/wiki/Harmattan; Britannica.com Accessed 17.11.2016*

[10] A short relatively dry period during the rainy season, mostly in August in the southern part of Nigeria. Very little rainfall is the prime characteristic of this period and in some days, there is complete absence of rainfall.

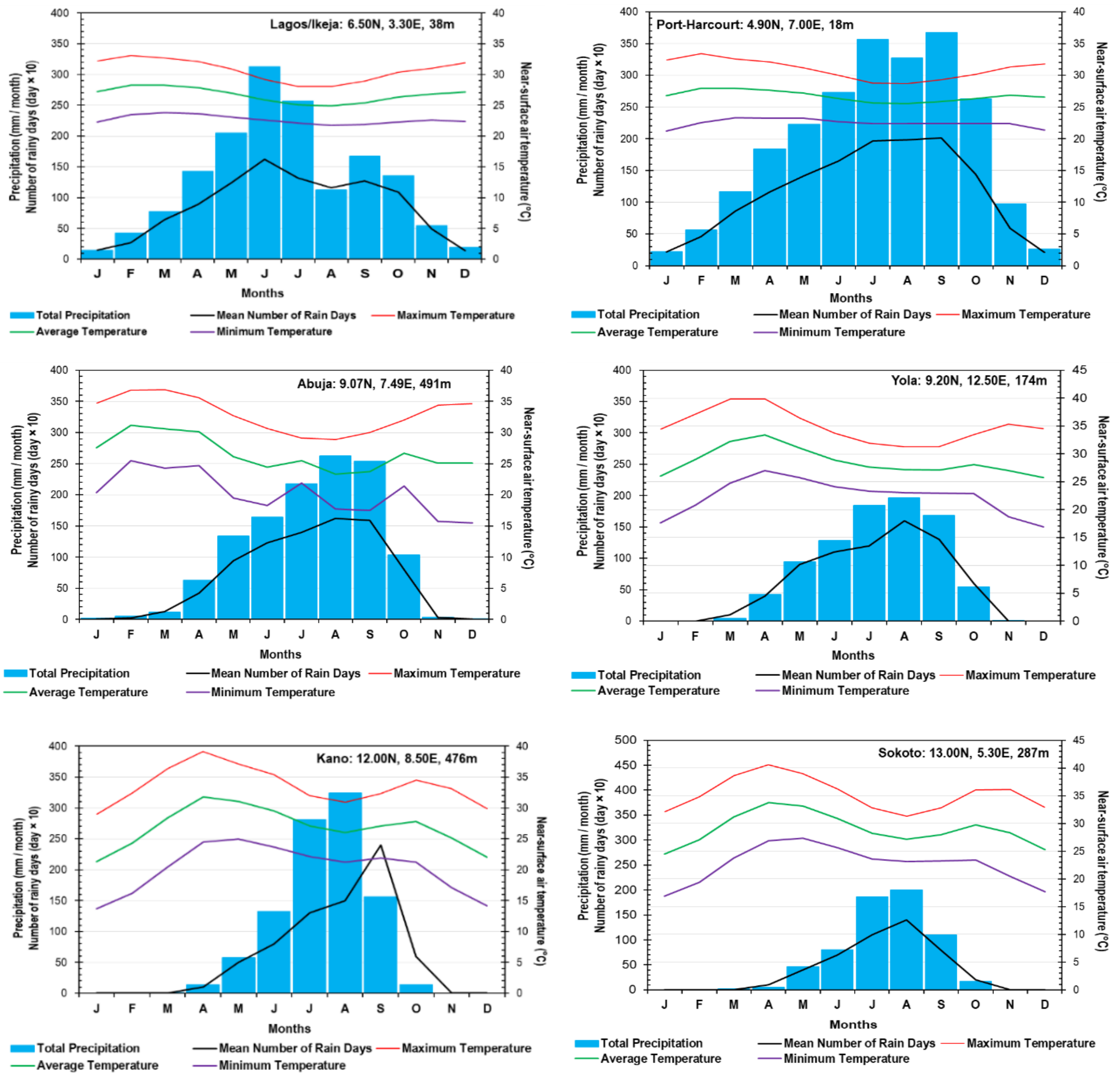


Figure 1.8 Rainfall and temperature patterns of Nigeria.
Data Source (NIMET, 2014).

The warm humid climate, coupled with the high rainfall of the nation favours a fast rate of waste decay, especially the organic content of the waste. Runoff and the flow of water, especially after the heavy rains are hindered by garbage heaps as constructed and natural water ways are blocked by swept away waste. This leads to seasonal flooding and and the spread of water-borne diseases and even epidemics like cholera. When the rain ceases, the streets are litered with more dirty plastics, papers, torn and stinking textiles as well as waste agricultural biomasss. (See Figure 1.1 above).

1.9 Vegetation and agro-ecological zones

Nigeria like its neighbours (Cameroon, Chad and Benin) is not dominated by forests. Its natural vegetation segregated as forests, savannah and montane (Iwena, 1996, 2012); with 80% being savannah (Aregheore, 2009), is a function of the interaction between climate, humidity, rainfall (Oyenuga, 1967) and soils (Iloeje, 2001). These elements have however been altered through man's activities on and with land (Iloeje, 2001; Oyenuga, 1967). Basing his classification on the above, (FORMECU, 1998; Oyenuga, 1967) classified Nigeria into nine agro-ecological zones. These are: (i) the mangrove forest and coastal vegetation; (ii) the fresh water swamp forest; (iii) the tropical high forest zone; (iv) the derived Guinea savannah with relict forest; (v) the Southern Guinea savannah zone; (vi) the Northern Guinea savannah zone; (vii) the Jos plateau; (viii) the Sudan savannah and (ix) the Sahel savannah. The Food and Agricultural Organization (FAO, 2005b) described agro-ecology in Nigeria as seen on Figure 1.9.

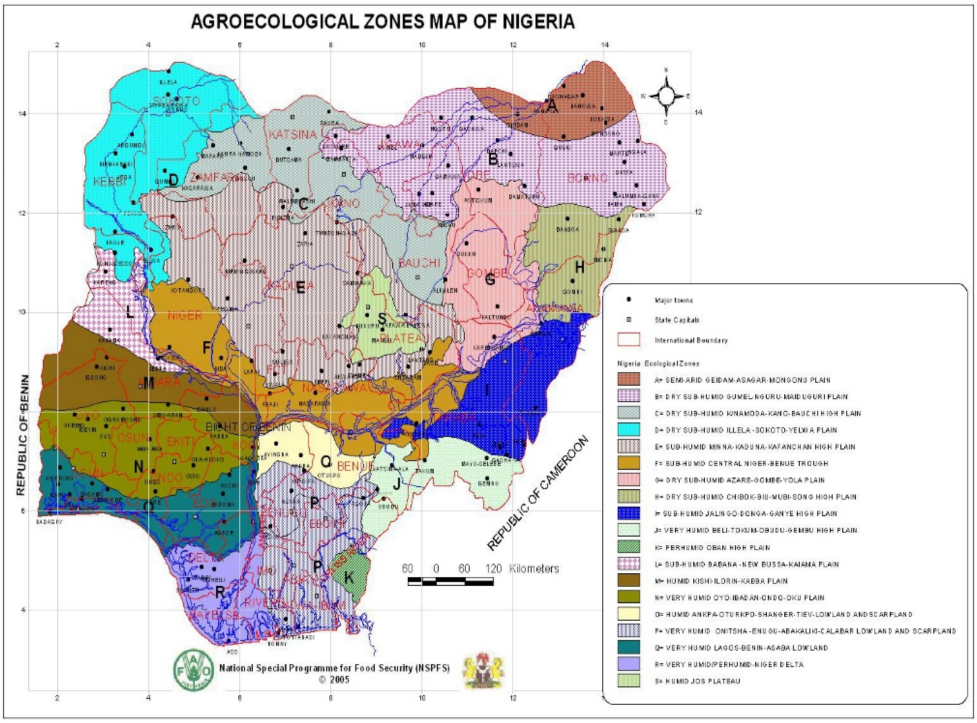


Figure 1.9 Map of Agro-ecological zones of Nigeria.
(FAO, 2005a).

Nevertheless, the vegetation of Nigeria has also been grouped into forest (salt-water swamp, fresh water swamp and high forest) and Savannah (Guinea savannah, Sudan savannah and Sahel savannah) (Iloeje, 2001) and montane savannah (Iwena, 2012).

Despite the diversity of agricultural zoning and land use in the country, five crops (cassava, yams, oil/palm fruits, Sorghum and maize) gain impetus in production (Eguono, 2014; FAO, 2015a). Though the country is the world's largest producer of cassava (Asante-Pok, 2013; Eguono, 2014; Okogbenin et al., 2013) and in 2014 produced about 54.8 million tons of this crop, its cumulative average production between 2004 and 2014 stood at 44.8 million tons (FAO, 2013).

On the other hand, Nigeria has observed a serious decline in its primary forest cover (Nzeh et al., 2015). This cover dropped from 17,234 hectares in 1990 to a merely 6,993 hectares in 2015 (FAO, 2015b). With an average annual deforestation rate of 2.38%, the country in 2005 had the highest rate of deforestation in the world (FAO, 2015b). Between 1990 and 2010, the country lost 47.5% of its forest cover.

1.10 Population and Economy

The Federal Republic of Nigeria has an estimated 203,452,505 inhabitants with a growth rate of 2.54%. (CIA World Factbook, 2019b); both of which are 2018 estimates. The population revealed by the 1991 census stood at 88.9 million and another in 2006 to be 140 million (NBS, 2010a; NPC, 2006). This growth trend reveals a population density of 106.9 persons per sq. km in 1990, 135.8 persons per sq. km in 2000 and 173.9 persons per sq. km in 2010. By 2014, the population density had risen to 194.9 persons per sq. km. With a growth rate of 2.7%, Nigeria's population is estimated by the United Nations to hit 206 million by 2020 and 410 million by 2050 (Worldometers, 2019). The country's population is dominantly rural fluctuating from 64.7% in 1990, 57.5% in 2000, 50.2% in 2010 and 53.1% in 2014. The country's urban population is estimated at 50.3 (CIA World Factbook, 2019b).

According to Aregheore (2009), Nigeria has 478 ethnic groups. The major ones are the Hausa-Fulanis (29%) (The northern part of the country around Kano, Sokoto, katsina States), the Yorubas (21%) (Western Nigeria around Lagos, Oyo, Osun, and Ogun States) and the Igbo group (18%) (Generally in the southeast in the States of Enugu, Anambra, Imo, Abia and Ebonyi) as well as the Ijaw (10%). These four groups make up for about 80% of the country's population. The Kanuri group (4%), Ibibio (3.5%); Tiv (2.5%), Edo, Nupe and others make up about 20%. The official language is English; but Hausa, Yoruba, Igbo, Fulani and more than 500 indigenous dialects are spoken (CIA World Factbook, 2019b).

The population of Imo State in 1991 as revealed by the 1991 population census was 2,485,635 (NPC, 1991). Of this population, 11.8% was clustered in Owerri; 5.7% in Okigwe and 4.7% in Orlu Local Government Areas (LGAs). In 2006, the population rose to 3,927,563 inhabitants (NPC, 2006). By this year, the population of these LGAs had increased that they were split; Onuimo LGA was mapped out of Okigwe and Owerri was split into Owerri Municipal, Owerri West and Owerri South. These three LGAs by 2006 only constituted about 12% of the State's population; but because of their established history, they became the three senatorial headquarters of the State and major centres of economic, social and administrative activities. The population of the State estimated to be 4.8 million inhabitants, a population density of 710 persons per sq. km (1,800/sq. mi.) and an urban population of 44% (NBS, 2012). Imo State is predominantly Igbo as they make up 98% of its population.

Nigeria's economy as reported by Akerele (2005) before and immediately after independence was predominantly rural and agrarian. The leading cash crops like cocoa, citrus, cotton, groundnut, palm oil, benniseed and rubber were also the country's major export in the 1960s and early 70s until they were surpassed by petroleum in the 1970s (Adelana, 2012). Emenike & Malaolu (2013) are of the view that informal sector operators mainly performed most of the activities. Meanwhile Ololwu & Okotoni (1996) explained that in urban areas like Lagos, Onitsha, Enugu, Owerri, Port Harcourt, Ibadan, etc. informal economic and commercial activities like trading, small-scale manufacturing, furniture making, woodworks, printing, tailoring, automobile mechanics, etc. were (and are) common. This informal sector according to Emenike & Malaolu (2013) since 1970 has been about 64.6% of the GDP. At the same time, this sector generates an uncontrolled amount of waste (Onyenechere, 2011).

Nevertheless, Nigeria's economy since April 2014 emerged largest in the continent (Aljazeera Africa, 2014; BBC News, 2014; Friedman, 2014; World Bank, 2014). The country's rich oil resource has been the principal source of income and government revenues since the 70s. With the discovery of the first oil field in Oloibiri (Bayelsa State) in 1956, the country joined the Organization of Petroleum Exporting Countries (OPEC, 2015) in 1971. As noted in the Annual Statistical Bulletin of the Nigerian National Petroleum Corporation (NNPCASB, 1997), Nigeria is endowed with a total of 159 oil fields and over 1,481 oil wells. With these endowments, the country stands out as the highest producer of oil in Africa noted by the NBS (2017) and the OPECASB (2016) and the eleventh in the world (NRGI, 2016). Despite these natural and economic advantages, the country is still plagued with inadequate electricity supply

(Sambo et al., 2012) poor environmental management, poor waste management systems (Onyekakeyah, 2013) and poverty. Statistics available indicate that more than 70% of its inhabitants live below the poverty line (NBS, 2010b; World Bank, 2015b) and the government has been ranked worst in the world (Brimah, 2014).

Though Nigeria's oil and gas sector contributes about 35% of the GDP (OPECASB, 2016) and over 70% of government revenue in 2011 (NBS, 2017), the country's economic growth has largely been accounted for by resilient agricultural growth (Eboh, 2005; Eboh et al., 2009), telecommunications and other services. Agriculture is an important arm of the economy as it provides over 40% of the GDP and employs about 60% of the working population (Nwafor et al., 2011; Oyinbo & Rekwot, 2014). This view is corroborated by (Adelana, 2012) who opined that agriculture is also a major source of livelihood providing employment for about 70% of the population and it grows a myriad of food and cash crops, with staples like cassava, yam, maize, beans, millet, rice, sorghum, etc.

Imo State is enriched with natural resources including crude oil, natural gas, lead, zinc, white clay, fine sand and limestone. The oil wells in the state are over 163, scattered in over 12 locations. These have attracted petroleum companies to the state such as Addax Petroleum, Chevron Corporation, Royal Dutch Shell and Nigeria Agip Oil Company. Some of the Local Government Councils that are oil-rich producers include Ohaji/Egbema, Oguta, Oru East, Oru West, Obowo and Ngor Okpalla (NNPCASB, 1997). In addition, Imo State like other oil producing States in Nigeria receives 13% as mineral derivation fund annually from the Federal Government. Besides, these States also earn billions from the Federation's account in monthly statutory allocations; they also benefit from interventionist agencies like the Ministry of Niger Delta, Niger Delta Development Commission (NDDC) and Amnesty program (NNPC, 2015).

Besides the presence of oil and gas investors in the state, there is also the international brewery - Heineken, managing the Awo-omamma Brewery through its subsidiary, - the Nigerian Breweries. The Awo-omamma Brewery began brewing on the 22 March 2003, and, at three (3) million hector litres, it is the largest brewery in Nigeria (NBS, 2010b). This brewery plant located on the banks of River Njaba is 25 kilometres from Owerri city. This proximity eases easy discharge of waste into the River.

Furthermore, there is the presence of the Imo mechanized Modern Poultry Farm at Avu in Obowo, the Imo Cattle (livestock) market, commercial/intensive fish farming and the Somachi car market[11]; it is the largest used car market in the South-East geo-political zone (NBS, 2010b). The high demand for the products, especially from the more than one hundred registered hotels with restaurants result in the generation of large quantities and types of waste. The State also boasts of an International Cargo airport in addition to its access to metropolitan markets like Onitsha, Aba, Enugu, Port Harcourt and Calabar as well as access to the seaports of Port Harcourt and Calabar. More so, Imo State has more than 1,269 Primary schools, secondary schools (NPC, 2015) and universities that attract a high population. All these establishments and businesses make use of material resources, which in turn account for the volume of waste generated and the haphazard spread.

[11]A place in Owerri where used cars imported from Europe and the USA are sold.

2 STATE-OF-THE-ART

Part I Framework and conceptualisation

Authors on the urban environment of Developing countries have often expressed concern about its degrading state. Considering that, the definition of environment involves a sum total of all external conditions influencing the growth and development of an organism (Abrams, 1971) and factors (physical, cultural, social and biological) that influence these variables of the organism (Keller, 1976). Waste can be considered a major threat on the environment if not properly and effectively managed. This is because environmental quality is considered central to health and well-being.

2.1 The waste concept

Waste as a term or concept can be easily understood. However, the precise legal, official and globally accepted definition of waste is difficult to come by. Waste is a very dynamic concept. Bontoux & Leone (1997) maintained that the notion of waste is relative in two domains. First, something becomes a waste when it loses its primary function for the user or owner. This means a waste is relative to this primary function. Second, what is considered waste to this primary function may be useful for a secondary function (Bontoux & Leone, 1997). These two authors argued that so long as someone is prepared to purchase a material, it is inaccurate to label it 'waste'. In other words, somebody's waste is someone else's raw material; or as asserted by Elwood & Patashik (1993) waste, like beauty is in the eye of the beholder. These two notions of waste will be part of my working objectives, as I will examine how waste can be resource-rich, a source of employment and wealth creation.

The word 'waste' is derived from a Latin word *uastus* meaning to lay empty, to ravage, to leave desolate or to fail to cultivate (Standbury & Thompson, 1995). Writing on the meaning of waste in the early pipe rolls of Henry II, (Medieval England) (Emilie, 1991) referred to waste as devastated land unable to produce accustomed revenue. This, the author explained further was either because of economic damage, 'waste' of crops, livestock or even men. This entails waste (land) was non-profit land. Waste was considered then as problems created by the civil war. In that context, the meaning of waste was already problematic as historians raised the question whether the said problems were agricultural, economic or something else (Emilie, 1991). The definition of waste was limited only to non-productive or non-profitable land. No reference was made to the role played by man on this land and the impact of his activities. No reference was made to materials or objects that were discarded or disposed. Also, Emilie (1991)'s reference to waste (land) is fixed; the author did not consider that devastated land could be used for something else (the re-use strategy of waste management) or be left to fallow and used later by future generations (the idea of sustainable management). Yet devastated or 'waste' land has been proven to be useful to an entire community in particular and to the nation/international community at large. This has been confirmed by works of (Ache, 2008; Fogwe & Ache, 2013, 2014) writing on the community production of rice in the Ndop plain, Upper Nun Valley of Cameroon. These studies explained how more than 10,000 hectares of inundated plain in the 1960s, considered then as wasteland became useful for the cultivation of wetland rice from the mid-1970s. The community gradually but steadily became interested in the cultivation of this crop as compiled by the Annual Statistics Board of the North-West Region and the Upper Nun Valley Development Authority (INSC, 2015; UNVDA, 2012). Cultivated area and estimated production rose from 824 hectares and 2,884 tons in the 1977/78 production year to 2,638.12 hectares and 10,536 tons in the 2009/2010 production. Currently, rice from this community is exported to neighbouring countries like Nigeria and Gabon (INSC, 2015). Hence, a waste (land) in the 1960s has become a vital resource and will continue to be – the concept of waste as a resource and sustainability.

Besides its origin, the term 'waste' has been given several definitions by different authors and organizations. Bontoux and Leone (1997) established that at the European level, the first legal definition of waste appeared in the first Waste Framework Directive – WFD (75/442/EEC) in 1975 (European Council, 1975). Since then, the Directive has been receiving amendments in 1991, 2006, 2008 and 2018 - (European Council, 1991a, 2006, 2008, 2018). In the 1975 Directive, waste is referred to as "any substance or object, which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force". This definition was also used by the Bamako Convention (1991) and the Basel Convention (1989). The fact that this definition was relative to the national legislation, member States of the European Union came up with a definition of waste (Bontoux & Leone, 1997). Faced with this critic, the situation changed when the Framework Directive on Waste (91/156/EC) was revised in 1991. Therein waste is any substance or object in the categories set out in Annex I (Box 1), which the holder discards or intends or is required to discard (European Council, 1991a).

In the central federal law of the German waste legislation *(Kreislaufwirtschaftsgesetz, 2012)*, 'waste' definition follows that of the Waste Framework Directive 2008/98/EC (European Council, 2008): "Waste shall mean all substances or objects, which the holder discards or intends or is required to discard".

Box 1 Annex I - Categories of waste *(Adapted from European Council, 1991a).*

Q 1	Production or consumption residues not otherwise specified below
Q 2	Off-specification products
Q 3	Products whose date for appropriate use has expired
Q 4	Materials spilled, lost or having undergone mishap, including any materials, equipment, etc. contaminated as a result of the mishap
Q 5	Materials contaminated or soiled as a result of planned actions e.g. residues from cleaning operations, etc.
Q 6	Unusable parts e.g. rejected batteries, exhausted catalyst, etc.
Q 7	Substances, which no longer perform satisfactorily e.g. contaminated acids, contaminated solvents, etc.
Q 8	Residues of industrial processes e.g. slags, still bottoms, etc.
Q 9	Residues from pollution abatement processes e.g. scrubber sludge, baghouse dust, etc.
Q 10	Machining/finishing residues e.g. lathe turnings, mill scales, etc.
Q 11	Residues from raw materials' extraction and processing, e.g. mining residues, oil field slops, etc.
Q 12	Adulterated materials, e.g. oils contaminated with PCBs etc.
Q 13	Any materials, substances or products whose use has been banned by law in the country of exportation.
Q 14	Products for which the holder has no further use, e.g. agriculture, household, office, commercial shops, and discards.
Q 15	Contaminated materials, substances or products resulting from remedial action with respect to land.
Q 16	Any materials, substances or products, which the generator or exporter declares to be waste and, which are not contained in the above categories.

Examining the aforementioned definitions there is a repeated use of the words 'discard' and 'dispose of', which dwindle down to "throw-away". Besides the throwaway attitude that characterizes the current era, there is also the out of sight out mind attitude and the 'not-in-my-back-yard' (*NIMBY*) syndrome. These three characteristics are detrimental to the state and nature of the environment. The definitions of waste provided by Basel Convention (1989), Bamako Convention (1991), European Council (1991, 2006, 2008), UNEP (2013) did not consider the space or place on which such substances or objects are disposed of, expected to be disposed of or discarded on to. This implies they did not consider the state or nature of the receptacle/sink (environment) and the impact such actions will have on the space or place. Considering that 'discard' and 'dispose of' are synonymous to 'abandonment', the definition of waste according to these international organizations is an act of abandonment of things with or without the interest in the final destination of the discarded things (Chenyne & Purdue, 1995) or what happens after abandonment of the things.

Furthermore, these Organizations' concept and cycle of waste ended with its disposal; it was not envisaged that waste could also be managed through the processes of reduction, re-use, recovery and recycling (Kaseva & Gupta, 1996; Kaseva et al., 2002; Lebedevas et al., 2006; Omuta, 1987; Sinha-Khetriwal, 2010; Snow & Dickinson, 2011; Spiegelman, 2006). These processes and strategies coupled with composting have proven to be useful to man and the environment. In addition to the above impact of waste disposal, its abandonment can also lead to environmental hazards like pollution - air, water and soil, (which mostly occur during burning and composting at poorly managed dump sites (UNEP, 2011d); blocked drainage and water channels causing flooding in cities (Fogwe & Lambi, 2001; Lambi & Fogwe, 2001; Ngnikam, 2001; Onyenechere, 2003), waste under bridges (Fogwe, 2008) health hazards such as the prevalence of parasites, typhoid, tetanus, malaria, cholera, diarrhoea, hepatitis, respiratory problems, skin and eye infections (Fogwe & Fombutio, 2010; UNEP, 2011d) in many African cities (Achankeng, 2003; McMichael, 2000; Nwanthi et al., 1997). These two dimensions of the impact of waste disposal constitute an objective in this study.

The Organisation for Economic Co-operation and Development (OECD, 1994) defined waste as materials other than radioactive materials intended for disposal, for reasons specified in Table 1[12]. Also, the United Nations Statistics Division (UNSD, 1997) defined waste as materials that are not prime products (i.e. products produced for the market) for which the initial user has no further use in terms of his/her own purposes or production, transformation or consumption, and of which he/she wants to dispose. This notion of waste is shared by the European Chemical Industry Council (CEFIC, 1995) who maintained that it is not the nature of the material which determines if it is waste, rather, the intentions or actions of the holder'. Hence, only the materials for which the holder has no further use and, which he intends to discard or discards are wastes. These three entities did not link the (negative) impact of these actions of 'disposal' and 'discard' to the recipient, which is the environment. In this study, waste will be inherently linked to the environment, obviously, because man who is at the centre and generator of waste within this defined source/sink (the natural environment) has not yet been able to create another source/sink to comfortably absorb or receive his waste. Therefore, there is an inevitable necessity to sustainably manage and enhance the only environment that we have with emphasis on waste generation, spread, collection, transportation and disposal (i.e. proper, efficient and sustainable waste management). This constitutes the second working theme of this research.

[12] Table 1 of the OECD is identical to Annex I of the EC

Agwuoke (2012) defined waste as residual materials, which are as a result of human activities that cannot be re-used or recovered as a resource, recycled into material production processes or thermally/biologically utilized for energy production. Furthermore, Lox (1994) saw waste as either an output with (a negative market) no economic value from an industrial system or any substance or object that has been used for its intended purpose (or served its intended function) by the consumer and will not be used'. On the contrary, waste materials have been recovered, re-used, used for energy production and recycled into other materials for production processes. In Nigeria for instance, Pasquini & Alexander (2004) stated that mixtures of manure and ashes from burning urban wastes have been used for soil amelioration to boost agricultural production in Jos. Falk & McKeever (2004) outlined the uses of waste wood and Kofoworola & Gheewala (2008) analysed the importance of construction and demolition wastes. Waste has been proven to have high economic value as waste picking and waste related activities and companies are growing and offering employment opportunities all-round the globe. An example here in Würzburg city is the 'Stadtreiniger' with about 290 workers (Die Stadtreiniger Würzburg, 2017). Earlier works indicating waste as an economic value as seen in scavenging and recycling activities are analysed by (Afon, 2007b; Diallo & Coulibaly, 1990; Diaz, 2016; Medina, 1997, 2007), etc.

Furthermore, Gourlay (1992) suggested that wastes are 'what we do not want or fail to use'. This suggestion is sequel to the argument that if a mustard or crumps of bread are left on a plate, it does not necessarily mean they are useless or have lost their value; it is simply because the owner failed to use them (consume). Such definition as argued by Oteng-Ababio (2014) is human-oriented and does not include the notion of wastes from production processes; it also neglects by-products that are not created from carelessness but resulting from the processes of production. However, items that are not used or not wanted and are discarded consciously or accidentally also belong to the domain of wastes.

One of the few definitions of waste that exhibits (though limitedly) the themes of this research is that provided by Gideon Omuta who maintained that those elements that insult the environment, which are many and varied, but most commonly – though not exclusively, manifest themselves as wastes (Omuta, 1988). These elements if properly managed can be of great help to the population that generates them thereby curtailing and why not stopping the insult they manifest on the environment. This is an important objective of this research as we analyze the varieties of wastes generated, their spatial spread within and on the environment and how wastes can not only 'insult' the environment but can also be a valuable resource to its generators and the environment at large. This study has an objective to examine the relationship between such generated waste and scavenging behaviour as well as between life and environmental quality.

The concept of waste in this work embraces all wanted or unwanted, useable or unusable (by-) products, which have been generated and discharged with or without economic significance. Waste also involves all other matters or substances, which in turn, alter the aesthetic value, nature and state of the environment; such materials can be either reduced, re-used, recycled, recovered or renewed/redesigned. Therefore, the term 'waste' and 'resource' are used in this work interchangeably to avoid any subjectivity in their meanings in the socio-economic system. These five strategies/aspects of waste management can either, and/or reduce human time and energy spent, create employment, reduce poverty, improve health and nutrition and generate wealth and keep the environment clean and neat for present and future generations (the notion of environmental sustainability). Therefore, waste in this context can be prevented (reduced to the barest minimum) and be used for and as something else other than their primary use (the strategy of re-use and the concept of waste as a resource). The use of coffee waste to produce the much desired tropical fungi – mushroom (Pauli, 2010a), production of plastics from food waste (Pauli, 2010b) and the use of waste fats of animal and vegetable origin for the production of biodiesel fuel (Lebedevas et al., 2006) are examples.

On the other hand, in the *'Kreislaufwirtschaftsgesetz, § 5 KrWG Ende der Abfalleigenschaft'* put forward by the German Federal Ministry of Justice and Consumer Protection – BMJV and the Federal Office of Justice – BfJ in 2012 *(Kreislaufwirtschaftsgesetz, 2012)* an artefact or a substance ceases to be waste when it meets the following criteria:

- A recycling and/or reclamation process has been carried out
- The substance is used for a specific purpose
- There is demand or a market for the substance
- Specific technical and legal requirements are met
- Use of the substance engenders no harm

The above criteria are said to be the End of Waste (EoW) status as defined in the above Act. This entails, there are many waste materials that have reached their end of waste, possessing the aforementioned traits and as such are no longer waste.

2.1.1 The Waste Management concept

Waste management has been defined as the collection, transport, recovery (including sorting) and disposal of waste, including supervision of such operations and the after-care of disposal sites, and including action taken as a dealer or broker (European Council, 2018). Managing wastes epitomizes one of the most vital issues a society must tackle vis-à-vis the environment. Donnelly et al. (1971) and Ivancevich (1974) consider management to be a process undertaken by one or more individuals to co-ordinate the activities of others to achieve results not achievable by one individual action alone. Management also involves planning, organizing, directing and controlling the various parts of an undertaking or organizational resources in pursuit of organizational goals (Dunham & Pierce, 1989). In addition, (Giglioni & Bedeian , 1974) planning, organising and controlling are each vital function in the management process. They maintained that, while the management theory provides information concerning planning, especially organizing, control analyses systematically.

Recently, Bateman et al. (2017, p. 13, 2018, p. 4) referred to management as the process of working with people and resources to accomplish organizational goals. They maintained that good managers do those things both effectively and efficiently. Sound management of refuse disposal activities is essential to achieve efficient sanitary, reliable operation that is well accepted by the community. The United Nations Human Settlements Program (UN-HABITAT, 2012) explained that achieving solid waste management is one of the six activity sectors essential for the meaningful green economy. Iwuala (2012) substantiated that the target of green economy is sustainable development in a sanitary, healthy and supportive environment.

Waste management is therefore an expensive venture for the African cities as they use between 20-50 percent of their budget on it; even at that, only about 20-80 percent of the waste is collected (Achankeng, 2003). Collection here entails, the waste materials are picked up from generation points and/or temporal disposal sites; but the final destination of the waste and the aftermath are not considered. The later percentage is not in contrast with statistics made available by the World Bank (Bhada-Tata & Hoornweg, 2012). By it, the percentage collected for low income countries or economies (LIC)[13] is estimated at 43% while for lower middle-

[13] All African countries fall within these two categories except for Botswana, Gabon, Mauritius, Namibia, Seychelles, South Africa and Algeria. LCI as of 01.07.2016 are defined as economies with GNI per capita, calculated using the World Bank Atlas method of $1.025 in 2015 while LMIC are those with GNI per capita between $1.026 and $4.035.

income countries (LMIC) it is 68%. The LIC are estimated to have spent about $1.5 billion while the LMIC spent an estimate of $20.1 billion on waste management in 2010. By 2025, it is estimated that these countries will spend about $7.7 billion (LIC) and $84.1 billion (LMIC) on waste management (Bhada-Tata & Hoornweg, 2012). However, this section of the work presents the review of literature of waste management: the actual trends, paradigms, methods and attitudes of the population at the regional, federal and State levels. Therefore, waste management can simply be considered (man's) reaction to waste (Pongrácz, 2002) as the later stems from various human, socio-economic and environmental activities.

The main objective of waste management opined Pongrácz (2002) seems to be that of waste removal. This notion is shared by Wilson et al. (2012) and Vilis et al. (2009) who opined that historically, waste management focused on removing potentially harmful materials away from human settlements in urban areas. The big question here is what happens after removal and whose responsibility is it. In most West African cities and Nigerian in particular, the sight of the wind blowing old papers and plastics about the town and runoff carrying them along the streets and water channels can make one to blame the authorities and waste management companies for not doing their job well. In this light, Godfrey (2006) argued that many municipalities fail to supply adequate waste management services to their communities. The citizens (waste generators) in this scenario do not blame themselves since the waste is out of their houses, offices, industries, companies, shops, etc. – a situation referred to as the '*not-in-my-back-yard*' syndrome. This syndrome is not a new in waste management. Bilitewski et al., 1994 reported that from 9000 to 8000 BC people learnt to dispose of their waste outside their own settlement to avoid odour, wild animals and nuisance from vermin.

(Solid) waste management as assessed by the World Bank (Silpa et al., 2018) is a global issue that matters to everyone in the planet. Waste management and environmental sustainability are two global, worrisome and current themes (UNEP, 2013). These issues are also challenges with crucial health and environmental problems facing governments of African cities (Achankeng, 2003). Also, paragraph 218 of *"The Future we want"*[14] called for the development and enforcement of comprehensive national and local waste management policies, strategies, laws and regulations as well as resource efficiency and environmentally sound waste management. All this does not mean, concluded by Pongrácz (2002) that humans cannot live a better life or

[14] The outcome document adopted at the UN Conference on Sustainable Development in June 2012

maintain a higher living and comfort without being immersed in and worried about heaps of waste. Therefore, one can say the actual challenge is not the volume of waste generated, rather, it is the rate at which it is left to accumulate, evacuated, disposed of and what is done to it after disposal. This can be supported by the assertion that although America according to Rosenbaum (1974) was said to be the most prolific producer of solid waste in the globe, it has not produced the filthiest cities. Paradoxically, though Africa (mainly sub-Saharan) said to be the least generator of waste amongst the seven regions of the world (Bhada-Tata & Hoornweg, 2012) it has produced the dirtiest city to be Lagos – Nigeria (Adedibu & Okekunle, 1989) and the world's most polluted city – Onitsha, Nigeria (WHO, 2016). The handling of waste should be integrating, involving both private and public domains as well as other aspects of the environment Tchobanoglous et al. (1993).

2.1.2 Integrated Sustainable Waste Management – ISWM - the concept

Klundert & Anschutz (2001) maintained that the core ISWM concept was founded out of an understanding to address specific common municipal waste management challenges pertaining to low-and middle-income countries in the South, and countries in transition. In the earlier work of Klundert & Anschutz (1999), the term 'sustainable' was explained to be a system that is appropriate to the local conditions in which it operates and is capable to maintain itself over time without reducing the resources it needs while 'integrated' was expressed to be a system that uses a variety of inter-related collection and treatment choices, involves all stakeholders and considers exchanges between the waste management system and other urban systems. Hence, the ISWM concept recognises three main important dimensions in waste management (Figure 2.1), which are stakeholders, waste system elements and sustainability aspects and four basic principles:

- Equity: this entails all inhabitants are enabled to an appropriate waste management system for environmental and health purposes;
- Effectiveness: the waste management model utilised will lead to the safe removal of all waste;
- Efficiency: waste management is done by benefit maximization, cost minimization and resource use optimization, which consider equity, effectiveness and sustainability;
- Sustainability: i.e. the system of waste management is appropriate to the local conditions and feasible technically, environmentally, socially, economically, financially, institutionally and politically.

With these four principles, Klundert & Anschutz (2001) maintained that ISWM should be able to maintain itself over time without exhausting the resources upon which it depends.

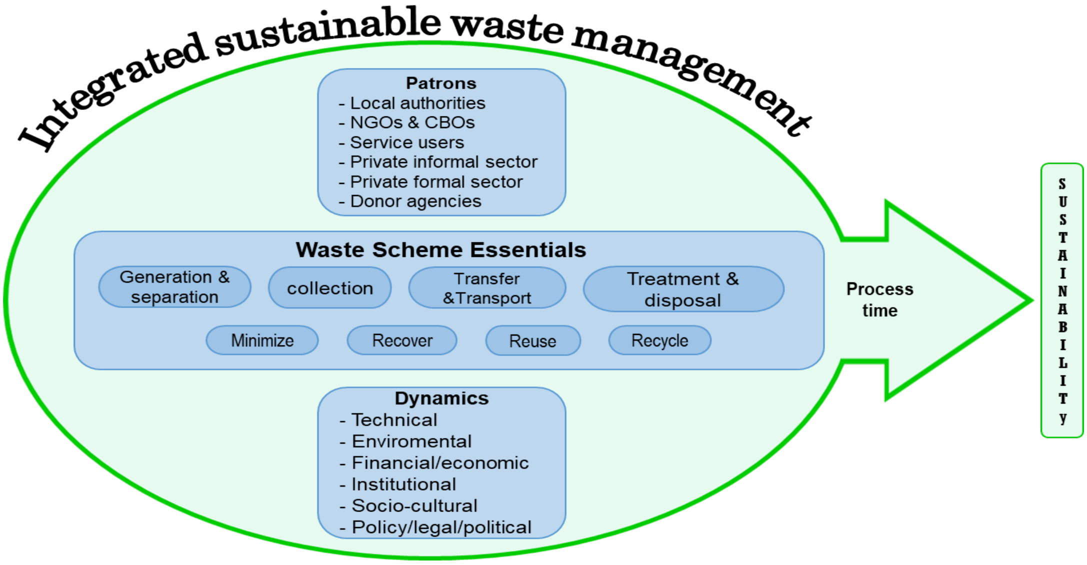


Figure 2.1 The ISWM model

(Modified after van de Klundert & Anschutz 1999).

This study seeks to appreciate the importance of an integrated waste management system for the sustainability of the Imo State environment. Hence, the ISWM put forward by Van de Klundert & Anschutz (2001) presents attributes of a system that Imolites could adopt.

2.2 Other Waste management related concepts and principles

The process of managing waste is complex leading to the development of concepts and principles that are instrumental in policy development. Such concepts and principles together with environmental policy and sustainable development are adapted and utilized in the development of national waste management strategies (UNEP, 2013). Figure 2.2 presents the different waste management related concepts and principles. These concepts are essential to waste management and the sustainability of any environment as they engulf artefact prior to its conception/production and back to conception/production of a new one or another type.

Figure 2.2 Waste management related concepts and principles.
(Modified after UNEP, 2013).

2.2.1 Sustainable consumption and production - SCP

Sustainable consumption was given a working definition by the Oslo Roundtable on Sustainable Production and Consumption to be the use of goods and services to cover basic needs and improve the quality of life by decreasing the use of resources (Ofstad et al., 1994). Sustainable consumption is a term that covers many issues including increase use of renewable energy sources and waste minimisation. SCP is an objective of, and an important requirement for sustainability recognised at the World Summit in 2002 in Johannesburg. Given the affirmation that economic growth and increased consumption are accompanied by increase in waste generation (Bhada-Tata & Hoornweg, 2012; Bogner et al., 2008) stakeholders were called amongst others to delink economic growth and environmental degradation through sustainable improvement in the use of resources, reduction in resource degradation, pollution and waste (UNEP, 2013). A specific example of SCP in action is disentangling economic growth and resource consumption, a suggestion of the United Nations Environment Program (UNEP, 2010).

2.2.2 Eco-design

Defined as the integration of environmental aspects into product design with the aim of improving the environmental performances of the product throughout its whole life cycle (European Council, 2009), eco-design focuses on the extension of product use period (a waste preventive measure), design for disassembly, repair or upgrading and constructing a product from materials that can serve as inputs to another process (UNEP, 2013). Eco-design is imperative in waste management as it has features of a sustainable environment and waste preventive measures.

2.2.3 Life-cycle approaches

The goal here is looking beyond waste itself; that is, the product that finally ends up as waste should be examined from its raw material extraction, production, packaging, transport, distribution, sale, use and end-of-life and the later phases of the waste management hierarchy (UNEP, 2013). It is thus the life cycle analysis of a product through from manufacturing. This life cycle approach/assessment, also referred to as the 'cradle-to-grave' is a procedure to test the environmental impact of a product from its creation to disposal. This will go a long way in preventing and/or reducing waste.

2.2.4 Resource efficiency

Resource efficiency focuses on the rethinking of the life-cycle of a product from the point of view of what resources are used at each stage; that is rethinking how the entire design of the product could be produced and delivered in a better way. This is similar to eco-efficiency that focuses on delivering the same or increasing levels of commodities at a reduced material and energy intensity, with a lesser impact on the environment (UNEP, 2013). This entails that products are produced and delivered in a better way with lesser materials and lesser energy intensity; these will be positive steps towards waste prevention, reduction and resource sustainability.

2.2.5 Eco-innovation

Eco-innovation is a concept adopted by the European Union to promote innovations that are needed to support transition to a sustainable society (European Commission, 2011). The concept refers to any form of innovation geared towards significant progress of sustainable development, through reducing impacts on the environment and enhancing resilience to environmental pressures or using natural resources more efficiently and responsibly (Eco Innovation Observatory, 2012).

2.2.6 Cleaner production

Defined as the continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment (UNEP, 1994), cleaner production aims not only at the efficient use of resources, it strives to reduce the use of hazardous materials in products and their production processes as well as the generation of emissions and wastes (Sinclair et al., 2000; UNEP, 2001). Cleaner production is therefore an imperative concept in the waste management initiative as in it is embedded reduction of risks to humans and environment as well as reduction of emissions and waste generation.

2.2.7 Green Economy Initiative

The Green Economy Initiative (GEI) was launched in 2008 by the United Nations Environment Program to improve human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011a, 2011c, 2016). Green economy's growth is drawn by investments that reduce carbon emissions, pollution, enhance resource and energy efficiency, preventing biodiversity loss and ecosystem services. The GEI was updated in 2015 to be Inclusive Green Economy (IGE) and it is an alternative to current economic model, which generates widespread environmental and health risks, encourages wasteful consumption and production. If with the Inclusive Green Economy environmental and health risks are reduced or curtailed, wasteful production and consumption discouraged, then it is possible to have a healthy environment and life as well as a prevention or reduction of waste generation.

2.8 Cradle-to-cradle

This concept focuses on defining the intent in the design of an artefact in terms of its positive impact, i.e., its socio-economic and environmental gains (Mulhall & Braungart, 2010). The cradle-to-cradle concept suggests a different lane from the step-down trend of the 'cradle-to-grave' notion of the life cycle approach (UNEP, 2013). McDonough & Braungart (2002) remarked that cradle-to-grave (womb to tomb) products were characteristically down-cycled after use, which resulted in a lower value product. Hence, the cradle-to-cradle concept focuses on designing products and schemes in a way which results in taking back the products at the end of their 'useful' life and turning them into new products of equal, if not greater value. Cradle-to-cradle is therefore a cyclical concept with basis from the natural world where organisms' metabolic remains serve as food for other organisms. Alternatively, materials at the end of their use period begin a new life (with an even higher quality; from where stems the concept of upcycling (UNEP, 2013). Hence, this approach eliminates the concept of waste. This is an important concept in this study as it seeks to establish a similar approach in Imo State, Nigeria. That is, waste materials can fit into the biological or technical cycle, especially if the five criteria shown on Figure 2.3 are considered. The goal of the cradle-to-cradle concept/approach of an artefact is sustainability.

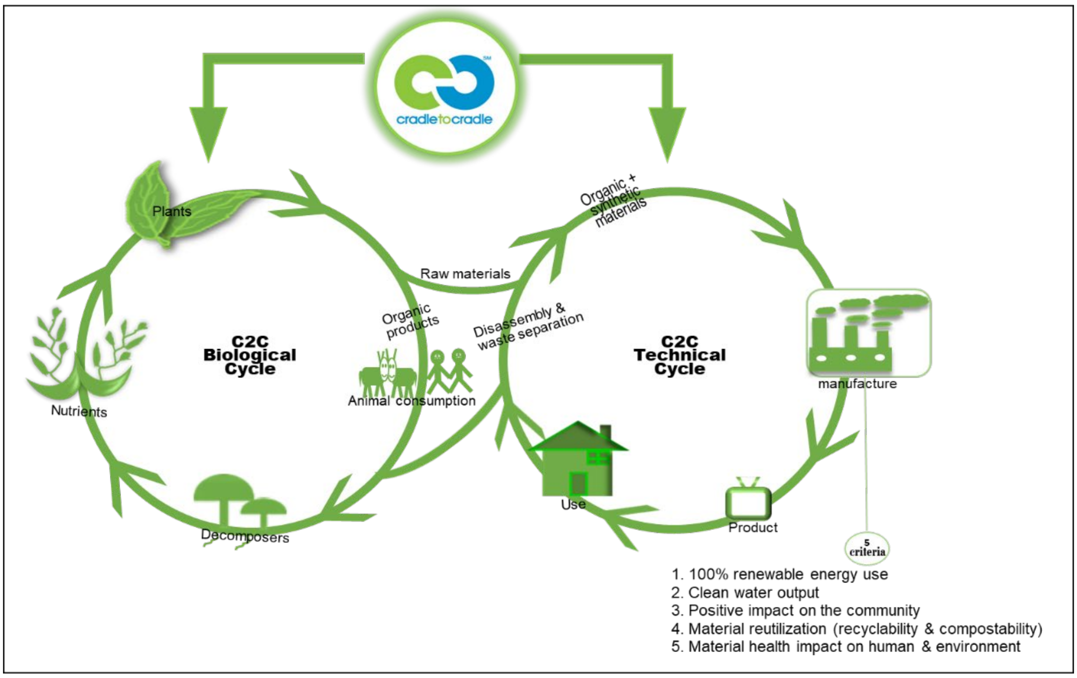


Figure 2.3 The Cradle-to-Cradle concept
(Modified after McDonough & Braungart, 2002).

2.3 The Sustainability concept

Sustainability as a term ostensibly defines the state of affairs necessary for the well-being of humanity in harmony with the ecological system. McDonough & Braungart (2002) referred to the term as the ways in which resources (human, material or natural) are used and these fit into the local culture, context and society. Diesendorf (2000) maintained that sustainability is the goal of sustainable development, which is 'types of economic and social development that protect and enhance the natural environment and social equity'. This concept gained prominence in the 1980s as it comes from a broader theme 'sustainable development' coined by the International Union for Conservation of Nature and Natural Resources IUCN's 1980 World Conservation Strategy (IUCN, 1980). Furthermore, Klee & Graedel (2004) claimed that sustainability has been regarded as a vague and politicized term given its variety of meanings in different contexts. Barkin (1998) also argued that since its universal consecration at the Earth Summit in 1992, sustainability and/or the sustainable development concept has be adopted and adapted by myriads of writers. Hence, the term is seen as banal and confusing as well as multifacetic.

However, Glavic & Lukman (2007) recognized that there has been increasing cognizance of the importance of the sustainability concept and this has resulted in a variety of terms explaining the concept. Hence, Kates et al. (2001) purported that a new field of sustainability science is emerging and (Ostrom , 2009) it seeks to understand the fundamental character of interactions between nature and society. Mihelcic et al. (2003) corroborated this idea adding that this new field integrates industrial, social and environmental processes in a global context. In this work therefore, we will be looking at environmental sustainability and sustainable development as concepts, which are committed to the same outcome.

Some authors opined that sustainability is of different types. Goodland (1995), Goodland & Daly (1996) and Moldan et al. (2012) pointed out that there are three types of sustainability: Economic, Social and Environmental. Their definition or focus of Economic sustainability is on the widely accepted definition 'maintenance of capital'. The recognised forms of capital being (i) human-made: (capital usually considered in financial and economic accounts), (ii) human: (such as investments in individuals' education, health and nutrition), (iii) social or moral: (such as institutional and cultural basis for society to function) and (iv) natural (Goodland & Daly, 1996). Natural capital to these authors is a stock of environmentally provided assets (like soil and its microbes and fauna (Pimentel et al., 1993, 1997) atmosphere, forests, water and wetlands that provides a flow of goods and services. According to the World Bank (2011), these kinds of capital are the focus of the economists because economic sustainability accepts that the environment and natural resources constitute the ultimate foundation upon which all future economic activities must be construed. That is, economic progress is increasingly dependent on the sustained integrity of the source and environmental base Therefore, the inclusion of natural capital in the above definition, entails economists are also concerned about natural resources. In this definition, there exists an overlap and links to the other pillars of sustainability.

The approach to Social Sustainability is diverse and varied. This diversity is comprehended because according to Moldan et al. (2012), individual countries have different cultural, social and economic conditions, which make a uniform definition of social sustainability difficult to come by. Black A. (2004) defined social sustainability as the extent to which social values, social identities, social relationships and social institutions can continue into the future. These social criteria operate and take place within the environment; interacting interchangeably and interdependently with it. This environment is 'our home' (earth) and is defined with finite resource base without which such social activities cannot take place. Therefore, social sustainability can be seen as a dimensional trait and an offspring of the environment within which it is conceived and grows. Hence, it can in this dimension be seen that social sustainability is an environmental component as all its activities stem from and operate within the environment.

Another meaning of social sustainability was given by Torjman (2000) who stated that from a social perspective, human wellbeing cannot be sustained without a healthy environment and is equally unlikely in the absence of a vibrant economy. In addition, Silvius & Schipper's (2010) notion of social sustainability entailed those individuals' needs such as those of health and wellbeing, nutrition, shelter and cultural expression should be met. The featuring of human wellbeing being sustained or met in both definitions advocates a common understanding; but the former is inter-woven with a healthy environment, which brings in the weakness of overlap (Moldan et al., 2012). In addition, since meeting a need is synonymous to satisfying a need, the second definition's idea of individuals' needs being met is a criterion that cannot be achieved. This later definition thus has the same inborn defect created in the notion and definition of sustainable development as presented by the Brundtland Report *(...meets the needs of the present...)* as needs cannot be satisfied (Kiss, 2011). Our objective however, is geared towards the fact that social sustainability is operational within the environment. All needs originate within the environment and the trends towards trying to meet them are within the environment.

Goodland (1995) and Goodland & Daly (1996) stated that social sustainability would be achieved only by systematic community participation and strong civil society. Traits like social cohesion, cultural identity, laws, fraternity, patience, humility, forbearance and discipline as mentioned by these authors, are features of a community/society and these are a component of the environment. Hence, a healthy sustainable environment (including its social and economic domains) will bread a healthy community participation in whatever good activity and a strong civil society.

The rather broadly defined concept of sustainability according to Moldan et al. (2012) was historically understood mostly as environmental sustainability. This was brought to the lime light by the World Conservation Strategy (IUCN/UNEP/WWF, 1980) who believed that humans must be aware and acknowledge the fact that the world and its resources are finite in nature, with limited capacity to support life. This fact is one very important reason why the environment should not only be enhanced, but also sustained.

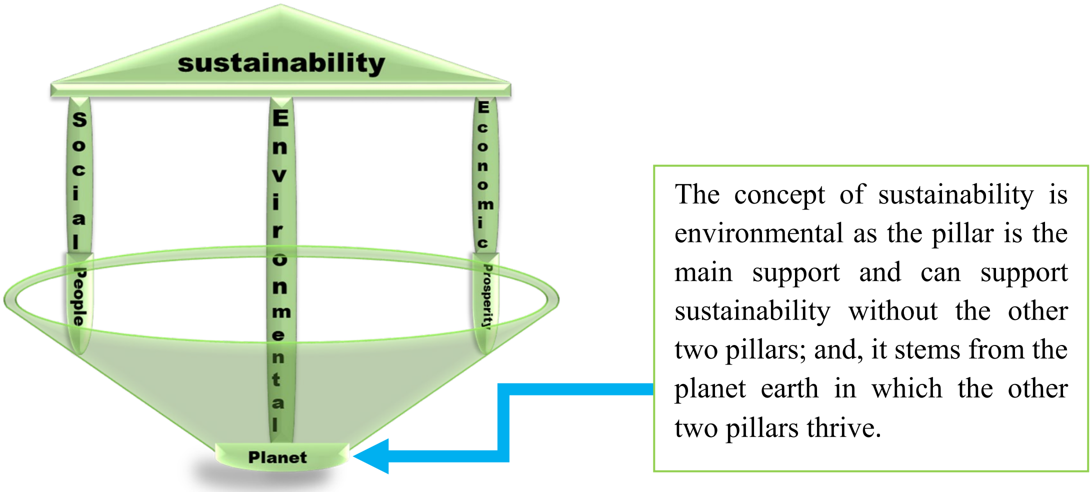


Figure 2.4 Schematic representation of sustainability.
(Author's concept, 2017)

2.3.1 The environmental sustainability concept

The term 'environment' defies any strict definition as different academic disciplines have different views of it. An economist will talk of an economic environment, a sociologist will talk of a social environment, but a geographer will engulf both and rather refer to it simply as (natural) environment from which stems any other type of environment. However, different authors have defined it based on the context of their research and domain. According to Abrams (1971) the environment is the sum total of all external conditions influencing the growth and development of an organism. In addition, Aina (1991) in defining the environment for the use in the Federal Environmental Protection Agency (FEPA) policy formulation in Nigeria noted that the term means all physical and biological systems in which humans and all other living organisms live. These definitions do not, however, make mention of the organism influencing the environment in turn. This aspect is one of the issues this study seeks to address.

Unlike the English meaning of environment, Kollmuss & Agyeman (2002) stressed that; '*Umwelt'* is almost entirely used to describe natural environments and their destruction (and/or protection). In this study, environment is understood as a merge of the two (Environment and *Umwelt*) together with the interaction organisms with and within the natural world as well as living in harmony and the enhancement of both.

Baba (1992) perceived the environment as the components and systems of the geosphere as is applicable in the natural sciences, or the reservoir of resources on which man draws to sustain his economic activities and assures his survival and wellbeing. In most cases, the geographer often refers to the environment as consisting of the physical and human/economic domains. Nevertheless, Ofomata (1976) conveyed out a broad view of the term environment. He explained that it consists of the realm of nature, the realm of man and the realm of nature and man; and, this is the totality of what geographers' study. In this study therefore, we consider the waste generation and disposal actions of man within the environment and the impact of such actions on himself and the environment.

The emergence of the concept of environmentalism, which states that the man-nature relationship is not a one-way affair (Liverman, 1999) is corroborated by Olofin (1989). The study explained that man affects his environment as he responds to the changing conditions set by the environment and the environment responds to the human manipulation, thereby creating a state of equilibrium that continues to adjust and readjust in time and space. The concept of environmentalism has become an acceptable working theme in geography. However, in this study, the operational definition of environment is the area of activities, interest and knowledge of man (human and economic domains: - the realm of man) and the area of activities, interest and knowledge of nature (physical domain: - the realm of nature), and, the inter-relationship between the two. Given this interaction, the environment has to be cared for protected, developed, conserved and sustained.

According to Goodland (1995) and Goodland and Daly (1996), environmental sustainability 'seeks to improve human welfare by protecting the source of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans'. In addition, Goodland (1995) defined the concept as the maintenance of natural capital, which constitutes input and output rules or maintaining environmental source and sink capacities unimpaired (Goodland & Daly, 1995). Goodland (1995) further stated that the concept is a set of constraints on the four major activities that regulate the scales of the human economic subsystem; i.e. the use of renewable and non-renewable resources on the source side and pollution and waste assimilation on the sink side. To reach or obey the Output Rule in Nigeria generally and Imo State in particular, proper sensitization and sustainable waste management initiatives are necessary in order to avoid harm to humans.

Furthermore, Holdren et al. (1995) defined environmental sustainability by focusing on the biophysical aspects; i.e. maintaining or improving the integrity of the life supporting systems of the earth. Another definition with this view is that provided by Goodland (1995) who maintained that environmental sustainability seeks to sustain global life-support systems indefinitely: principally those systems that maintain human life. These are ideas conceived with defects or lapses: what about the non-human species/life? Can human life go on without interacting with non-human species? Our scope of environmental sustainability in this study is not focused principally on the biophysical aspects or those systems that maintain human life; we engulf all other aspects that operate within Imo state and its environs, that is, all human inter-related aspects, processes or activities that generate and spread wastes within the and on the environment. Hence, environmental sustainability should not be tilted mainly towards improving life-supporting systems of the earth; it should be a healthy sustainable interaction and interdependence between life and the milieu in which it dwells.

Moldan et al. (2012) argued that the concept of environmental sustainability is based on a notion of ecosystem services – both renewable and non-renewable resources as well as waste absorptive capacity that provide benefits to humans, thereby improving their welfare. Hence, to use and enjoy the services provided by our environment, humanity must learn to live within the limitations of this environment – our defined earth.

Looking at a brief history of the concept of environmental sustainability, Moldan et al. (2012) opined that the term was probably first coined by scientists at the World Bank. Then, ‘environmentally responsible development’ was the term used (World Bank, 1992). Afterwards, the term ‘environmentally sustainable development’ was used (Serageldin, 1993; Serageldin & Steer, 1994) and finally the concept of environmental sustainability was developed (Goodland, 1995). This concept has been given different definitions by different writers and organizations, which, are all committed to the same (positive) goal: caring, maintaining and living on a healthy and durable earth, which is the only home humanity has for now.

Given the working themes of this study – waste management and environmental sustainability, our notion of the later concept engulfs managing (protecting, maintaining, integrating, enhancing and sustaining), the Imo State environment in particular and Nigeria in general given the widespread waste disposal by the population: therefore, Imo State environment constitutes all waste generation activities (social, economic and natural processes) within the State. This entails our reference to environmental sustainability in this research is all encompassing (economic and social legs inclusive) since all the socio-economic activities are generated, operate within, interact and interdepend with the environment (Figure 2.5). The question is how can the environment be healthy or sustained given the widespread waste disposal and insult on/within it?

Figure 2.5 The encompassing concept of environmental sustainability.
(Author's concept, 2017)

Goodland (1995) explained that there are two fundamental environmental services – the source and the sink functions; and these two as coined by Daly (1977, 1980, 1988) must be maintained unimpaired as a requirement for sustainability. This means waste emission from the environment (source) should be kept within the assimilative capacity (sink) of the same (local) environment without unacceptable degradation of its future waste absorptive capacity or other services (Output Rule). Contextually, sink is the capacity of the environment to absorb the unwanted (by-) products of production and consumption; exhaust from combustion or chemical processing, water used to clean products or people, discarded packaging and goods no longer wanted (UN et al., 2003). Furthermore, the rates of harvest of renewable resources should be kept within the regenerative capacities of the natural system that generates them; another aspect of sustainability. In this light, El Serafy (1989, 1991, 1993) explained that depletion rates of non-renewable resources should be set below the rate at which renewable substitutes are developed by human technology, i.e. innovation and invention (Input Rule). However, our emphasis on environmental sustainability in this research will be focused on the 'Output Rule' that presents the environment as a source and a sink. Figure 2.6 indicates that what comes in from the natural sources, through the human activity system comes out as waste. Singh (2016) stressed that the increasing demand for natural resources has increased the amounts of inflows and outflows as well as the resources' stocks.

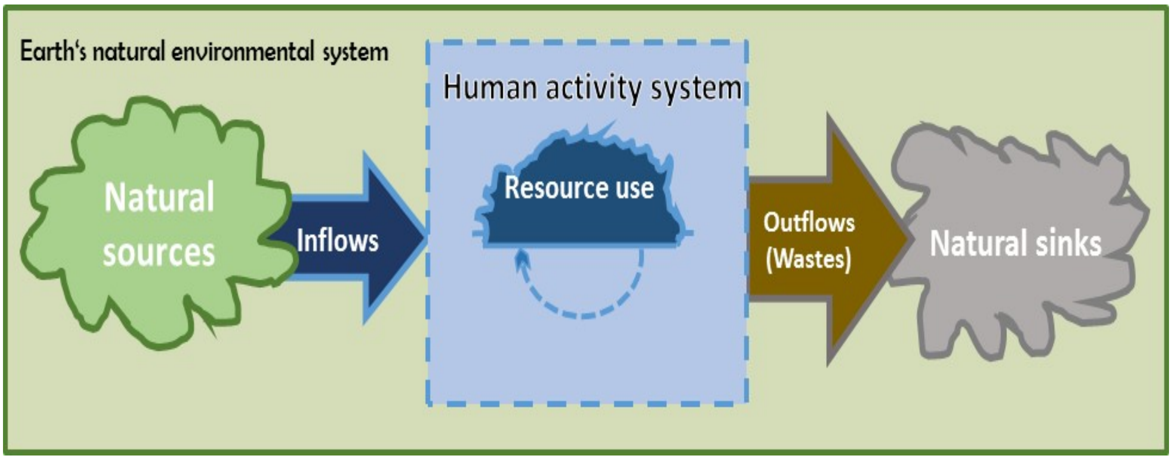


Figure 2.6 Illustration of source and sink capacities of the environment: with human activities, the outflow is not in pair with inflow in both quality and quantity.
(Modified after Singh, 2016).

2.3.2 The Sustainable Development concept

With the creation of the World Commission on Environment and Development - WCED in 1983 by the UN General Assembly, sustainable development was given a definition. In the Brundtland Commission's Report - Our Common Future[15], it was defined as 'development which meets the needs of the present generations without compromising the ability of future

[15] The then prime minister of Norway, Honorable Mrs. Gro Harlem Brundtland who chaired the UN's WCED is listed as the primary author of the 1987 report – Our Common Future, generally referred to as 'the Brundtland report'. She put forward almost worldwide political consensus on the urgent need for sustainability and since then countries, agencies and authors have been wrestling with the problem of defining it.

generations to meet their own needs' (WCED, 1987). Goodland (1994) claimed that when environmental sustainability is the goal (as the case may be), then sustainable development could be path or the means to approach that goal. He therefore defined sustainable development as development without growth beyond environmental carrying capacity. As humanity tries to meet its needs through production and consumption activities, wastes and emissions are generated which cause adverse environmental, economic and social impacts.

Though the definition of sustainable development contained in the Brundtland report has been the most quoted, it has been cogitated as human-centred focus since they are entitled to live a healthy and productive life in harmony with nature (Moldan et al., 2012). With this 'loophole', the definition was later extended at the Earth Summit in Rio de Janeiro, Brazil in 1992 with the production of 'Agenda 21' (UNCED, 1992). Its completion and formalization were done at the Rio+10 in Johannesburg 2002 (UN, 2002). At this Summit, sustainability, simultaneously referred to as sustainable development was attributed the notion of three-foot holds: - social, environmental and economic sustainability. These were henceforth referred to as sustainability pillars and these pillars were symbolic of the Summit's motto 'People – Planet – Prosperity' (Moldan et al., 2012).

Looking at the aforementioned evolution of sustainable development and sustainability as concepts, it is needless noted Bell & Morse (1999) to say the meaning of the two is not identical, although the basic sense is fundamentally the same. Moldan et al. (2004) explained that, while sustainability features on quality, (enhancement and endlessness); it is believed that the focus of the concept of sustainable development is "human beings are at the centre of concerns". Therefore, the basic and fundamental sense of the two concepts dwindle down to the fact that human life should be healthy, productive and in harmony with nature (endlessly).

Sustainability should be dynamic and long-term (endless) in nature and should conserve natural resources to ensure continued development and to support all life. Hence, for the purpose of this research, sustainability and sustainable development are simultaneously considered with regard to their basic and fundamental sense. This coined principle or approach implies a quest for a balance amongst the sustainability/sustainable development pillars since they are all committed to the same positive outcome. Human life as affirmed by (Moldan et al., 2004) is neither isolated nor independent; it is actually part of complex cycle/web of natural and socio-economic relationships and interdependencies. Since man lives in a defined world and finite resource base (Goodland, 1995), and generates waste from his numerous natural, socio-economic and political activities within this defined base (source); it is absolutely necessary and important to make sure that the waste assimilative and absorption capacities of this base (local) should be acceptable without degradation of its future waste absorptive capacity (sink).

In this study, we analyze how the waste streams (source) in Nigeria especially in Imo urban areas should be directly proportional to their assimilative capacities (sink). The waste generated in Imo urban areas should be managed within (though not necessarily) the State without endangering the environment (inhabitants, plants, animals and the ecosystem/environment in which they interact and interdepend) both currently and in future. How can this be achieved given the widespread waste disposal trait of the citizenry? The population should be sensitized about waste management strategies (reduction, recovery, re-use and recycle); they are made to understand that waste is actually a resource that through proper management it can be used to boost farming (through composting of organic waste to produce manure (Oteng-Ababio, 2014); can be used to improve food and nutrition (through the use of coffee waste to produce mushroom (Pauli, 2010a) can generate wealth and create jobs (Odeyingbo et al., 2018; Oteng-Ababio, 2014; Spiegelman, 2006; WIEGO, 2016).

2.4 Waste generation and sources

Statistics indicate that about 3.5 billion of the world's population are without access to waste management services, and, in most Low and Lower Middle-income countries, open dump remains the prevalent disposal method (UNEP, 2013). More than 90% of waste is openly dumped or burnt in low-income countries (Silpa et al., 2018). The World Bank document – *What a waste 2.0* (Silpa et al., 2018) stated that the world will, by 2050 generate 3.40 billion tons of waste annually. This figure per these authors is a drastic increase from the current 2.1 billion tons annually. Omuta (1988) argued that the volume of waste visible in the cities of Third World countries could not be an acceptable indicator of prosperity; rather it can be seen as measure of the extent of ineffectiveness and failure of urban authorities to cope with the inevitable by-products of development. According to Sally Fegan_Wyles[16] and Achim Steiner[17], poor waste management can lead to significant environmental and health hazards such as the contamination of soil and water by leachate from waste, pollution from open

[16] The UN Assistant Secretary-General, Acting Head and Executive Director of UNITAR, 2013
[17] The UN Under Secretary-General and Executive Director of UNEP, 2013

burning and the failure to use recycled materials means an acceleration in the depletion of raw/natural materials. Unfortunately, the urban poor live and work near waste disposal/dump sites that are most at risk and sometimes suffering acute health impacts.

Conferring the World Bank Report *What a waste* (Bhada-Tata & Hoornweg, 2012), the OECD countries generate almost half of the world's waste, while South Asia region and sub-Saharan Africa produce the least; (Table 2.1) and the higher the income level, the greater the quantity of waste produced (Bhada-Tata & Hoornweg, 2012, p. 9; Silpa et al., 2018, pp. 20-21). This assertion is supported by the fact that almost all the OECD countries are high-income economies (the emerging countries in this organization are Mexico, Chile and Turkey). It is also estimated that an approximately 62 million tons of waste is generated in sub-Saharan Africa a year; and per capita waste generation is averagely low (0.65 kg/capita/day) but spans wide (i.e. 0.09 to 3.0 kg per person per day) (Bhada-Tata & Hoornweg, 2012, p. 8).

Table 2.1 Waste generation and projections for 2025 by world Regions.
(Adapted from Bhada-Tata & Hoornweg, 2012; Silpa et al., 2018).

World regions	2012 (Mi.tons/year)	Global percentage	2018* (Mi.tons/year)	Global percentage	2025 (Mi.tons/year)
SSA	61.7	5%	174	9%	161
EAP	269.7	21%	468	23%	680
ECA	92.9	7%	392	19%	129
LCR	159.7	12%	231	11%	265
MENA	63.3	6%	129	6%	134
OECD	571.7	44%	na	na	635
SAR	70.2	5%	334	17%	207
North America	na	na	289	14%	na
Total	1.3 billion	100%	2.01 billion	100%	2.2 billion

SSA – sub-Saharan Africa
EAP – East Asia and Pacific
ECA – Europe and Central Asia
LAC – Latin America and the Caribbean
MENA – Middle East and North Africa
OECD – Organisation for Economic Co-operation and Development; and the
SAR – South Asia Region
(The OECD has been incorporated into the Europe and Central Asian Region in the 2018 Report).

Data available in 2012 (Bhada-Tata & Hoornweg, 2012) indicated that over 50 percent of the waste generated globally is organic; this is the same for the Sub-Saharan region, West Africa and Nigeria. (Figure 2.7). The organic percentage of waste in Sub-Saharan Africa reduced to

43 percent while plastics also reduced from 13.0 to 8.6 percent by 2016 (Silpa et al., 2018, p. 78). However, the OECD countries present a different scenario as displayed on Figure 2.7.3. The high percentage of Africa's organic waste content is according to (FAO, 2012; UNDP, 2012; World Bank, 2007; 2015) because of the continent's geographical location, the fact that it has one-quarter of the world's agricultural land, with the sector employing 70% of its working population. Meanwhile, the highly industrialized and rich OECD countries with high per capita waste production make use of and produce high per capita packaging waste made of plastic and paper. Current available data in the World Bank's 'what a waste 2.0' report indicates that the global waste generation has altered: organic waste generation has declined to 46%, paper and cardboard have increased to 17%, Plastics have increased to 12%, glass increased to 5% and metal to 4% (Silpa et al., 2018, p. 29).

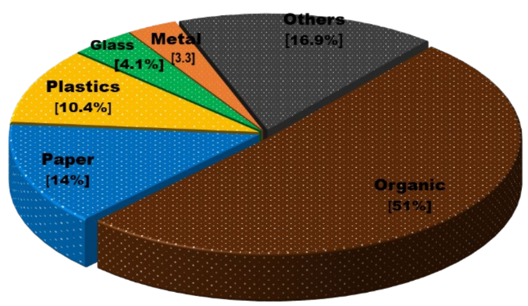


Figure 2.7.1 Global waste generation and Composition.

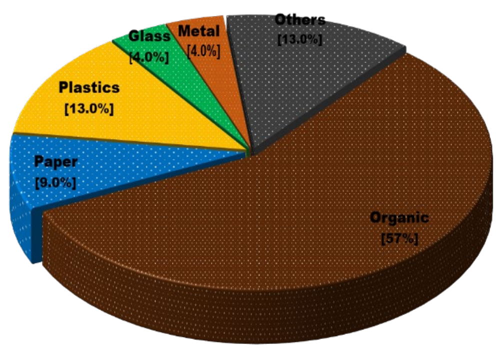


Figure 2.7.2 Waste generation and composition of Sub-Saharan Africa.

(Data source Bhada-Tata & Hoornweg, 2012)

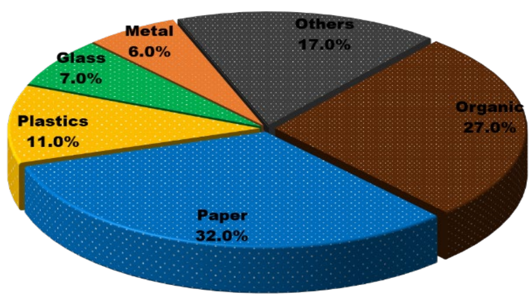


Figure 2.7.3 Waste generation and composition of the OECD countries.

(Data source Bhada-Tata & Hoornweg, 2012).

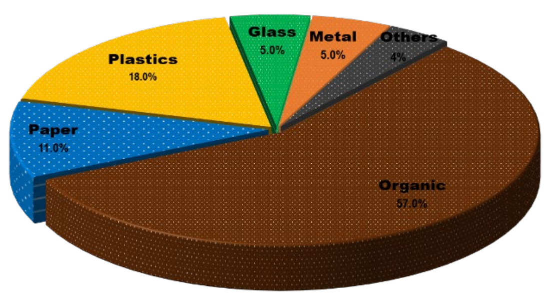


Figure 2.7.4 Nigeria's waste generation and Composition.

(Data source Imam et al., 2008)

The United Nations Environment Program (UNEP, 2013) in its publication on guidelines for national waste management strategies outlined several sources of waste. These include households, offices, cafés and restaurants, hotels, food stalls; retail operations (shops, supermarkets, warehouses, etc.); markets, public facilities (sport grounds, street sweeping and cleaning); hospitals and other health facilities; educational institutions; agriculture and food processing facilities; building sites; manufacturing facilities; water treatment and sewage treatment facilities; land transport facilities (truck depots, bus parks, etc.); car yards and car repair shops; etc. (UNEP, 2013).

2.4.1 Municipal and household wastes - the concept

Numerous activities take place in houses and municipalities leading to the generation of wastes. Hence, there exist household wastes and municipal wastes. Although municipal waste has been confused with household waste, the former per Pongrácz (2002) is not unambiguous. Fischer (2000) explained that until recently, the two terms have been used thus:

- Household waste is a concept linked to waste generation and includes all wastes from a unique or particular source: - households.
- Municipal waste is above all is a management/collection concept; that is, they are waste items collected by, or on behalf of the municipality.

Household waste, referred to as materials usually generated in the residential environment is defined in the Environmental Protection Act (EPA, 1990a) as all waste collected by waste collection authorities (WCA) (EPA, 1990b) all waste arising from household waste recycling centres (HWRCs) (EPA, 1990c) and waste collected by third parties for which collection or disposal reuse or recycling credits are paid (EPA, 1990d). Waite (1995) explained that household waste comprises of those unwanted items, which arise in a domestic dwelling: discarded products such as furniture, clothing, or toys, used packaging, food leftovers, garden waste and other by-products. Municipal waste's (global) production estimated to be 1,636 million tons per year (Bhada-Tata & Hoornweg, 2012) are items generated by residential, commercial and public sectors that are collected by local authorities for treatment and/or disposal in a central location. Also, estimates indicate that municipal solid waste (MSW) generation levels are about 1.3 billion tons per year, and this is expected to increase to about 2.2 billion tons by 2025 (Bhada-Tata & Hoornweg, 2012) and to 3.4 billion tons by 2050 (Silpa et al., 2018, p. 25). These authors stressed that MSW generation rate is influenced by economic development, the degree of industrialization, public habits and ambient climate. In addition, MSW is usually applied to a heterogeneous collection of wastes produced in urban areas, the nature of which varies from region to region (UN-HABITAT, 2009). Hence, MSW is a collection concept.

Municipal waste as described in the Landfill Directive (European Council, 1999) include both household waste and waste from other sources which are similar in nature and composition; and which include a significant proportion of wastes generated by businesses and not collected by Local authorities. To avoid this ambiguity, Municipal waste is referred to a new definition with the need of defining a new term to describe the data collected by Waste-Data-Flow. Hence, Municipal waste according to (DEFRA, 2011) refer to waste collected by local authority (Local Authority Collected Wastes – LACW). However, since the definition of Municipal waste is subject to change with time and differs from country to country, the OECD (2013) defined it again as waste collected by or on behalf of municipalities; this includes households (i.e., waste generated by domestic activity of households) and similar waste from small commercial activities, offices, institutions like schools and government buildings, small businesses that treat or dispose of waste at the same facilities used for municipally collected waste. Nonetheless, Buenrostro et al. (1995) argued that the territorial limits of a municipality are the boundary of municipal wastes. The two terms are interwoven since some households (residence) are found in municipal areas and a single truck may collect wastes from different sources as well as the two sources may produce the similar types of waste materials. Hence, waste items from households and the municipality find themselves in the same waste streams.

Data on waste management for a great majority of the African cities are unreliable and unavailable; and these are sensitive issues and an impediment in sustainable waste management. In most cases due to the collection method (i.e., use of one truck for municipal waste and household waste), it is difficult to get the quantity of household waste generated since much emphasis is placed on what the truck carries and not what enters the truck from generation point. In this research, household waste and municipal waste are considered alike since both are in the same waste stream and conveyed by the same truck; households are part of the municipality.

2.4.2 Electrical and Electronic Equipment

The manufacture, importation and use of electrical and electronic equipment in Africa have led to the generation of waste electrical and electronic equipment (WEEE) or electronic waste (E-waste). Though electrical and electronic equipment are found in the same waste stream, Laha (2015) stressed the difference between the two: electronic devices usually have Integrated Circuits or Microchips[18] inside them while electrical devices generally operate without Integrated Circuits. Robinson (2009) further made a distinction between WEEE and E-waste explaining that the former includes traditionally non-electronic goods like refrigerators and ovens while the later describes waste electronic gadgets like computers, televisions and cell phones. Nonetheless, Kohler & Erdmann (2004) maintained that such a distinction is becoming less sharp due to the advent of pervasive computing[19]. This is because currently, (Hilty, 2005) programmable microprocessors are incorporated into electrical equipment like refrigerators, which are not normally considered electronic items.

Furthermore, in accordance to the EU WEEE Directive (European Council, 2002) the terms WEEE and E-waste are used synonymously. Since there is not yet a standard definition of electronic waste (Widmer et al., 2005), WEEE or E-waste has been defined differently by different organizations and authors. The EU WEEE Directive (European Council, 2002, 2012) defined E-waste as electrical or electronic equipment, which is waste… including all components, sub-assemblies and consumables, which are part of the product at the time of discarding. The EU WEEE Directive therein outlined ten categories of E-waste. (Table 2.3). Also, the Basel Action Network (BAN) stated that E-waste encompasses a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos and consumer electronics to computers, which have been discarded by their users (Puckett et al., 2005; Puckett & Smith, 2002). The definition of E-waste by the WEEE Directive and that of the BAN render the identification and estimation of E-waste difficult; while the former considers electrical and electronic equipment, the later considers just electrical equipment (Puckett et al., 2005).

[18]Integrated circuit is a set of electronic circuits on a small plate (chip) or semi-conductor material, normally silicon.
[19] Also termed ubiquitous computing, it is an emerging trend associated with embedding microprocessors in day-to-day objects, it entails computing is made to appear anytime and everywhere.

Furthermore, the OECD (2001) defined WEEE as "any appliance using electric power supply that has reached its end-of-life". It also considered an electrically powered appliance that no longer satisfies the current owner for its original purpose (Sinha-Khetriwal, 2004). Another definition suggested by the United Nations University's Solving the E-waste Problem (StEP, 2005) to be the reverse supply chain which collects products no longer desired by a given consumer and refurbishes for other consumers, recyclables, or otherwise processes wastes. Furthermore, the United Nations University – Institute for the Advanced Study of Sustainability (UNU, 2007) referred to E-waste as a term used to cover all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use.

Table 2.2 E-waste categories and types according to the EU Directive on E-waste
(Adapted from European Council, 2002).

Nº	Category
1	Large household appliances (e.g. Washing machines, refrigerators, freezers, dishwashers, dryers)
2	Small household appliances (e.g. hair dryers, toasters, coffee makers, iron,
3	IT & Telecommunication equipment (e.g. PCs, telephones, mobiles, laptops, printers, scanners, photocopiers, faxes, etc.)
4	Consumer equipment (e.g. TVs, DVDs, music players, transistor radios, electric toothbrushes, etc.)
5	Lighting equipment (e.g. tube lights, bulbs, fluorescent lamps, etc.)
6	Electric and electronic tools (e.g. handheld drills, saws. Screw drivers, etc.)
7	Toy, leisure and sports equipment (e.g. play station, Gameboy, etc.)
8	Medical devices (i.e., with the exception of all implanted and infected products)
9	Monitoring and control instruments
10	Automatic dispensers

The use of ICT equipment and other electronic equipment is growing and consequently the rapid growth of WEEE. This growth is expected to accelerate, since the equipment lifetime per Baldé et al. (2017) decreases with time and growing consumption. While the annual consumption of new EEE was calculated to be 60 million metric tons in 2016 (Baldé et al., 2017), the E-waste thereupon generated stood at 44.7 million metric tons in the same year (Baldé et al., 2017, p. 4), a percentage estimated to rise to 52.2 million metric tons by 2012. This increase is fanned by a per capita increase from 6.1 kg in 2016 to an estimated 6.8 kg by 2012 (Baldé et al., 2017, p. 5). Robinson (2009) opined that most of the E-waste is produced in Europe, the United States and Australia. This is in line with the results of Baldé et al. (2017, p.

6) who maintained that the per capita generation of E-waste in Africa is only 1.9 kg, while in Europe it is 16.6 kg. Robinson (2009) pointed out that computers, mobile phones (and televisions (Cobbing, 2008) are abundant in the waste stream because of their short lifespan. In this regard, Betts (2008) stated the typical lifespan of a computer to be 3 years, a mobile phone 2 years (Cobbing, 2008) and a television to be 5 years (Li et al., 2009). E-waste is one of the emerging global environmental challenge of the 21st century, especially in Africa (Baldé et al., 2017; Forti et al., 2018; Odeyingbo et al., 2018; Oteng-Ababio, 2014). Widmer et al. (2005) concluded that WEEE constitutes about 8% of municipal waste and is one of the fastest growing waste fractions. The generation of E-waste is projected to have increased from 33.8 million tons in 2010 to 49.8 million tons in 2018 (Ottaviani, 2016).

Li & Tee, (2012) claimed that the penetration and use of electronic gadgets are less in developing countries. This is ambiguous as a report published on the *Spielgel Online* (Sörbye et al., 2017) maintained that thousands of tons of used electronics leave Germany to West Africa, especially Nigeria. For instance, in 2008, an estimated 155,000 tons of used electronics were shipped from Germany to West Africa and about 1.3 million tons shipped from the EU region annually undocumented. According to the report and those involved in the trade, more than half of what is shipped is waste; thereby accumulating about 400,000 tons of E-waste in Nigeria alone yearly. This figure is again ambiguous as compared to the Basel Convention Coordiniation Centre's (BCCC-Nigeria & Empa, 2011) report on the Africa WEEE project. Therein, Nigeria alone generated 80% (1.1 million tons) of E-waste amongs the five West African countries considered in the project.

The utilisation of electrical and electronic equipment (EEE) in Africa may seem unimportant if compared to the rest of the globe. The continent's use of computers per Mueller et al. (2009) is estimated at 1.5% globally. This notwithstanding, a relatively low amount of EEE can generate reasonable amount of WEEE. Hence, Li & Tee (2012) stated that Developing Countries have the fastest growth in EEE consumption. In addition to the E-waste generated in the continent, Schmidt (2006) explained that a considerable amount is intentionally or unintentionally imported as used electrical and electronic equipment – UEEE. In this light, Puckett et al. (2005) reported that considerable media attention has pointed on this issue especially in Nigeria and (Brigden et al., 2008) Ghana. Studies indicate that Africa's use of EEE is fast growing (Finlay & Liechti, 2008; Magashi & Schluep, 2011; Wasswa & Schluep, 2009). Consequently, it will increase the quantity of WEEE generated (Schluep et al., 2009).

The global environmental watchdog organization – Basel Action Network (BAN) regulates transboundary movement of E-waste since the creation of the Basel Convention. E-waste contains highly toxic substances like cadmium, mercury, lead (European Council, 2007; European Environment Agency, 2009), beryllium and brominated flame-retardants – BFRs (Osibanjo, 2012) and environmental contaminants especially Pb, Sb, Hg, Cd, Ni, polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) (Robinson, 2009). Even though E-waste also contains some valuable substances like gold and copper (Widmer et al., 2005) as well as iron, aluminum, silver, platinum, palladium, rhodium and ruthenium (Osibanjo, 2012), existing legislation in developed countries compels them to dispose of it in an environmentally friendly manner (Osibanjo, 2012; Widmer et al., 2005); a move that is usually expensive (Osibanjo, 2012). Sequel to this, most E-waste ends up in landfills (Robinson, 2009) that is about 90% (Pongrácz, 2002). Consequently, these countries adopted an unsound and cheaper way of disposal by dumping WEEE in least developed countries (Osibanjo, 2012), though illegal under the Basel Convention (Basel Convention, 1989). Hence, lamented Osibanjo (2012) that a significant proportion of illegal shipments or legal shipments but deceitfully presented as donations end up in Africa, particularly West Africa.

Table 2.3 presents the situation of EEE imported, used and the consequent E-waste generated in five West African states. The data indicates about 1.5 million tons of e-products are imported yearly with Nigeria alone importing about 1.2 million tons (i.e. about 80%). Also, of the about 7 million tons of e-products in use in these five countries per annum, Nigeria uses about 90% and generates about 1.1 million tons of E-waste (80%) of the 1.4 million tons generated annually in these five countries.

Table 2.3 Quantitative data for EEE in five West African countries.
(Adapted from Basel Convention, 2011)

Country	Year	Import of EEE		EEE in use		E-waste generated
		Tons/year	Thereof used (%)	Kg/person	Tons/year	(tons/year)
Benin	2009	16,000	30	6.32	55,000	9,700
Ghana	2009	215,000	70	41.0	984,000	179,000
Ivory Coast	2009	25,000	48	4.8	100,000	15,000
Liberia	2009	3,500	10	4.6	17,000	NA
Nigeria	2010	1,200,000	35-70	44.0	6,800,000	1,100,000
	Total	1,499,500	----	----	7,956,000	1,303,700

To check the illegal movement of this equipment, the Basel Action Network – BAN carried out a two-year study in 10 EU countries by secretly installing GPS trackers in some old computers, monitors and printers (BAN, 2019). The report estimates 352,474 metric tons of WEEE per annum, leaving the EU to Developing Countries. This amount per BAN (2019) could fill 17,466 large-size intermodal shipping containers; and if loaded onto trucks, they will stretch back-to-back for 401 km. Only Hungary of the 10 countries studied (Austria, Belgium, Denmark, Germany, Ireland, Italy, Poland, Spain and the UK) was not involved in exports. BAN (2019) discovered from the tracked scrap, illegal shipments from these countries to Africa (Ghana, Nigeria, and Tanzania), Asia (Hong-Kong, Pakistan, Thailand) and Ukraine. The BAN Director (Puckett J. , 2019) lamented that instead of improving enforcement against such criminal activity, the EU is hypocritically working to make such dangerous exports legal.

2.4.3 Hazardous materials and substances

The use of some materials and substances and their consequent disposal has led to the generation of hazardous waste. This waste like any others poses a great threat to human life and the environment. This threat is not new as in the early 80s it became a leading environmental issue and by 1991, accounted for about 50% of the $8.2 billion environmental consulting market (LaGrega et al., 1994). These authors explained further that hazardous waste commands importance because amongst other aspects, it has the potential to cause toxic reaction in humans. Hazardous waste has been given much attention by different international bodies and organizations; in each case a list clearly spelt out of what is considered hazardous.

However, hazardous waste is defined by LaGrega et al. (1994) as wastes [solids, sludge, liquids and containerized gases] other than radioactive [and infectious] wastes which, by reason of their chemical activity or toxic, explosive, corrosive or other characteristics, cause danger or likely will cause danger to health or the environment, whether alone or when coming into contact with other waste. In addition, the European Union refers to hazardous wastes in accordance to the definition provided by the Council's Directive 91/689/EEC (European Council, 1991b). Therein, hazardous wastes are those featuring on a list drawn up in accordance with the procedure laid down in article 18 of Directive 75/442/EEC (European Council, 1975) based on Annex I[20] and II[21] to this Directive. Such wastes must have one or more of the properties listed in Annex III[22].

Furthermore, the Basel Convention refers to hazardous wastes as wastes that belong to any category contained in Annex I[23] unless they do not possess any of the characteristics contained in Annex III[24]; and wastes that are not covered under paragraph (a) but are defined as, or considered to be hazardous wastes by the domestic legislation of the Party (country) of export, import or transit (Basel Convention, 1989). It is worth noting as observed by Cointreau-Levine (1994) that while in developed economies like the USA, hazardous waste are strictly regulated to be source segregated and managed in secured transport, processing and disposal facilities, it is not the same in developing countries. She maintained that an even higher level of hazardous wastes may be observed in municipal solid waste, despite the lower level of commercial, industrial and institutional activity, due to the lack of or disorganised regulatory framework and enforcement system. Often, bloodied bandages, cotton swabs and syringes from hospitals are mixed in with the municipal solid waste of a developing country. Also common are hazardous solvents, asbestos from construction and demolition sites (Cointreau-Levine, 1994). It is evident that in LACW (MSW) of the developing countries, hazardous materials are always present. The challenge with this waste type as noted by Pongrácz (2002) and Ferronato & Torretta (2019) that data about its quantity is scarce and difficult to get.

2.4.4 Construction and demolition debris/waste (C&D or CDW)

The European Union defines CDW as waste that results from construction and demolition activities in a general way, it includes waste arising from minor do-it-yourself construction and demolition activities within private households (European Council, 2018). The initiative *'kreislaufwirtschaft Bau – KWB',* which commenced the documentation of mineral

[20]It contains categories or generic types of hazardous waste listed according to their nature or the activity, which generated them; the waste may be in liquid, sludge or solid form. It has Annex I.A. (wastes displaying any of the properties listed in Annex III) and Annex 1.B. (wastes which contain any of the constituents listed n Annex II and having any of the properties listed in Annex III)

[21] Herein are constituents of wastes in Annex I.B., which render them hazardous when they have the properties described in Annex III.

[22]Annex III contains the properties, which render a waste hazardous, and it is in directive 91/689/EEC amended to be directive 2008/98/EC.

[23]Annex I covers a wide range of waste categories e.g. category Y1 – clinical wastes from medical care in hospitals, medical centres and clinics; Y2 – wastes from the production and preparation of pharmaceutical products; Y3, Y4, … and Y44.

[24] Annex III contains list of hazardous characteristics e.g. with UN class code 1H1 Explosives, 3 H3 Flammable liquids, and 9 H13 Capable by any means, after disposal, of yielding another material.

construction waste generation and treatment in 1995, distinguished five major categories of CDW to be:

- Demolition waste
- Road construction waste
- Soil and stones
- Construction waste on gypsum-base
- Construction waste (*Die Deutche Bauindustrie*, *1995*)

CDW are mostly made up of inert materials like rubble, masonry, concrete, bricks and timber. Brennan et al. (2014), Butera et al. (2015) Cosper et al. (1993) noted that these are materials generated from residential and commercial buildings as well as from road construction (i.e., wood, concrete, corrugated cardboard, drywall, metals and roofing). Although CDW is another priority waste type in the EU (Pongrácz, 2002), the data is West Africa is not readily available or difficult to get. In addition, Cosper et al. (1993) reiterated the point that very little accurate information exists about CDW. The reason according to them is that in most cases, this waste type is not studied separately from municipal solid waste. Hence, in line with data from the EU where waste data is considered comparatively high in quality (UNEP, 2013), Pongrácz (2002) stated that CDW account for approximately 25% of total waste generated in the EU. By 2006, this waste type had increased to 38.2% of the total waste in the EU with mining and quarrying contributing an additional 17.8% (UNEP, 2013). Bhada-Tata & Hoornweg (2012) maintained that CDW like building rubble, concrete and masonry can represent up to 40% of the entire waste stream in some cities.

For instance, Köhler (1991) maintained that in Germany CDW played a greater role in municipal solid waste composition as it made up for an approximate 80% by weight and 60% by volume of the federation’s annual municipal waste generation. Also, Bruchner & Scholten (1992) opined that of the 12 countries in the European Economic Community (EEC)[25], Germany generated more than one third of the all the CDW, which was especially due to the demolishing of the old Cold War structures such as the Berlin Wall. This promoted debris recycling. Hanisch et al. (1991) maintained that over 30% of such debris was being recycled. Pongrácz (2002) regretted that CDW is also of great environmental concern as it has the

[25] The EEC was a regional organization, which aimed at bringing economic integration amongst its member states. Established by the Treaty of Rome of on 25 March 1957, the EEC was incorporated and renamed European Community upon the formation of the European Union (EU) in 1993. However, in 2009, the European Community’s institutions were absorbed into the EU’s wider framework and the community ceased to exist.

presence of some hazardous materials like asbestos, and PVC, which, in some treatment techniques causes emission of toxic gases (dioxins).

In Western societies where construction is an indicator of prosperity (Pongrácz, 2002), the objective to prevent waste generation from increase is limited. However, the chances of improving recycling are possible. For instance, the recycling of this waste type is about 80% in Germany, Denmark and The Netherlands while in Finland, Ireland and Italy it is between 30-50% (Pongrácz, 2002).

2.4.5 Water and wastewater treatment facilities

Liquid waste or wastewater is the water supply after it has been used in a variety of applications in a community. Hence, wastewater according to Metcalf & Eddy (1991) and Tchobanoglous et al. (2003) is a combination of the liquid or water-carried wastes removed from residences, institutions and commercial establishments together with such groundwater, surface water and storm water, as they may be present. Though termed 'wastewater', it contains sewage sludge[26] and further bio solids that can be used as fertilizer in agricultural pursuits. In this regard, Wiechmann et al. (2013) noted that the utilization of sewage sludge for agricultural engagements has recently been on the rise (i.e. 2006 to 2011) at about 29 percent. This upswing according to them is attributable to more rigorously binding sewage sludge standards. Hitherto, the Water Environment Federation (APHA, AWWA & WEF, 1998) adopted a policy defining 'biosolids' as a primarily organic, solid, wastewater treatment product that can be recycled beneficially (Metcalf & Eddy, 2003). In this regard, the Danish Environmental Protection Agency explained that the organic content of sludge can improve soil structure and that sludge helps stimulates biological activity in soil (Pongrácz 2002). Wiechmann et al. (2013) further affirmed that sludge also contains nutrients like Nitrogen, Potassium and Phosphorus; and, it is *en route* to more importance as a raw material principally because of the higher concentrations of the later nutrient in it.

Tchobanoglous et al. (2003) lamented that when wastewater accumulates and goes in to septic, the breaking down of the organic substances (45 to 90% (Wiechmann et al., 2013) in it causes a serious nuisance to health and environment such as the odour it produces. This view is shared by Pongrácz (2002) who opined that sludge is contaminated with heavy metals, bacteria, viruses

[26] A by-product or residue of the sewage treatment process usually in a semi-solid form that has to undergo further treatment before being suitable for disposal or land application.

and several organic matter, a view also supported by the works of Bueno et al. (2012). Wiechmann et al. (2013) expressed that the series of harmful substances contained in sludge complicate its management task. Hence, within the European Union, the Landfill Directive on waste (European Council, 1999) provides restrictions on the landfilling of organic waste. This is because before then, sludge landfilling was considered an inexpensive disposal means, but with the Landfill Directive and national regulations, it became expensive (Christensen et al., 1992) and complicated. This is especially with conditions to be met in Articles 7 (application for a permit), 8 (conditions of the permit), 10 (cost of the landfill of waste), 12 (control and monitoring procedures in the operational phase) and 13 (closure and after-care procedures) of the EU Landfill Directive.

In order to protect water bodies and coastal areas explained Pongrácz (2002), wastewater treatment plants have increased in number and improved methods of treatment (for instance, in Germany alone the number of solar dryers in use rose by more than 60 setups between 2004 and 2010 while in 2012 about 114 sludge drying facilities were operational (Wiechmann et al. 2013); this is considered a positive breakthrough for the environment. This increment, accompanied by a rise in the amount of sewage sludge is seen as a challenging issue for the waste management process and policy (Brodersen et al., 2002). For instance, municipal sewage plants in Germany produce about two million tons of dry sewage yearly, with an increase in thermally treated sewage sludge from 31.5% in 2004 to over 54% in 2011 (Wiechmann et al., 2013). Pongrácz (2002) explained that sludge incineration reduces it to ash, which can be landfilled. In addition, Wiechmann et al. (2013) expressed that the processes of sludge thickening, dewatering and drying help reduce its volume. In addition, past combustion or incineration (at least 1,200°C) of gases from liquid waste has been proven to destroy toxic organic pollutants such as dioxins and furans.

In Africa, especially Sub-Saharan, water and wastewater treatment facilities have not gained much prominence (Estache, 2017; WHO, 2015; World Bank Group, 2017). Hence, the practices in the continent are insufficient to ensure a safe water and basic sanitation (Wang et al., 2014). This is expressed in the findings that there is an increase in Africa's urban population without sanitation services (UNICEF, 2015) from about 88 million in 1990 to 175 million in 2008. For instance, studies on wastewater treatment practices in the continent indicate that in West Africa (Burkina Faso, Ghana and Senegal) have sanitation coverage ranging between 32 and 72%

(Nikiema et al., 2013). Consequently, there is very much the use of the flying-toilet[27] in the continent (Wang et al., 2012) and fly tipping. Obuobi et al. (2006) for instance explained that in Ghana, about 38% of the population dispose of their liquid waste on the streets or outside their houses, about 21% directly into gutters and 35% in the compound. Given the background that most households in Africa lack proper sanitation and toilet facilities, for instance, 20% households in Ghana do not have toilet facilities in all the ten regions of the country, with an increase to about 70% in the three northern regions (Gyampo, 2015), there is an increase use of the flying-toilet. In Nigeria, only 29% (in 2015) were using sanitation facilities that are considered safe (UNICEF, 2015).

These practices increase the amount of wastewater and sewage in the environment placing human health and the later at risk. This is further worsened when run-off washes it into nearby water bodies or when infiltration and further percolation occurs, groundwater is also contaminated. Wang et al. (2012) stated that an estimated 75% of Africans rely on groundwater for drinking. (Table 2.4). This percentage and practices place a great part of the continent's population at risk of water-borne diseases due to wastewater mismanagement. Furthermore, the afore-mentioned practices can confirm the assertion of Wang et al. (2014) that domestic wastewater is a major source of water pollution.

Table 2.4 Typical problems or (ground) water pollution by wastewater in Africa.
(Adapted from [1] UNEP, 2011b; [2] Water Services Regulatory Board, 2016; [3] Wang et al., 2014; [4] Parkman et al., 2008; [5] Gyampo, 2015)

City/country	Problems of groundwater pollution
Port Harcourt, Nigeria and Nairobi, Kenya	- More than 80% of drinking water is sourced from groundwater, but its shallow water table makes it prone to pollution sources like untreated wastewater [1] - The city's upper aquifer is vulnerable to pollution especially from landfills, dumpsites and infiltration from polluted streams [2]
Kisumu, Kenya Ghana	- Pollution from industrial wastewater and pesticides [3] - Contamination by overflowing pit latrines [4]
Bolama Island, Guinea-Bissau Kampala, Uganda	- Industries discharge their wastewater directly into water bodies without any form of treatment [5] - About 79% of the wells present moderate to heavy faecal contamination [3] - Contamination from pit latrines deteriorating groundwater quality [3]

[27] Plastic bags used for defecation and thrown away (mostly when it is dark or early morning) along the roads/street, on open spaces, gutters, abandoned buildings or nearby bushes and farmlands

Generally, wastewater treatment in Africa is done mainly using the wastewater stabilization ponds (WSPs) (Gyampo, 2015; Nikiema et al., 2013; Phuntsho et al., 2008; Wang et al., 2014) the trickling filters and the activated sludge system (Gyampo, 2015; Nikiema et al., 2013). The positive side of the WSPs systems is its low capital, operation and maintenance cost, the reduction of sludge volume and high treatment efficiency if properly designed (Phuntsho et al., 2008). On the other hand, the WSPs if not properly designed, horrible odour may emanate from them, mosquitoes and other vermin can breed in and around such areas if the vegetation is not controlled (Phuntsho et al., 2008), and it is difficult to control or predict ammonia levels in effluent (US EPA, 2002).

Given the above background, West Africa in general and Nigeria in particular need to understand and learn from the high income and OECD countries the importance of waste data, beginning from the quantity generated; for this is the base of waste management. Given the fact that waste generated in developing countries is mostly organic (Bhada-Tata & Hoornweg, 2012; Silpa et al., 2018) as well as waste in countries located in humid, tropical and semitropical areas are usually characterized by a high concentration of plant debris (Bhada-Tata & Hoornweg, 2012), Sub-Saharan Africa needs to learn how to convert these materials that constitute a nuisance in to a vital resource and an opportunity of great importance. The processes in the conversion of waste to vivaciousness or vitality will touch all sundry positively, especially in the domain of agriculture, which is still to a greater extent the region's economic backbone.

2.5 Waste treatment strategies – the waste management hierarchy (WMH)

Seven facts illustrate the magnitude of the challenges and benefits associated with waste (Table 2.5).

Table 2.5 Seven facts about waste *(Adapted from UNEP, 2013; Chamberlain, 2012)*

	Facts	Tips	Figures/Examples
1	Waste generation	Waste must be generated	Yearly, an estimated 1.3 billion tons of solid waste is generated; it is expected to increase to 2.2 billion by 2025.
2	Greenhouse gases and other risks	Waste produces odour and greenhouse gases	Decay of organic waste stinks and contributes 5% of global greenhouse gases
3	Market size	Waste has a market	US$410 billion yearly is the estimate for the global waste market from collection to disposal,

			not including a sizable informal sector in developing countries.
4	Resource savings	Waste saves resources	A ton of aluminum recycling saves 1.3 tons of bauxite residues, 15m^3 of cooling water, 0.86m^3 of process water and 37 barrels of oil, while preventing the emission of 2 tons of carbon dioxide and 11kg of Sulphur dioxide.
5	Employment	Waste is an employment source	In the EU recycling activities in 2000 created 229,286 jobs, by 2008 it increased to 512,337; an annual growth rate of 10.57%. About 422 persons per million inhabitants in 2000 were employed in waste-related activities in Europe alone and this increased to 611 in 2007, an increase of 45%. In Nigeria & Ghana, informal E-waste collection & recycling yields between US$0.22 & $9.50/capita/day, while refurbishing yields salaries between US$2.22 & $22/day.
6	Food waste	Food generates waste	One-third of food produced for human consumption is lost or wasted, amounting to about 1.3 billion tons per year.
7	Profitability	Waste is profitable	E-waste contains 40-50 times the amount of gold in ore mined from the ground; some amounts of copper, aluminum and rare metals that exceed by many times the levels found in typical ores. Printed circuit boards are may be the richest waste stream.

The principle of waste management hierarchy is set by the European Council to be prevention, recovery and safe disposal (European Council, 1991a, 2008). The waste management hierarchy can therefore, be considered a chain of commands, which indicates an order of preference for actions to deal with (manage) waste. This order indicates the first as the most preferred and the last as the least preferred. The following organizations present a different order of the WMH, ending with disposal as the last and the least preferred option (Figure 2.8:1-4). The question one can raise at this stage is ‘what happens to the receptacle of the waste disposed of?’

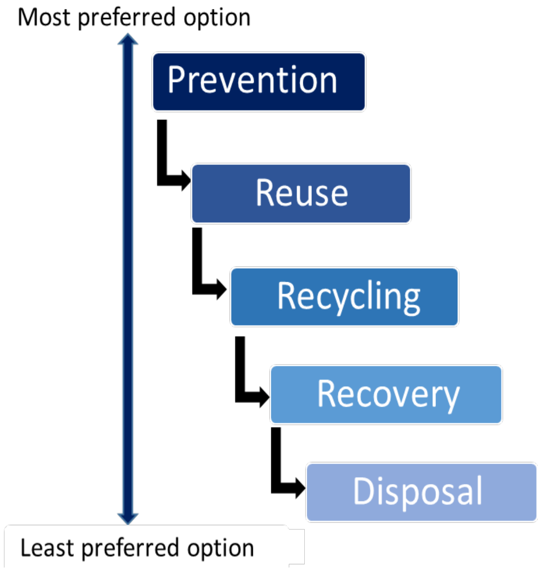


Figure 2.8.1 WMH (European Council, 2008; OECD, 2013).

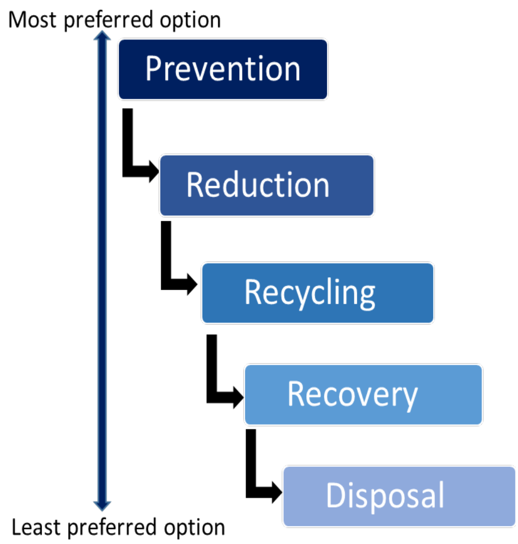


Figure 2.8.2 WMH (Basel Convention, 1989).

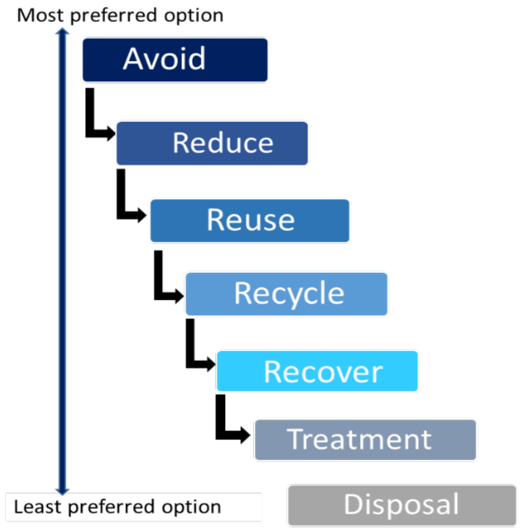


Figure 2.8.3 WMH (EPA, 1990).

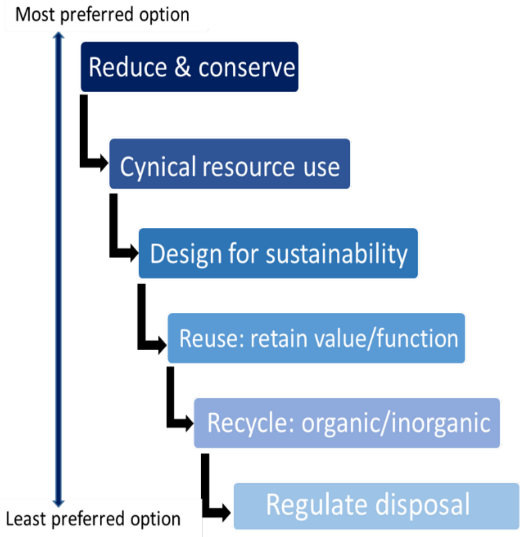


Figure 2.8.4 (Zero Waste Europe, 2013).

2.5.1 Waste prevention

Waste prevention includes the use of less material in design and manufacture; keeping products longer, their re-use and the use of less hazardous material (DEFRA, 2013). The prevention of waste per the European Council (2018) is the most efficient way of improving resource efficiency and the reduction of waste's environmental impact. Given the importance of waste prevention, the OECD held its first workshop in 1999 devoted ultimately to waste prevention (OECD, 2000). This organization however argued that though the waste prevention principle is universally accepted, its practice has lagged far behind. Waste prevention (OECD, 2000) engulfs activities that reduce both the quantity and hazardous nature of wastes; and this encompasses three actions:

(i) Strict avoidance (complete prevention of waste generation by virtual elimination of hazardous substances or by reducing material or energy intensity in production, consumption and distribution)
(ii) Reduction at source (minimizing use of toxic or harmful substances and/or minimizing material of energy consumption)
(iii) Product re-use (multiple use of a product in its original form, for its original purpose or for an alternative, with or without reconditioning).

The preceding definition exposes the dissimilarity of terms and meanings in the waste management hierarchy. While prevention per the OECD (2000), DEFRA (2013) and European Council (2008) encompasses reduction at source and re-use of products, the former action stands as the second most preferred option of the UNEP (2013). With this lack of coherence, Vancini (1997) stressed that consensus efforts should be made to have a common understanding of terms when discussing waste management or policy. Further, the OECD clarified that confusions should not be made with the use of related terminologies. For instance, between waste prevention and waste minimization. The difference is clear as the latter is broader and means preventing and/or reducing waste generation at source; improving the quality of waste generated such as reducing the hazard, encouraging re-use, recycling and recovery (OECD, 1997,1998).

There is a common adage that *'prevention is better (and cheaper) than cure'*. This can be applied to waste management prevention strategy as it has benefits both to the environment and man. Preventing waste (generation) minimizes the urge for further investments and energy use to collect, store, process and dispose of what would have been generated as waste. This entails some fewer collection vehicles; reduced air pollution reduced need for storage space, reduced treatment and disposal and reduced negative environmental and human impact (OECD, 2000).

Since methane is also a product of decomposing waste and a contributor to global warming, waste prevention will mean reduction in the generation of methane gas and other toxic gases. This will go a long way in reducing the impact of such gases on the ozone layer depletion. Most advantageously, communities, governments and companies will save money through waste prevention as well as natural resources will enjoy longevity. A case in focus would be that of plastics. Plastic re-use will not only keep the environment tidy (streets, roads and public areas: the case of Nigeria in general and Imo State in particular where plastic tends to litter almost all the streets, notably commercial areas), the quantity of municipal waste stream will be reduced. There will be reduction in plastic consumption, reduction in plastic distribution and most importantly reduction in plastic production as well as oil extraction (OECD, 2000). In Nigeria (especially in the Niger Delta area where Imo State belongs), much financial[28], technological, human and other material resources will consequently, not be used in cleaning the Delta area, water ways and exclusive economic zone. These areas are always suffering from oil spills (from oil exploration) thereby rendering aquatic life difficult.

By using an artefact several times for the same or different purposes, the quantity of waste to be generated is automatically reduced both in time and space. In Nigeria and Imo State multiple use of a product is practical. However, since waste cannot be absolutely prevented (for always there will be by-products [consciously or unconsciously] from human processes and activities to be termed 'waste'), we must reduce the quantity once it is termed 'waste'.

2.5.2 Waste reduction

The logical starting point for proper waste management explained by UNEP (2005) is to reduce the amounts of waste that will be managed either informally within the generator's site or formerly and externally by another body once the waste is discarded by the generator. The reduced waste does not have to be collected or managed. Hence, waste reduction means re-use of waste within a generator's site or re-use of materials in essentially their current form by a similar group (for instance, the re-use of clothes as second-hand). Waste reduction is particularly important in the waste management hierarchy as it is backed by some international organizations and agencies. Article 21 of Agenda 21 (UNCED, 1992) emphasizes that waste reduction and maximization of environmentally sound waste re-use and recycling should be the first steps in waste management.

Reducing waste is important and cheap compared to other waste management strategies. For instance, in rich countries the push for reducing waste is mostly related to the high cost and

[28] For instance, UNEP recommended that the Federal government of Nigeria should establish a fund with an initial investment of $1billion to clean up the Niger Delta; but the government had set aside only $10million (Friends of the Earth Europe, 2016)

scarcity of suitable sites associated with the establishment of new landfills, and the environmental degradation caused by toxic materials in the deposited waste (UNEP, 2005). This is relevant to large metropolitan areas in the developing world that are often surrounded by other populous entities. Also, UNEP (2005) suggests several waste reduction actions:

- redesigning of products or packaging;
- promotion of consumer awareness;
- promotion of producer responsibility for post-consumer wastes;
- diversion of materials from the waste stream through source separation and trading;
- recovery of materials from mixed wastes;
- support of home composting, either centralized or small-scale, etc.

In many developing countries, waste reduction occurs naturally as a matter of normal practice because of the high value placed on material resources by the people; hence, re-use of materials is widespread (UNEP, 2005). This organization explains that there is a large potential for waste reduction in these economies where traditional labour-intensive practices of repair, re-use, waste trading and recycling have endured; and the recovery for synthetic or processed materials is being emphasized. In Sub-Saharan Africa, waste reduction measures for more than a decade have been gaining grounds as most governments are engaged in the banning (of the importation, manufacture and use), taxing and fining of the daily-used plastic shopping bags; i.e., the importation, production, sale and use are prohibited. Table 2.6 presents a list of countries that have so far embarked on this ban. Other countries like Mali, Guinea-Bissau, Ethiopia and Malawi have limited their use, adopted or announced bans on the use of plastic shopping bags.

Table 2.6 Plastic reduction measures in some African countries.
(Adapted from Iwuoha, 2016; Yaboa, 2014; Channels TV, 2019; Waweru, 2019).

Countries	Dates of ban and measures
South Africa	2003 – banned lightweight and placed a tax on thicker ones
Rwanda	2004 – banned lightweight and placed tax breaks encouraging recycling
Eritrea	2005
Tanzania	2006
Uganda	2007 – banned lightweight and placed a punitive tax of 120% on thicker ones
Botswana	2007 – retailers charge fees for the use of such bags
Kenya	January, 2011
Ethiopia	2011
Mali	2012
Cameroon	2012 (all lightweight plastic bags of 60 microns and below).
Mauritania	2013

Malawi	2014
Morocco	October, 2015
Senegal	April 2015 (even possession of such bags is prohibited)
Nigeria	May 21, 2019 – banned the use of plastic bags and placed a fine

2.5.3 Waste reuse

The Waste Framework Directive gives priority to prevention followed by the preparing for re-use option once waste is created. Hence, preparing for reuse means checking, cleaning, repairing and refurbishing whole items or spare parts (DEFRA, 2011). Although reuse is contained in the waste prevention and minimization options, it is still considered as a separate option in the waste management hierarchy (Pongrácz, 2002) and many still consider it as the second preferred option. This means the definition and use of reuse are operational and contextual. (Table 2.7).

Table 2.7 Operational/specific definitions of reuse.

(Basel Convention, 2011) for E-waste Africa program	Reuse is the process of using again used equipment or a functional component from used equipment in the same or similar function, possibly after refurbishment, repair or upgrading.
(Basel Convention, 2011) for E-waste Africa program	Direct reuse is continued use of EEE and components by another person without the necessity or repair, refurbishment, or upgrading; provided that such continued use is for the original purpose of the equipment and components.
(European Council, 2009) for setting eco-design Directive	Reuse means any operation by which a product or its components, having reached the end of their first use, are used for the same purpose for which they were conceived, including the continued use of a product which is returned to a collection point, distributor, recycler or manufacturer, as well as reuse of a product following refurbishment.
(European Council, 2000) end-of-life vehicle Directive	Reuse means any operation by which components of end-of-life vehicles are used for the same purpose for which they were conceived.
(European Council, 1994) Packaging Waste Directive	Reuse entails any operation by which packaging, which has been conceive and designed to accomplish within its life cycle a same purpose for which it was conceive, with or without the packaging to be refilled; such re-used packaging will become packaging waste when no longer subject to re-use.
(Lox, 1994)	Reuse is use for the second time of a product for the same purpose under the same form and with the same properties of the material as

	the first use, the material having constantly remained under the same form between several uses.

The definitions in Table 2.7 indicate that reuse is comprehended as using again for the 'same purpose or as in the original purpose'. There is another dimension of reuse, which is use for another purpose Lox (1994). He maintained that reuse for another purpose is the use of an artefact for a different intent as the original one, under the form with the same properties of the materials as the first use, the material having constantly remained under the same form between several uses.

UNEP (2005) maintained that material reuse in developing countries is generally motivated by scarcity or expense of virgin materials; extreme poverty; the availability of workers who are ready to accept minimal wages; the meagre values of even the well-off households and the large markets for used goods and products made from recycled plastics and metals.
Considering the European Council's decision on mineral oils (European Council, 2014) where waste oils are reused as fuel, and the regulation about the reuse of wastewater to irrigate parks in Madrid (Castro-Fresno et al., 2013). Pongrácz (2002) argued that reuse was not contextually defined in these regulations and so it is difficult to determine what reuse for another purpose signifies. He doubted if reuse of waste oils as fuel is actually re-use, or reuse of waste water for irrigation is really reuse; since these 'new products' had no previous purpose. Therefore, the first purpose of wastewater will be irrigation, which is wastewater utilized or water reused (Pongrácz 2002), a logic which I adhere to since these waste materials are actually 'new'. In the same light, the use of coffee waste to grow mushroom (Pauli, 2010a) cannot be considered the reuse of waste coffee; it is either coffee reused or waste coffee utilized. Thus, the concept of waste as a resource.

2.5.4 Recycling

Its brief history indicates humanity has been practicing it for thousands of years; nature has also been recycling plants and animals for as long as it has existed. Recycling is therefore not a new activity. It is as old and natural as the world itself. Motor City Free Geek - (MCFG, 2011) maintained that recycling is still the wise thing to do as indicated by its development and how it has become a way of life for millions of people. Table 2.8 indicates some recycling activities and dates.

Table 2.8 History of some recycling activities.
(Adapted from "History of Recycling", 2014; Bradbury, 2017; The Economist, 2007).

Dates	Activities
1031	Japan commences the first recorded use of waste paper for making new paper.
1690	-Recycled paper manufacturing process introduced with Rittenhouse Mill (near Philadelphia) making paper from fibre gotten from recycled cotton and linen rags.
1776	-America declares independence and rebels turn to recycling to provide materials for the war of independence; Gen. George Washington urges the reuse of old chains from frigates[29], iron kettles and pots are melted for ornaments.
1801	The first paper mill producing from material other than cotton and linen rags is built in England.
1865	The Salvation Army is founded in London and begins collecting, sorting and recycling unwanted goods.
1874	Curb side recycling begins in Baltimore, Maryland
1897	New York City creates a material recovery facility where trash is sorted and separated into different grades for recycling and reuse.
Early 1900s	Recyclers and reuse programs adopt the phrase 'waste as wealth' to describe the benefits made from sorting and reselling of items picked in household waste.
1904	The US's first aluminum can recycling plants open in Chicago and Cleveland.
1916	Chicago city jail sets an ultimate recycling experiment with prisoners collecting and sorting waste materials.
1916 -1918	The US government, due to shortages of raw materials during the WWI creates the waste reclamation service with the motto 'Don't waste waste – save it'.
1929	The municipal garbage department of Sacramento, California, steps up its annual revenue by selling the city's wastepaper to an independent paper company.
1939-1945	To support the U.S and Allied troops during the WWII, thousands of tons of materials were recycled: more than 400,000 volunteers and millions of citizens pledging to 'get the scrap', introduction of 'Special Salvage Days' for children, 'Salvage Commandos' – women's volunteer group and the 'Junior Salvage Commandos' – a group of 3,000 carrier boys enlisted by the *Herald & American* newspaper in Chicago to move form house-to-house in search of scrap iron.
1964	The all-aluminum can is introduced as its value when used is recognized as a raw material for making new ones. Its collection in the US grew from 1.2 billion cans in 1972 to more than 62 billion in 1995 with more than 10,000 recycling centres.
1970	-First national Earth Day held on April 22 with recycling as one focus; -recycling and litter clean-up programs gain grounds in the country: schools, religious institutions, environmental organizations and youth groups champion the moves; -US Environmental Protection Agency is created; -Congress passes the Resource Recovery Act shifting interest from disposal to recycling, resource recovery and waste conversion to energy.
	-The first 'bottle bill' is passed: Oregon introduces a refundable deposit on beer and soda bottles as an incentive to recycle.

[29] Small and fast navy ships that move along with other ships to protect them.

1971-1972	-Canadian government establishes the Department of Environment – Environment Canada. -The first recycling mill is built in Conshohocken, Pennsylvania.
1973	The polyethylene terephthalate (PET) plastic bottle is patented by chemist Nathaniel Wyeth with PET recycling growing from 8 million pounds in 1979 to 622 million in 1995.
1981	Woodbury, New Jersey becomes the first city in the US to mandate recycling.
1990	-McDonald's stops using Styrofoam containers. -The 20th anniversary theme for Earth day is recycling.
1991	Germany made history when it passed an ordinance shifting responsibility for the entire life cycle of packaging to producers. Creation of 'Duales System Deutschland' (DSD)[30]
1995	About 47.6 billion soft drink containers recycled in the US; more than 10,000 recycling centres and at least 4,000 curb side collection programs.
1996	-The US recycles at the rate of 25%; EPA sets a new goal of 35%. -In Germany, Elopak[31] and SINTEF team up to sell the first infra-red sorting machine.
2000	The EPA confirms link between global warming and waste; showing that reducing garbage and recycling cut down greenhouse gas emissions.
2006	Dell Computer starts offering free recycling service for their products.
2007	-Five States pass laws requiring unwanted electronics be recycled -San Francisco sets first to prohibit the distribution of plastic bags by grocery stores.
2012	More than 585 million pounds of consumer electronics are recycled; more than 25% rise over 2011.
2015	California enacts the first ever-statewide ban on plastic bags in grocery and convenience stores.
2016	A team of Japanese scientists discover a bacteria species (*ideonella sakainesis*) that eats plastics usually found in water bottles. The bacteria secretes an enzyme that turns the PET to breed a transitional chemical, it is taken up by the cell and then broken down giving the bacteria carbon and energy to grow.
2017	An engineering team at Stanford came up with a new semiconductor that is flexible as skin and also biodegradable. This could decrease E-waste drastically
2018	01.01: China bans 24 categories of recyclable materials 01.03: China announces quality standards to be met by scrap material imports 31.12: China bans 16 more solid waste scrap materials import
	30.03: Min. of Env. & Climate change Ontario released their Food and Organic Waste Framework. It is aimed at preventing organic waste from reaching disposal.

[30] Duales System Deutschland is the Deutsch Company that organizes a separate waste management system, which co-exists with public waste collection. DSD pays for collection, sorting and recycling of packaging materials by charging a licensing for its 'green dot'.

[31] Elopak is a Norwegian producer of drink cartons made of plastic-laminated cardboard; setting out to find a way to automate the sorting of its cartons in the early 90s, teamed up with SINTEF, - a Norwegian research Centre before selling its first unit in Germany.

Table 2.8 summarizes much about recycling; and, it is glaring that as the volume of or concern about waste increases, so do recycling efforts. Recycling is defined by the European Council (2008) as the reprocessing of waste materials in a production process for the original purpose or for other purposes but excluding energy recovery. Given this definition, the question is 'is recycling worth doing on environmental grounds'? Recycling exists as feedstock and mechanical.

- *Feedstock recycling* Also termed known as chemical recycling (Bio Intelligence Service, 2011) or tertiary recycling (Vadicherla et al., 2017), it is a recycling method used when the waste plastics' energy content is used by other methods than simple combustion, referred to as tertiary polymer recycling (Horvat & Ng, 1999). Thus, Pongrácz (2002) argued that the processes of feedstock recycling are not recycling by the 'classical' understanding of the word. His argument is, since plastics are generally of high calorific value (especially non -recyclable plastics (Kellinger & Wilson, 2015) ranging approximately from 18,000 to 38,000 kcal/kg and their utilization for energy alone or for related chemical production may be an alternative option (Bisio & Merreiam, 1994).

  Aguado & Serrano (1999) noted that feedstock recycling of plastic waste looks at their conversion into valuable chemicals useful as fuels or raw materials. Feedstock can include wood waste (sawdust and bark), crops, agricultural waste, wastewater treatment plants' bio-solids, LACW/MSW, animal waste (i.e., stall wastes) and a mixture of various feedstock Since these processes lead to the reclamation of metals and means to generate energy, they are considered as energy recovery strategies and will be discussed as such.

- *Mechanical recycling* it is the recovery of (plastic) materials from waste while maintaining the polymers' molecular structure. The Association of Plastics Manufacturers in Europe (APME, 1995) explained that all types of plastics can be mechanically recycled with little or no quality impairment. It is evident therefore from its definition that the process of mechanical recycling though termed as such, is a recovery process.

The term plastic is the general common word for a wide range of synthetic or semi-synthetic materials used in a myriad and increasing range of applications. Derived from a Greek word *"plastikos"* meaning fit for molding, plastic materials are of two broad categories: thermoplastics and thermosetting plastics. The former can be heated up to form products and can be re-heated to soften and melt again. Thermosetting plastics can be melted and formed once, after solidification, they remain solid, hence cannot be re-melted. Plastics have been broadly classified into seven types by the Society of the Plastics Industry - SPI in 1988. Manufacturers place a Resin Identification Code (RIC) or SPI number on each plastic product, which is usually molded into the bottom.

Table 2.9 Plastics identification codes.
(Adapted from American Chemistry Council, 2007; PlasticsEurope, n.d.; Wilhelm, 2008).

Resin codes	Scientific name	Properties	Common Applications
1 PET	Polyethylene Terephthalate	Clear, hard, solvent resistant, good gas & moisture barrier, softens at 80°C	Carbonated beverage/water bottles, pillow & sleeping bag filling, textile fibres
2 HDPE	High Density Polyethylene	Hard to semi-flexible, chemical & moisture resistance, waxy surface, easily coloured, softens at 75°C	Shopping bags, containers for milk & shampoo, reusable shipping container
3 PVC	Polyvinyl Chloride	Strong, can be clear, can be solvent welded, resistance to grease, oil & chemicals, softens at 80°C	Flooring, pipes, window frames, wire & cable insulations, packaging
4 LDPE	Low Density Polyethylene	Soft, flexible, waxy surface, resistant to acids & vegetable oil, tough, softens at 70°C	Bags, for garbage, dry cleaning, frozen foods; toys, adhesives, packaging
5 PP	Polypropylene	Hard but flexible, low moisture transmission, withstand solvents, translucent, softens at 140°C	Yogurt, syrup, ketchup & margarine bottles, bottle caps, kettles, straws
6 PS	Polystyrene	brittle, clear to opaque, glassy, low thermal conductor, high clarity, moisture barrier, softens at 95%	CD/video cases, plastic cutlery & service items, medical products & toys
7 Other	Letter below indicates ISO code like Polycarbonate (PC), Nylon (PA)	Resin or combinations of resins. Are identified with the number 7 or a triangle with numbers from 7-19.	Baking bags, automotive components, computers, electronics, packaging

The International Solid Waste Association (ISWA, 2015) upheld that though not ranked second on the waste management hierarchy, studies have found out that recycling has the highest climate/environmental benefits and lower environmental impacts than other waste management approaches; this tends not only to be the situation in OECD (Christensen & Fischer, 1999; ISWA, 2009) but also in developing economies (Chintan, 2009; Pimenteira et al., 2005). Such benefits (ISWA, 2015) include:

- reduction in energy use (e.g. the virgin production of paper on an average followed by incineration with energy recovery uses twice as much energy as paper recycling);
- production of virgin aluminum requires 10-20 times more energy than recycling aluminum. There is a universal benefit in recycling aluminum although regional differences in energy sources cause large variation in the extent of GHG savings;
- production of virgin steel requires two times as much energy as production of steel from recycled scrap. As mentioned above, there is a global climate benefit in recycling steel though regional differences in energy sources can cause variations in the extent of GHG savings;
- climate benefit e.g. closed-loop recycling (i.e. where a waste material is reprocessed back into the same or similar product requiring at least severe properties as the previous one, so that after several uses it can be used again for the original purpose (Lox, 1994);
- environmental gains (e.g. where recycled plastics replace virgin plastics of the same kind in ratio of 1:1 by weight [especially mechanical recycling], the recycling of plastics has a net environmental benefit compared to incineration, (APME, 1995).

2.5.5 Recovery

The term recovery at a glance can be easily understood to mean retrieval, salvage, rescue, reclamation or recuperation of something that was lost or something from a useless source to a useful source. In the waste management hierarchy, before materials are re-used, they have to be recovered from the waste streams; this is the primary glance of recovery (material recovery). Sundberg (2016) opined that material recovery is, from an environmental perspective, a better recovery technology than energy recovery. Material recovery involves the dismantling and sorting of discarded products to separate out useful materials, and where appropriate to clean them and ready them for re-use (UNEP, 2013). The treatment and dismantling of end-of-life vehicles to obtain tyres, glass, plastics, metals and other reusable or recyclable materials are aspects of material recovery especially in Sub-Saharan Africa. Sundberg (2016) also reported that countries with the most developed waste management schemes have invested in both recovery operations: these are Sweden, Denmark, Austria, Germany, The Netherlands, Belgium, Switzerland and Japan; with Sweden treating 99% of its household waste in recovery processes. This entails these countries have the lowest proportion of landfills consequently the lowest climate impact from waste management per ton of waste.

One can understand energy recovery (from waste) as the high technological burning (incineration) of waste converting it to alternative energy (electricity, steam or liquid fuels). Energy recovery also termed quaternary recycling (World Energy Council, 2016) in waste management is seen from different angles. The European Council (2008) refers to it as 'any operation, the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy'. Technologies involved in energy recovery have been given different lexicons. These include:

- **Waste-to-energy (WTE) or energy-from-waste (EFW)** The Confederation of European Waste-to-Energy Plants (CEWEP, n.d.) simply refers to waste-to-energy as plants that burn household and similar waste that could not be prevented or recycled. It maintains that WTE is a hygienic method of treating waste, reducing its volume by about 90%. Also, Gershman & Bratton (2013) referred to WTE or EFW as the mass burn technology and that it involves the complete combustion of unprocessed LACW. They noted that recyclables may be removed from the bulk LACW prior to delivery to the mass burn facility and the fly and bottom ash, which are produced after combustion, can be used as alternative daily cover at landfills or as construction aggregate.

Box 2.2 Recovery Operations Annex IIB of the 1991 WFD.
(Adapted from European Council, 2008)

R 1	Use primarily as a fuel or other means to generate energy
R 2	Solvent reclamation/regeneration
R 3	Recycling/reclamation of organic substances, which are not used as solvents (including composting and other biological transformation processes).
R 4	Recycling/reclamation of other metals and metal compounds.
R 5	Recycling/reclamation of other inorganic materials.
R 6	Regeneration of acid or bases.
R 7	Recovery of components used for pollution abatement.
R 8	Recovery of components from catalysts.
R 9	Oil re-refining or other reuses of oil.
R 10	Land treatment resulting in benefit to agriculture or ecological improvement.
R 11	Use of waste obtained from any of the operations numbered R 1 to R 10.
R 12	Exchange of waste for submission to any of the operations numbered R 1 to R 11.
R 13	Storage of waste pending any of the operations numbered R 1 to R 12 (excluding temporary storage, pending collection, on the site where the waste is produced.

- **Waste to fuels or feedstock recycling** in this procedure, chemical feed stocks, syngas or liquid fuels are produced from the conversion of industrial scrap or post-consumer waste plastics through thermal treatment processes like pyrolysis or gasification (Buekens, 2006).
- **Solid recovered fuel (SRF) or refuse derived fuel (RDF)** this is obtained through a systematic technique that detaches high-energy constituents or elements of waste streams such as plastics for use as a source of fuel in cement kilns and coal utility plants. Gershman & Bratton (2013) explained that RDF differs from WTE because incoming waste is processed before combustion to improve fuel performance. Recyclable and non-combustible materials are first removed from the LACW, and then the refuse is frayed, dried and/or trodden into pellets or cubes. These steps help to produce a more homogenous fuel. RDF is therefore considered a manufactured fuel depending on the degree of processing.

The notion of energy recovery by the Gershman & Bratton (2013) corroborates Bisio & Merreiam's (1994) argument that feedstock (recycling) is not classically considered a recycling type since plastics are generally high calorific value products ranging approximately from 18,000 to 38,000 kcal/kg, utilization for their energy alone for related chemical production may be an alternative option.

2.5.6 Incineration

International bodies like the European Union, the Environmental Protection Agency, the United Nation Environment Program and the Zero Waste Hierarchy (Figure 2.8) that have waste management and environmental sustainability as one of their priority do not consider incineration as an independent stage in the waste management hierarchy. The European Council (1991a, 2006, 2008) maintained that incineration is a disposal operation. In addition, the same body classified the process as the main alternative disposal method to landfill. Backing up this classification, the European Council (1997) stated that incineration produces toxins and heavy metals. To prevent their release, expensive filters must be installed in incinerators. Used filters with highly concentrated contamination, together with the quarter of the waste's original weight, must still be landfilled. Supporting this assertion, the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU, 2018) and the Federal Ministry of Environment (*Umweltbundesamt)* (UBA, 2008) stated that waste incineration is an ecological means of waste disposal when the waste is not otherwise redeemable.

Incineration considered by the Gasification Technologies Council (GTC, 2011) to mean "to render to ash", to burn completely or to burn to ashes, has been defined by Knox (2005) as a waste treatment process that involves the combustion of organic substances contained in waste materials. In addition, Hulgaard & Vehlow (2011) specified that waste incineration is carried out with surplus of air during which energy is released and there is the production of solid residues as well as the emission of flue gas. DEFRA (2013) acknowledged that incineration, an established thermal (waste) treatment, usually involves the combustion of unprepared (raw or residual) LACW. It added that the incineration plant combustion temperatures usually exceed $850^{\circ}C$ and the waste is converted into carbon dioxide and water; with non-combustibles like metals and glass remaining as solids termed Bottom Ash. The GTC (2011) established that incineration uses LACW as a fuel, burning it with high volumes of air (oxygen) to form carbon dioxide and heat. It indicated that the incineration of LACW also leads to the formation of toxic dioxins and furans, especially from PVC-containing plastics. Even though Reimann (2006, 2009, 2012) in his reports maintained that WTE generate both electricity and heat through thermal treatment of MSW, CEWEP (n.d.) confirmed that waste incineration generates slag and environmentally harmful substances (lead, cadmium, mercury) in flue-gas cleaning residues; these residues must however be buried in hazardous landfills.

Rand et al. (2000) pointed out that MSW incineration plants tend to be amongst the most expensive solid waste management options needing highly skilled personnel and a careful maintenance. They are mostly adopted by the developed countries. Referring to incineration as a waste treatment technology that involves burning commercial, residential and hazardous waste, the Global Alliance for Incinerator Alternatives GAIA[32] (2012) stated that the process converts discarded materials including paper, plastics, metals and food scraps into bottom ash, fly ash, combustion gases, air pollutants, wastewater, wastewater treatment sludge and heat. Rand et al. (2000) upheld that air pollution control remains a major problem in the implementation of incineration of solid waste disposal. These authors however, advised that incineration plants can be located close to the centre of waste generation, thereby avoiding or reducing the cost of waste transportation.

[32] GAIA – Global Alliance for Incinerator Alternatives/Global Anti-Incinerator Alliance is a worldwide alliance of more than 800 grassroots groups, NGOs, and individuals in over 90 countries whose ultimate vision is a just, toxic-free world without incineration. The Alliance was born in South Africa in 2000. Internet link: www.no-burn.org.

Having seen the two sides of incineration (i.e., the production of toxic ash, furans, dioxins and heavy metals (Zafar, 2008) and reduction in waste quantity, reducing the need for landfill, energy recovery as well as the positive advantages listed by Gandy (1994) and Petts (1994), it is a doubled-edged process especially from the environmental point of view. This controversy is shared by citizens in some Chinese cities, who were affected by incinerators and who worry about the environmental and health effects of these plants (Wong, 2014). According to the Alternative Energy Company – ecoprog's 2018/2019 press release (Ecoprog, 2018), there are more than 2,440 operational incineration plants worldwide with an annual treatment capacity of over 360 million tons. Of this number, 86 are in the US with an annual burnt capacity of 29 million tons (Baptista, 2018), 68 in Germany with a capacity of about 20 million tons (Engelmann, 2015) and just one in the whole of the African continent (in Ethiopia) with a daily capacity of 1,400 tons (Alfa-Shaban, 2018). The controversies and two-sidedness of waste incineration have been coined by GAIA (2012) as the 'myths and facts about WTE incinerators'.

Table 2.10 Myths and facts about waste-to-energy incinerators *(Adapted from GAIA, 2012)*

Myths		Facts
1	Waste incineration is a source of renewable energy.	LACW is non-renewable & it is derived from finite natural resources like forests, which are being depleted at unsustainable rates. Burning creates for waste, reduces resource conservation efforts, increases packaging & waste, discourage recycling. More than 90% of incinerated & landfilled materials can be reused, recycled & composted· (Platt et al., 2008).
2	Modern incinerators have pollution control devices like filters and scrubbers that make them safe for communities.	Incinerators pose significant health & environmental risk. Released pollutants contaminate air, soil and water. Incinerator workers & those living near are at high risk of exposure to dioxin & other contaminants (National Research Council, 2000) Among industries in the US waste incineration has the highest ratio of negative impacts from air pollution compared to its financial value. (Nordhaus et al., 2011).
3	Modern incinerators produce less carbon dioxide than alternatives.	Burning waste contributes to climate change. Incinerators emit more CO_2 per unit of electricity (2988 Ibs/MWh) than coal-fired power plants (2229 Ibs/MWh) (Nordhaus et al., 2011) E.g., Denmark's incinerators are releasing double the amount of CO_2 originally estimated making the

		country to miss its Kyoto Protocol GHG reduction targets (Buley, 2011)
4	Modern incinerators efficiently produce electricity.	All incinerators are a massive waste of energy. Incinerators only make small amounts of energy due to waste's low calorific value, while destroying large amounts of reusable materials. New incineration technologies generate electricity at rates lower than 19-27% (FCE Ltd, 2004) whereas recycling & composting conserve 3-5 times the amount of energy produced by waste incineration (Jeffery, 2005)
5	Incinerators provide jobs	Recycling creates 10-20 times more jobs than incinerators. E.g., with a recycling rate of about 33% over 800,000 jobs are provided in the US. Hence, recycling rate of 75% would create 1.5 million jobs (Tellus Institute, 2011).
6	Incinerators are an affordable option.	Incinerators are the most expensive method to handle waste & generate energy, while creating also significant economic burdens for host cities (Rand et al., 2000). E.g., the projected cost of new waste incinerator is $8,232 per kilowatt hour; this is twice the cost of coal-fired power and 60% more than nuclear energy. Waste incinerator operations & maintenance costs are ten times more that coal & four times more than nuclear (US IEA, 2010).
7	Incinerators are compatible with recycling.	Incinerators compete for the same materials as recycling programs but they burn valuable resources that can be recycled & composted. More than 2/3 of the materials used are still burnt or buried even though one can cost effectively recycle; a clear majority of what is wasted.
8	Countries like Denmark with expanding incineration highest recycling rates & they only burn materials that are not recyclable.	Household waste data from Denmark in 2005 showed that regions with increased incineration have lower recycling and vice versa. A 2009 study reported that over $6billion worth of resources that can be recycled is lost via burning in Europe (Friends of the Earth Europe, 2009).
9	Modern European incinerators produce clean energy, less pollution.	Waste incinerators in the EU continue to pollute the climate and cause remarkable public health risk, while burning billions of dollars' worth of valuable, non-renewable resources. E.g., modern incinerators in the EU are a major source of ultra-fine particulate emissions (Howard, 2009).
10	The EU is way ahead; the US lags behind in waste reduction.	US communities have been pioneers in the field of Zero Waste, as have many in Europe that prioritize Zero Waste above incineration. Zero Waste is the design and management of products and processes to reduce the

	volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.

2.5.7 Disposal

Disposal in practically all waste management hierarchy is the last option. Often termed landfill or final storage, disposal is considered any operation, which is not recovery even where the operation has a secondary consequence, the reclamation of substances or energy (European Council, 2008). Annex I of Directive 2008/98/EC sets out a list of disposal operations. (Box 3).

Box 2.3 Disposal operations *(Adapted from European Council, 2008)*

D1	Deposit into or on to land (e.g. landfill, etc.)
D2	Land treatment (e.g. biodegradation of liquid or sludgy discards in soils, etc.)
D3	Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories, etc.)
D4	Surface impoundment (e.g. placement of liquid or sludgy discards into pits, ponds or lagoons, etc.)
D5	Specially engineered landfill (e.g. placement into lined discrete cells, which are capped and isolated from one another and the environment, etc.)
D6	Release into water body except seas/oceans
D7	Release to seas/oceans including sea-bed insertion
D8	Biological treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of nay of the operation numbered D 1 to D 12
D9	Physico-chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures, which are discarded by means of the operations numbered D 1 to D1 2 (e.g. evaporation, drying, calcination, etc.)
D 10	Incineration on land
D 11	Incineration at sea
D 12	Permanent storage (e.g. emplacement of containers in a mine, etc.)
D 13	Blending or mixing prior to submission to any of the operations numbered D 1 to D 12
D 14	Repackaging prior to submission to any of the operations numbered D 1 to D 13
D 15	Storage pending any of the operations numbered D 1 to D 14 (excluding temporary storage, pending collection, on the site where the waste is produced).

A Landfill is a waste disposal site for the deposit of waste onto or into land (i.e. underground); it can be an internal waste disposal site (i.e. where a waste producer is carrying out his own waste disposal at the place of production) and/or a permanent site (i.e. more than one year) (European Council, 2008). Landfill, especially in Nigeria (Imo State in particular) seems to be considered a very simple and careless remedy; i.e., dumping the waste out of sight and definitely out of mind and cover it to rot or burn it. A modern sanitary landfill is different; it is a carefully thought and engineered unit. Guzzone (2010) noted that it is well designed in shape, size and location, with geo-synthetic liners and capillary barriers, together with leachate and landfill gas collection equipment as well as a monitoring system. Significant amounts of materials are however engraved in land, producing methane, which Pongrácz (2002) alleged that it is up to 60 times more than CO_2 in its contribution to global warming as well as leaking leachate containing potential toxic compounds. Much of the materials buried in landfills are important biomass that could be used for (energy) recovery processes (GAIA, 2012).

Disposal does not only entail landfill (Box 3). It also includes thermal destruction of wastes; since incineration is considered the most expensive method to handle waste and generate energy (Rand et al., 2000; US EIA, 2010); most communities and countries still tend to landfill generated waste. The European Council (1999) maintained that both incineration and disposal are hypothetically detrimental to human health and environment. There is the growing concern about the increasing number of landfills worldwide. Table 2.11 presents the ten largest landfills in the globe (in terms of size and biomass received) as at December 2018.

Table 2.11 Current biggest landfills in the world.
(*Adapted from Adam, 2016; Exploredia Team, 2016; Freeman, 2012; Karuga, 2017; Mills, 2018; Silverman, 2007*).

	Name of landfill	**Location**	**Size (in acres)**	**Tons per day**	**Tons per year (Millions)**
1	The Great Pacific Garbage patch	Pacific Ocean	Size of Texas ($695{,}662 km^2$)	88,000*	1.8 trillion*
2	Apex Regional landfill	Las Vegas, Nevada	2,200	10,500	3.8
3	Bordo Poniente landfill	Mexico City	927	12,000	4.4
4	Laogang landfill	Shanghai, China	830	10,000	3
5	Malagrotta Landfill	Rome, Italy	680	4,500-5,000	2.3
6	Puente Hills Landfill	Los Angeles	630	13,300	3.6
7	Sudokwon Landfill	Incheon, S. Korea	570	18-20,000	6.9
8	Delhi Landfill	New Delhi, India	500	6,000	2.2
9	Deonar landfill	Mumbai, India	326	5,500	2
10	West New Territories landfill	Hong Kong	272	6,200	

The Guiyu waste dump in Southern China per Exploredia Team (2016) is the world's largest E-waste dumpsite. It is commonly referred to as the "electronics' graveyard" and is considered one of the most dangerous. The site employs over 150,000 workers to disassemble old dumped electronics while the community recycles over 15,000 tons of wastes daily. The presence of the site and its activities release large amounts of pollutants, heavy metals and chemicals into nearby rivers contaminating water supplies, devastating farm harvests and damaging health with children reported to have abnormally high levels of lead in their blood (Xu et al., 2015). Contrary to the above information, a compiled list of countries used as dumping ground for waste (When on Earth, n.d.) placed Ghana at the first position amongst 20. The Agbobloshie region in Accra, Ghana is known as one of the world's biggest E-waste dumps, with about 6,000 settlers. Its horrible activities gave it the name 'Sodom and Gomorrah', after which a movie *'Welcome to Sodom. Dein Smartphone ist schon hier'* was made (Hayessen, 2018; Lehneis, 2018). Heise Online News (2016) reported that Ghana is the central destination of illegal E-waste export, and that most of it comes from Germany.

Part II *„Die Stadtreiniger "*– The Würzburger Experience

Creation and certification

The County of Würzburg located on the banks of the River Main of Lower Franconia in Northern Bavaria; Germany has an estimated population of 128,873 persons (2016 estimate). The city with an altitude of about 177m and a surface area of 87.6 km^2 is the seat of the 'Würzburg city cleaner' – *"Die Stadtreiniger"*. Belonging to the city of Würzburg, *die Stadtreiniger* certified since October 1998 as a waste disposal company, it was/is a recognition and confirmation that the quality of the services provided meets the requirements of the Waste Management Companies' Act *(Die Stadtreiniger Würzburg, 2017)*. *Die Stadtreiniger* is charged with waste services/management, street cleaning, winter services, waste advice, and technical service (vehicle fleet and administration, vehicle procurement, landfill and technology); the Environmental station at Zellerau is also a part of this company *(Stadt Würzburg, n.d.-l)*. The enterprise since 2006 is part of the Bayern Environmental Pact – *'Umweltpakt Bayern'* and in 2009, it was EMAS certified. The Eco-Management and Audit Scheme - EMAS developed by European Communities in 1993, is an instrument for companies that want to improve their environmental performance. The Würzburg *Stadtreiniger* therefore strives for a continuous improvement of its environmental standards through the sustainable management of waste. With an annual turnover of about 25 million Euro and about 80,000 customers, the enterprise has 290 employees in different sections and services *(Die Stadtreiniger Würzburg, 2017)*.

2.6 Duties of *„Die Stadtreiniger"*

2.6.1 Waste Services

The waste services' section with about 90 employees has an annual turnover of about 14million Euro. The city of Würzburg divided into thirteen Districts with over 125 routes has about 70,000 waste containers at various waste generation points (households, offices, hotels, restaurants, supermarkets, etc.). Of this number, about 21,000 are organic, about 22,000 for paper and approximately 26,000 for other waste types. This entails about 2.3 million containers emptied yearly with an estimated equivalent of 383 million litres. The waste trucks have to ply all 125 routes and streets to pick up the waste and empty the waste containers according to schedule *(Die Stadtreiniger Würzburg, 2017)*.

2.6.2 Waste Separation and Pick-up in Würzburg City

Waste in the city is separated into various types and categories: organic, paper, plastic, other/residual waste, hazardous waste, glass, textile, E-waste, old wood, small (household quantities) of construction and demolition waste and bulky wastes. However, each household is obliged to have at least four separate containers with different colours for the first four – organic, paper, plastic and residual waste. Table 2.12 presents a breakdown of some of the waste groups and their components.

Table 2.12 Major waste groups and their components in Würzburg city.
(Adapted from Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-o).

Waste groups	Waste components
 Organic	Kitchen waste, garden and plant wastes and compostable wastes
 Paper	Cardboard, carton, books, newspapers, brochures, parcelling paper, envelopes, paper bags, writing and drawing papers, magazines.
 Residual waste	Small animal beddings, diapers, meat & fish waste, ash, cigarette ends, sanitary paper, photo papers, etc.
 Plastic	Yogurt cups, milk and beverage cans, packaging sales bags made of plastic and metal, canned food containers, aluminium trays, empty spray cans, etc.

	Hazar-dous	Batteries, energy saving lamps, pesticides, fluorescent tubes, nail polish & chemical dyes, acids & alkalis (up to 3l), spray cans with colour remnants
	Glass	Only hollow glass like drinking glass, glass bowls, whisky, wine & beer glass. No window or door glass, no ceramics, porcelain, lead, mirror, etc.
	Textile	Well-preserved, clean clothes, bed & household linen and shoes in pairs. No mattresses, torn or muddy textile, no single shoes.
	E-waste	Household appliances like cookers, iron; telecommunication devices; medical & IT equipment; light source; electrical tools & toys with batteries

a) Organic waste

These wastes are mostly put in brown-coloured waste bins and the items include:

► all kitchen wastes raw and cooked (excluding bones of fish and meat), fruits, vegetables, potato and fruit peelings, bread and pastry, coffee and tea filters and bags;

► garden and plant wastes including grass and shrubs, flower soil and room plants (excluding the flower/plant jar);

► other compostable waste items like individual newspapers, kitchen towels and paper napkins are all considered organic waste. These waste materials are wrapped in newspapers and other biodegradable papers, i.e., the waste bin is lined with such papers to reduce the waste's moisture content and the lid of the bin always tightly closed to prevent flies and other insects. Organic waste containers should be kept in a shade to prevent easy/fast fermentation and odour development. Waste items like diapers, meat and fish items, ash, cigarette ends do not belong to this category; rather to the residual waste *(Stadt Würzburg, n.d.-b)*. Furthermore, when lawns are cut and the waste cannot fit into the organic waste container, bigger bio sacks are available at 4€ in shops (See Table 2.13) as well as at the customer service office of *Die Stadtreiniger*. Per *die Stadtreiniger Würzburg (2017)*, organic waste constitutes one-fifth of household waste and so are picked up weekly. However, in winter (from December to February), organic waste bins are picked up and emptied once every fort-night while Christmas trees are picked up during the second and third weeks of January. Furthermore, green waste materials (maximum 5m^3) are also delivered at the compost plant at *Kitzingerstraße 60* and at the plant at *Edith Steinstraße7*; in the latter, only a maximum of one cubic metre (1m^3) is accepted.

Table 2.13 Sales points of waste (collection) containers in Würzburg city
(Adapted from Stadt Würzburg, n.d.-m)

Districts	Sales points	Types of waste bags/containers sold				
		RWS	**OWS**	**OWB**	**NGS**	**PSP**
Frauenland	Buntstift, Seinsheimstraße 4	*		*		
	Dollansky Schreibwaren, Erthalstraße 46	*				
Altstadt ohne Mainviertel	Bürgerbüro, Rathaus, Rückermainstraße 2	*	*	*		
	Müller Drogeriemarkt, Dominikanerplatz 4	*	*	*		
	Papier Pfeiffer, Sanderstraße 4 a	*	*			
	Schneider Haushaltswaren, Rottendorfer Straße 9	*				
Versbach	"Versbacher Lotto-Lädle", Versbacher Straße 185	*	*	*		
Zellerau mit Mainviertel	Umweltstation, Zeller Straße 44	*	*	*	*	*
Grombühl	Die Stadtreiniger, Kundenbüro, Äußere Aumühlstraße 5	*	*	*	*	*
	Städt. Wertstoffhof, Gattingerstraße 29	*	*	*		
	Teppich Reuter, Wagnerstraße 16	*				
Lindleinsmühle	Einkaufsparadies No. 5, Schwabenstraße 4	*	*	*		
Heidingsfeld	Weißenberger, Wenzelstraße 16	*		*		
	Gartencenter Busch, Bürgermeister-otto-Straße 8	*		*		
Sanderau	Kestler Schreibwaren, Danziger straße 4	*	*	*		
Heuchelhof /Rottenbauer	Städt. Wertstoffhof Edith-Stein-Straße 7, Gewerbegebiet Heuchelhof	*	*	*		

RWS – Residual waste sacks (€ 3.50)
OWS – Organic waste sacks made of paper (€4.00/piece)
OWB – Organic waste bag (€ 1.00)
NGS – Neutral green sacks (€ 0.50/piece)
PSP – Paper sack made of paper (€ 1.00/piece)

b) Paper and cardboard wastes

Mostly in blue coloured bins, they include items like cardboard, cartons of all kind, books without plastic cover, newspapers, and brochures, parcelling/wrapping paper, envelopes, paper bags, writing and drawing papers as well as magazines. However, waste items like sanitary and photo papers, milk and beverage cartons, parchment and leftover wallpapers as well as polluted and pasted papers and stickers should not and do not belong to this category of waste; rather to the residual waste category. Like the organic waste containers, when the volume of paper and cardboard is large, bigger paper bags (sacks) are available (at 1€) at the customer office of *Die Stadtreiniger* and at the Environmental Station (see Table 2.13). Unlike organic waste, paper and cardboard waste containers are picked up once in a fortnight at the generation points of the different Districts following a detailed plan *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-h)*.

c) Other or residual waste (Restmüll)

The container for this waste category is mostly grey or ash in colour. Residual waste items include:

► treated and contaminated papers like carbon, fax, blue and proof papers, parchment paper, stickers, wallpaper remnants, handkerchiefs and washing sponge and cloths.

► Hygienic items like diapers, sanitary napkins, tampons and condoms.

► Medical articles such as plasters, injury-dressing materials, puncture-proofed syringes.

garbage and ash materials like vacuum cleaner bags, cigarette and the butts, carbon ash and small litter.

► Housework waste materials as waste floor carpet, cable residues, installation fabrics, tools, car plastics, treated wood, pressed fibre and compressed wood.

► Home or heavily soiled fabrics such as cleaning rags, stockings, bags, belts, tapes, and worn shoes.

► Office supplies and writing materials like pencils, ballpoint pens, markers, coloured pencils, stamp pads, stickers, glues, proofing paper or liquid without solvents, toners and ribbons.

► Sporting materials such as bicycle tires, tennis balls, tennis rackets and hoses[33];

► Food residues like meat and fish wastes, bones, chewing gum, shards of glass, ceramics,

[33] Either a pair of tight trousers or pants that fit over the legs worn by men in the past or a long tube made of rubber or plastic used for putting water onto fires and gardens.

porcelain and clay.

► Plastic and rubber articles like toys, flowering pots, cooking spoons, and similar household articles.

► Candle and floor wax as well as hair removal (including mesh).

► Harsh smelling or completely rotten/polluted waste such as paper used in wrapping raw meat, fish or cheese. When the residual waste container is filled up (especially after renovation of an apartment) or it is too small, bigger bags (sacks) are available at 3.50€ at different sales points in the city (see Table 2.13). The residual waste containers are emptied every fortnight *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-j).*

Annual charges are applied per property or household for the picking-up of the above-mentioned four types of waste. These are standard charges based on the volume of the waste container as seen on Table 2.14.

Table 2.14 The Würzburger waste bin volume and annual charge.
(Adapted from die Stadtreiniger Würzburg, 2017)

Type of bin	**Container volumes**						
Residual	60 litres	80 litres	120 litres	240 litres	660 litres	770 litres	1100litres
Paper	80 litres	80 litres	80 litres	120 litres	240+120litres	2*240 litres	660 litres
Organic	80 litres	80 litres	80 litres	80 litres	120 litres	120 litres	2*120 litres
Fees	182.21€	204.25€	248.32€	438.59€	1,104.85€	1,255.42€	1,952.65€

d) Plastic waste – the Yellow Sack and The Green Dot

The yellow sack is a recycle bin itself and not a waste sack. It is reserved only for used shopping bags as well as sales packaging packs made of plastic, composites and metal. Hence, the following items belong to the yellow sack:

► cleaned canned food containers, metal covers and containers, aluminium trays and unrumpled aluminum foils, clean paint cans and brush and empty spray cans.

► Plastics such as sales packaging foils, plastic bottles, plastic canisters and containers up to 5litres, empty containers of dairy products, margarine, cooking/vegetable oil, toothpaste and food packaging.

► Composite materials like cartons of milk and other beverages, vacuum packaging, portion cans and composite packaging such as solid cardboard, plastic or metal. The yellow sack is picked up from generation points twice monthly following the waste pick-up calendar. A roll constituting 26 yellow sacks is given annually to each generation point (households, offices,). However, citizens can besides the customers' office of *Die Stadtreiniger* get these yellow plastic bags at different places in the city (Table 2.15). *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-f)*.

***Table 2.15 Places,* days and times of yellow sack free collection.**
(Adapted from die Stadtreiniger Würzburg, 2017)

Places of collection	Days of collection	Opening hours
Community office at the town hall (*Rathaus Würzburg*)	Mondays and Thursdays	8:00am – 1:00pm
	Tuesdays	8:00am – 12:00pm & 2:00pm – 4:00pm
	Thursdays	8:00am – 12.00pm & 2:00pm – 6:00pm
	Fridays	8:00am – 12.00pm
Environmental station	Mondays to Thursdays	8;00am – 4:30pm
	Fridays	8:00am – 12.30pm
Customers´ office at *die Stadtreiniger*	Mondays to Thursdays	8:00am – 12:00pm & 1:00pm – 4:00pm
	Fridays	8:00am – 1:00pm
Bookshops in Versbach, Heidingsfeld, Lengfeld and Heuchelhof	Mondays, Wednesdays and Fridays	2:00pm – 6:00pm

Die Stadtreiniger is neither responsible for the recycling of these picked up plastics nor does it recycle the yellow sack and its contents. The enterprise is in cooperation with *DSD – Der Grüne Punkt*[34], which provides nationwide collection of used sales packages and obtains secondary raw material from them – a take-back system. When these plastics reach the sorting plants, they are sorted (by hand) into different grades of plastics and are further handed over to the different recycling companies. However, heavily soiled packaging is sorted out and included in the residual waste category.

[34] Founded on 28 September 1990 in Köln, it is an enterprise for waste prevention and secondary raw material extraction. Established by a group of companies active in the food and packaging industry in Germany, it was set before the entry into force of the Packaging Ordinance of 12 June 1991; thereby serving as a second disposal system in addition to the existing public waste disposal system – thus the name 'dual'. Internet link http://www.gruener-punkt.de/corporate/unternehmen/portraet.html

e) Hazardous waste

These are waste materials that contain poisonous substances or material, solvents and/or heavy metals. The following are therefore considered hazardous waste materials:

► paint stripper and waste oil of up to 5litres (this is the quantity that can be accepted from the Würzburger or from a property without payment. Any quantity beyond this is paid for upon delivery at the recycling yard).

► Vehicle batteries (up to 2 pieces) as well as other batteries and cell buttons

► Residues of construction chemicals with hazardous content, wet residues of colour and vanish, unmixed and wet photo chemicals (up to 3 litres) as well as disinfectants.

► Energy-saving lamps and fluorescent bulbs (up to 10 pieces).

► Adhesives with solvents, pesticides, nail polish and chemical dyes.

► Spray cans with residual contents, propellant gas residues, acids and alkalis (up to 3litres).

► Wood preservatives rising agents, petroleum and petrol, rustproofing agents and converters.

► Residues of cleaning agents for toilets, ovens and grill as well as other solvents (up to 1litre).

Hazardous waste components are picked up four times in a year: in March, June, August and October. Also, citizens can also transport their hazardous waste to the recycling yard or they can call the pick-up service of *Die Stadtreiniger* when they have large quantities of hazardous (and pay a fee) or they can also call the municipal waste consultants at the Environmental station if they have large quantities of hazardous waste/substance (for instance waste containing asbestos) *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-i)*.

f) Used glass

The container for waste glass is often partitioned into three: white, green and brown glasses. Blue, pink and black glasses belong to the green glass container. Only hollow glasses like disposal bottles, jam jars, drinking glass, glass bowls and glasses of whisky, wine and beer are dropped into these containers. No window or door glass, no ceramics, porcelain, lead, mirror, crystal or light bulbs should be dropped into the containers. Würzburg city has a total of 135 sets of waste glass containers stationed at different locations in the 13 districts. (Table 2.16). When the containers are full, there are toll free numbers on them to call for subsequent emptying and re-stationing. *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-g)*.

Table 2.16 Number of waste glass containers in the Districts of Würzburg.
(Adapted from die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-g)

	Number of Districts	Number of containers	
		Glass	**Textile**
1	Altstadt	17	03
2	Frauenland	17	06
3	Grombhül	09	03
4	Heidingsfeld	09	04
5	Heuchelhof	10	04
6	Lengfeld	12	05
7	Lindleinsdmühle	05	05
8	Dürrbachalle mit Hafen	09	02
9	Rottenbauer	04	01
10	Sanderau	12	03
11	Steinbachtal	08	03
12	Versbach	05	03
13	Zellerau mit Mainviertel	17	04
	Total	135	42

g) Textile waste

Mostly painted yellow or white, the used textile container is meant only for well-preserved and clean clothes, bed and household linen. Shoes in pairs are also dropped inside such containers. This is because only donations that are well packed in bags remain usable. The public is advised not to drop mattresses, torn or muddy textile, fabric residues and single shoes inside such containers. The textile containers are in many cases stationed close to the glass containers in the respective districts; they are however lesser in number as compared to the glass containers as seen on Table 2.16 above. While some of these textile waste materials are recycled, some are given to social companies like Red Cross and Caritas as second-handed clothes and shoes. The Würzburger also gives out some used (no longer needed) textile (and other household items) to the Würzburg Social Department store – *"Brauchbar gGmbH"*[35] *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-g).*

h) E-waste

E-waste or waste electrical and electronic equipment (WEEE) contains valuable secondary raw materials such as precious metals and plastics, which can be recycled as well as large amounts

[35] A charitable establishment founded in 1997 by the '*Diakonisches Werk Würzburg e.V.*' and the Würzburg protestant church parish to tackle the problem of rising unemployment. Its objectives include environmental protection, reintegration of the unemployed and creation of jobs and support for low-income households. More at: https://www.brauchbarggmbh.de/

of pollutants like heavy metals or CFCs and so must be disposed of properly. Although there is more possibility of WEEE recycling; repair, refurbishing, upgrading and reuse of some of the WEEE are possible and important. The public is therefore advised to give out or sell old (but still functioning) WEEE to friends and/or family, during/on Fair markets, via the free online-exchange market *"Tauschmarkt Mainfranken" (www.tauschmarkt-mainfranken.de)* or hand over to charity organisations (the Environmental station waste consultants can be contacted for help). The following appliances are classified as WEEE:

► large household appliances such as washing machines, cookers, refrigerators, dryers and electric lawn mowers.

► Small household devices like hairdryer, vacuum cleaner, iron, toaster, kitchen machines and shaving apparatus.

► Telecommunication equipment such as all kinds of telephones, fax machines and routers.

► Entertainment electronics like radio, television and video players

► Information technology devices like computers, printers, photocopiers and scanners.

► Electrical tools such as drilling and grinding machines as well as jigsaw saws.

► Medical equipment such as Blood Pressure monitor and diabetes monitor.

► toys with batteries or electric motors.

► Light sources such as Neon tubes and energy saving lamps *(Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-e)*.

Per *die Stadtreiniger* (waste services' department), manufacturers are obliged to take back old equipment from consumers and dispose of them in line with ecological standards. Hence, even small electrical appliances such as toasters, irons, telephones or mobile phones are no longer allowed to be thrown into the residual waste bin; they are assembled as WEEE and must be disposed of at the recycling yard. These small appliances and mobile phones can also be dropped at the Environmental station *(Nigglweg 5)* and at the mobile recyclables centre. With a proof of residence in Würzburg city, the *Würzburger* can dispose of his WEEE free at the recycling yard. However, firms and institutions are only allowed to dispose of household appliances and lamps of household quantities at the recycling yard. Meanwhile, electricians who take back old gadgets from customers can dispose of up to twenty of such items at the recycling yard if such delivery had been previously registered at the Environmental station. This is a proof to ascertain if the equipment originates from private households of Würzburg city. However, when citizens cannot transport their WEEE to the recycling yard, they can call the customer care of *die Stadtreiniger* and make an appointment for pick up at the cost of € 5.00/m^3 of load.

❖ **Bulky waste**

Besides the above-named waste categories is bulky waste. These are waste items from private households in quantities that cannot fit into the residual waste bin. Except for tyres, doors and windows (frames) no fee is charged when residents transport these materials to the recycling yard themselves. Like E-waste, this offer is only for Würzburg citizens with valid ID cards. Generally, when the waste services' department of *die Stadtreiniger* transports bulky waste, garden waste and WEEE, a protection fee of € 5.00/m^3 is always applied. Hence, bulky waste includes:

► maximum of two large electrical appliances like refrigerators, washing machines, dryers and spin-dryers, dishwashers, radios, televisions, PC-Monitors, shaving machines, lawn mowers, computers, vacuum cleaners, scanners, photocopiers, fixed and mobile phones.

► Household furniture and wood like tables, beds (and mattresses), chairs, cupboards, wardrobes (only in household quantities, no timber and fence wood).

► Doors and windows without frame for a fee of € 2.50 per item.

► Empty cookers and stoves (i.e. without oil).

► All kinds of bulky household items that could not fit into the residual waste bag.

► Bulky PVC and floor carpets.

► Metal scrap (but no car parts or metal from house renovation).

Bulky green wastes, which are collected twice a year (in spring and autumn), are also part of this category. Before pick-up, the citizen must bundle the waste using an organic rope (cord), maximum length of the bundle to be 1.50m *(Stadt Würzburg, n.d.-d).* There should be no use of plastic bags, no foliage, and moss or grass cuttings. Citizens can also donate green waste materials (like foliage, grass, shrub and hedge) to the compost plant; the prerequisite here is that the citizen transports the materials to the plant. The *Würzburger* upon request can in return receive finished rich-compost.

2.6.3 Street cleaning and winter services

An approximate 725,000 front meters (a front meter is the first one meter in front of every property) are swept per week, which corresponds to 37,700,000 front meters in a year (Die Stadtreiniger Würzburg, 2017). The city centre is cleaned daily, unlike the different districts, which are cleaned at least weekly. This section has sixty-nine (69) employees and use four large and twelve small sweeping machines as well as 2000 brooms yearly. Their annual turnover is estimated at € 6 million (*Die Stadtreiniger Würzburg*, *2017*; *Stadt Würzburg, n.d.-k*).

Street cleaning in Würzburg city by the State dates far back to the Street Cleaning Statute of 5 October 1977, last amended on December 21 2018 (Stadt Würzburg, 2018b). Therein, the city is charged with the responsibility of cleaning all public transport areas as well as connecting streets. This is done per the regulation on the maintenance and cleaning of public roads and squares as well as road classes defined on the road map. The latter is an integral part of the Statute and specifies the need for and extent of cleaning. The streets are classified into five cleaning classes with a defined scope of cleaning as seen on Table 2.17. The cleaning of these streets is not free; a fee is applied to each class of road as backed by the Statute on the Collection of Road Cleaning charges in Würzburg city - (Stadt Würzburg, 2018a). This Statute – The Road Cleaning Fee of 28th, December 2001, last amended on the 21 December 2018 went into force from January 1 2019. By it, charges shall be applied (Table 2.17) to the front meter of every property.

Table 2.17 Classes, fees and scope of streets' cleaning in Würzburg city.
(Adapted from Stadt Würzburg, 2018a)

Streets' Cleaning classes	Scope of cleaning	Fees applied
Cleaning class 11	Cleaning at least every three weeks	3.03€
Cleaning class 1	Cleaning at least once weekly	9.10€
Cleaning class 2	Cleaning at least twice a week	18.20€
Cleaning class 3	Cleaning at least five times a week	36.40€
Cleaning class 4	Cleaning at least seven times a week	45.50€

Street cleaning and winter services are a statutory order under the Bavarian Road and Lanes Act (*Bayerischen Straßen-und Wegegesetz*), implemented in the Ordinance on the Maintenance and Cleaning of public Roads and the Protection of winter tracks in the city of Würzburg – *Straßenreinigungs-und- sicherungsverordnung* last amended on 14th December 2018 (Stadt Würzburg, 2018c). By the latter, a track of about 1.50 m width in front of each property built or not built must be cleared of snow or ice residues. If there is no path, a corresponding strip along the road must be freed. Snow and ice residues must be cleared in a way that drainage channels, canal inlets and pedestrian crossings should be free. Also, bus and tram stops should be cleared in a way that buses and low vehicles should not be hindered. Winter Street clearing (of ice residues and snow) is required to take place between 7:00 am (or 8:00 am on public holidays) to 8:00 pm (and can be done until 8:00 pm if necessary). This is especially on major public roads, paths and squares (Stadt Würzburg, n.d.-k).

An important aspect of the winter services in Würzburg city is the spreading of defrosting agents on sidewalks like lava granules, sand or grit with the environmental label 'The Blue Angel'. These agents do not only work at temperatures below -15° but also reduce the risk of snow and ice slipping without harming the environment. The use of salt as a defrosting or thawing agent on sidewalks in Würzburg city is prohibited on public roads as spelt out Subsection 10 paragraph 1 *(§ 10 Sicherungsarbeiten)* of the Road Cleaning and Safety Ordinance (*Straßenreinigungs-und-sicherungsverordnung* (Stadt Würzburg, 2018c). It is considered an administrative offense in the subsection 13, paragraph 4 (*§ 13 Ordnungswidrigkeit)* of the same Ordinance and a failure to comply with this requirement is subjected to a fine of up to €1,000. This is because salt solution seeps and damages vegetation negatively affects the quality of drinking water as well as attacks roads and metals and cause the soring of animal paws. However, in the case of ice blocks or ice sheets (sequel to freezing rain) and extreme danger, the use of thawing substance is exceptionally permissible (only on affected areas) as outlined in Subsection 10, paragraph 2 of the Road Cleaning and Safety Ordinance. This is an exemption from the Section 10, paragraph 1 of the same Ordinance.

2.6.4 Advice about waste

Waste advice is offered by a part of *die Stadtreiniger* situated at *Nigglweg 5,* 97082 Würzburg – The Environmental station of Würzburg city. This office is also the urban centre for environmental education and information, waste and environmental consulting as well as the co-ordination centre for local Agenda 21. Established in 1990 as a pilot study within the framework of the country's outlook (*Landesgartenschau*), it was the first environmental station in Bavaria and has been the municipal centre for the above-mentioned services since 1991 (Die Stadtreiniger Würzburg, 2017; Stadt Würzburg, n.d.-l).

The station offers internships to students and a special project sponsored by the Bavarian Ministry of Environment and Health annually. It is also open to guests from around the country and the world as well as offers sensitization talks to the public especially during the 'Environmental week' (in July), 'Day of the Tree' and 'Biodiversity Day'. In addition, they have permanent public offers to nursery, primary and secondary school pupils as well as university students on current topics like waste prevention and sorting, biodiversity, water, climate change, energy saving, etc. The station's library, updated in 2010 is open to the public and is made up of an estimated 5,000 works, a large part of which is financed by the Bavarian Ministry of Environment and Health.

The idea of the Environmental station in Würzburg city is symbolic of an environmentally friendly cyclical management, especially that of recycling. This is seen in the oval-shape of the projected new Environmental Station where recycled concrete is currently being used for the first time in Bavaria (Stadt Würzburg, 2017) – the practicality of waste as a resource (secondary raw material).

2.7 Die Stadtreiniger's Networking

2.7.1 The waste temporary recycling yards – 'die Wertstoffhöfe' in Würzburg

There are two temporary sites in Würzburg for recycling materials – the centre at *Gattingerstraße 29* and at *Edith-Stein-Straße 7*, which, receive bulky waste materials, E-waste and other valuables as outlined in the terms of use of the deposit yard document (Stadt Würzburg, 2008). No green wastes are accepted at the *Gattingerstraße 29*, (Stadt Würzburg, n.d.-n) but, used and old items are sold at this yard at reasonable prices. At the *Edith-Stein-Straße 7* deposit yard, green wastes of up to one cubic meter as well as building debris of up to 50 litres are accepted free; the latter is also accepted at the *Gattingerstraße 29*. Annually, these two plants receive approximately 5,700 tons of such materials from the citizens.

At the recycling yards, only vehicles with maximum weight of 3.5 tons and a width of 2 m can drive in. Citizens with larger vehicles should contact the customer service of *die Stadtreiniger.* Also, citizens should be able to pre-sort the waste they transport to the yards and can unload heavy or bulky items themselves. Furthermore, if citizens bring residual waste items that could fit into the residual container, a fee of € 3.00 is applied per bag/container. Car tyres without rim are accepted for a fee of € 1.50 per piece and with rim for a fee of € 2.50 per piece. Hollow glasses are accepted provided they are separated into white, green and brown. The yellow sacks filled with the appropriate materials as well as aluminum, corks, CDs without cover, tins and cans are accepted in any quantity. Generally, the different categories of bulky wastes are accepted following the prescribed rules and regulations (Stadt Würzburg, 2008).

2.7.2 The waste-to-energy plant – *Das Müllheizkraftwerk (MHKW) Würzburg*

Petts (1994) maintained that waste incineration has an important role as for thousands of years the value of burning wastes has been recognised, both to reduce the quantity of surplus materials generated by households, trades and agricultural practices; and to provide fuel for heating or cooking. He however confirmed that recognition of potential environmental problems generated by burning wastes also has a long history. The German Federal Environment Agency (UBA, 2008) maintained that the first ever waste incineration plant - *Destructor* was built in Nottingham, England in 1876; and the first in Germany built in 1894/95.

The *MHKW*, established in 1979 as a public right of Würzburg (city and district) and the district of Kitzingen, (Dima et al., 2016) is a property of the Joint Waste Management Authority - *Zweckverband Abfallwirtschaft Würzburg* (ZVAWS, 2009). With the main goal of financing, planning and constructing a waste incineration plant and a landfill where the incineration residues will be buried, the plant situated at Gattingerstraße 31 receives waste from about 900,000 inhabitants. The city energy supplier – *die Stadtwerke Würzburg AG,* a subsidiary of the Würzburger Utilities and Transport company– *Würzburger Versorgungs-und Verkehrs-GmbH (WVV)* was commissioned by the Joint Waste Management Authority to operate the incineration plant in Würzburg.

The Plant with a pit capacity of about 12,000m^3 (though 3,000m^3 is permanently vacant for about five days) has ten tipping sites and three operation lines. Lines one and two have a waste burning capacity of 8 tons/hour each; they also generate steam temperature (415°C), pressure 42 bar and steam output of 28 tons/hour. Line three with a waste burring capacity of 15 tons/hour generates the same amount of temperature and pressure but with a steam output of 60 tons/hour. With this capacity, the plant in 2017 (ZVAWS, 2018) produced about 80 million kWh of electrical energy and 53 million kWh of district heating. The Plant is therefore a reliable generator of electricity and district heating since commissioning as it supplies an approximate 10 percent (Lewetz & Dima, 2012) of the annual steam heat in the district.

2.7.3 The composting plant in Würzburg

Per *die Stadtreiniger* Würzburg (2017), composting is not only the oldest form of organic waste treatment; it is the most cost-effective and most environmentally friendly way of treating organic waste. According to the Federal Quality Association Compost – *Bundesgütegemeinschaft Kompost – BGK,* 26% of generated waste in Germany is organic (with fractions of paper, cardboard and pulp); and this is the most important fraction of household waste generated. In the Republic, there are currently 558 compost plants and 173 fermentation plants (as of February 20, 2019) (BGK, 2019). These plants process more than 12.8 million tons of organic waste annually with about 9 million tons of compost and fermentation products.

BGK Bavaria, established on 24 April 1990 as a State-owned community of compost, joined the quality assurance as the hundredth plant on September 7, 2015. The compost plant in Würzburg – *Kompostwerk Würzburg GmbH* - *'Erdenmarkt',* which has been active in the State for over two decades receives yearly about 30,000 tons of organic biomass from Würzburg city, the municipalities of the Würzburg and the Main-Tauber districts; about 10,000 tons of garden waste from Würzburg (city and district) as well as private customers. The plant has an approved capacity for the processing of 67,000 tons of waste yearly; but they produce 29,000 cubic meters' compost per year and distribute 18,000 cubic meters of loose and bagged earth as well as mulch yearly with over 22,000 customers.

Products of composting include:

- Fresh compost, which is more hygienic but not fully mature compost and contains medium and coarse grains. It however encompasses levels of easily degradable organic substances which serve as the asserted 'nutrient humus'; it comprises all nutrients important for planting and fertilization as well as vital for agriculture.
- Finished and substrate composts are sanitary and mature compost and occur in fine and medium gains. Both contain higher magnitudes of stable humus constituents and enhance soil improvement – thus termed permanent humus. Both contain all plant nutrients essential for fertilization and are used in gardening, landscaping and agriculture. (BGK, n.d.) .
- Fermentation products, which are dregs of anaerobic treatment of organic biomass occurring in biogas plants, are used as fertilizers and soil conditioners in agriculture as well as other plant-based areas.

Composting can also be done in a small scale such as slat composting (i.e. the use of plug-in slats made of natural resistant wood), composting in a wire mesh container, quick composting (i.e. in a high-speed plastic (bin) compressor) and worm composting (i.e. 500 compost worms – *Eisenia foetida* and not earth worms – *Lumbricus terrestris)* (BGK, n.d.). However, when done on a large scale like at a composting plant, the process involves the following schematic steps (See Figure 2.9).

Figure 2.9 Composting stages, processes and products.
(Modified from BGK, n.d.).

2.7.4 Landfill in Würzburg

The city is responsible for the old Landfill at Laudenbach, which operated from 1975 to 1985. In it, household and bulky wastes as well as sewage sludge were dumped. The Laudenbach Landfill, now termed *'Altdeponie Laudenbach'* (Stadt Würzburg, n.d.-a) received 75.65% bulky and household waste from Würzburg city, 15.73% of same waste fraction from Würzburg district, while the Würzburg (city and 13 districts) sewage treatment plant deposited 75.65% sewage sludge in the pit (Stadt Würzburg, n.d.-a). The coinage of *Altdeponie* stemmed from broken concrete of the 34m deep-water drainage, which made it impossible for the leachate in the landfill not to be fully pumped off as part was partially discharged into underground water. Hence, Würzburg city has since 1989 been refurbishing the landfill by so many modern measures – to be the excavation and rubble debris sites of Würzburg city.

On a total area of 9 hectares, the new landfill which has been in operation since 1989 has a capacity of 282,00m^3; and, following rubble statistics, the landfill is can operate for the next 20 years (Stadt Würzburg, n.d.-c). Located by the B27 highway in the Main-Spessart district, the landfill only receives non-recyclable construction and demolition debris (with proof) and this includes waste from gravel and rock fragments (waste code No. 01 04 08), waste of sand and clay (waste code No. 01 04 09) and soil and stones (waste code No. 20 02 02). The new landfill therefore has a tyre cleaning plant and five groundwater-monitoring fountains (used to monitor the groundwater level and the chemical composition of the water). In addition, each year, a short-term and a full examination is conducted according to the LAGA – *Länderarbeitsgemeinschaft Abfall*.

Per the Statute on the use of the building rubble dump of Würzburg city located in Main-Spessart district, and, in collaboration with the Bavarian Waste Management Act of 1999, amended on 9 December 2004, the landfill belongs to Würzburg city. While Würzburg city can assign the site to a supplier for use as outlined in subsection 2 of the Statute – *(§ 2 Benutzungsregelung*) (Stadt Würzburg, 2004b), the site may also in principle be used by suppliers whose waste items are accrued within the meaning of subsection 4 – *(§ 4 Deponierfähige Abfallstoffe*) in Würzburg urban area. In addition, while delivery on the landfill is by prior arrangement with *die Stadtreiniger,* opening times are announced; (subsection 3 – *§3 Öffnungszeiten*) outside these, delivery is not possible. Before delivery, a clear visual inspection must be carried out at the entrance of the landfill as outlined in subsection five of the Statute – (*§ 5 Anlieferung und Abnahme von Abfällen*); if this is not possible, the waste must be unloaded 10 – 15m in front of the installation site and checked. The supplier must provide the landfill representative with precise information on the origin and composition of the waste. If any unauthorised materials are found, the supplier must immediately remove them. The waste quantity to be dumped is determined by the landfill representative in a consensus way, possibly by estimation.

At the landfill, suppliers and their assistants must comply with the instructions of the site representative as laid out in subsection 6 of the Statute – *(§ 6 Verhalten auf der Deponie).* While unauthorized persons are not allowed to enter the site, collection and transport (taking away) of materials of any kind on the site is prohibited. Fees as outlined in subsection 7 – (*§ 7 Gebühren)* depending on the usage rules as spelt out in subsection 2. While special arrangements are permitted as spelt out in the Fee Statute of the City of Würzburg for Building Dump - (Stadt Würzburg, 2004a), the normal fee is 20,50€ per cubic meter waste deposit.

3 MATERIALS AND METHODS

The essential notion of this research method was to identify the waste management strategies, which range from the identification of waste generators, sensitization and citizenry participation in waste management activities, waste treatment systems and (administrative) options that boost the sustainability of the activity and the State's environment. To achieve the objectives of this study, detailed qualitative and quantitative research methods were used. Qualitative information was assembled through interviews, non-participant observation and focused group discussions. In this light, Saunders (2013) researching on the UK's Environmental Movement Organization and Resource Mobilization, expressed the advantage of using a qualitative approach for clarifying the reasons why the formal organizational structure inclined to compete for the resources, which the quantitative approached failed to capture (Saunders, 2007; 2013, S. 17). In addition, in their studies, Ogilvie & Rootes (2015) argued that the qualitative approach is beneficial as it brought to light the dynamics between the actors and the impacts of protests in studying environmental campaigns. In addition, quantitative data were gathered by means of a questionnaire survey conducted on the different strata of the study population. A detailed field work was necessary to complement both secondary and primary data. Hence, secondary data relevant to waste management were consulted with emphasis and scenarios in Third World towns, Sub-Saharan Africa and particularly Nigeria. (See Figure 3.1). The chapter is summarized thus:

- Research design
- Study area and population
- Sample and sampling techniques
- Secondary data collection
- Primary data collection - instruments
- Field survey
- Validation and reliability of instruments,
- Administration of instruments and methods of data analysis

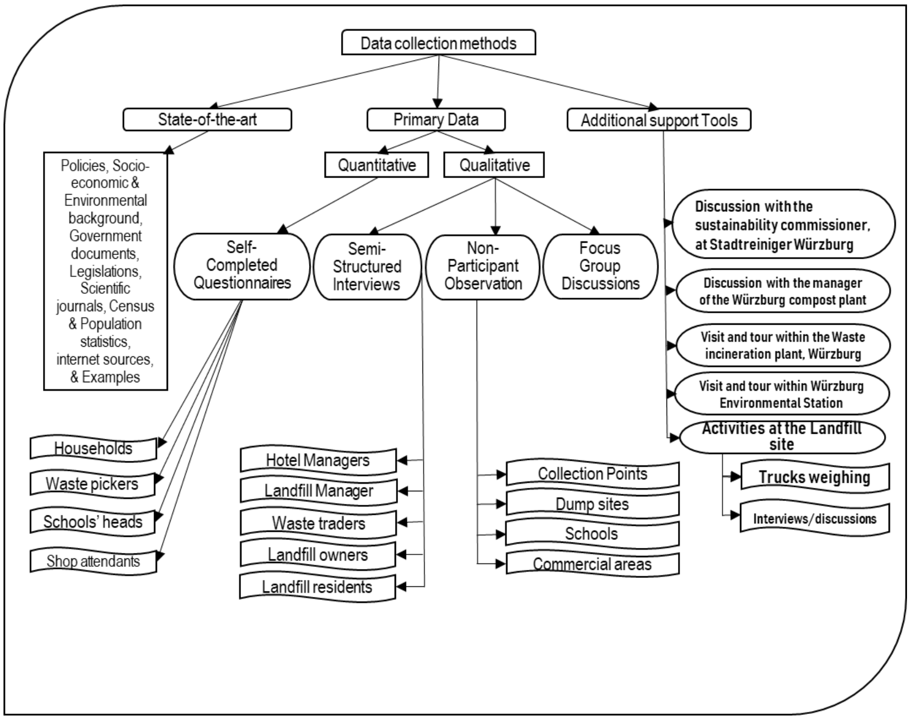


Figure 3.1 Methodology summary.

3.1 Research design

Per Nworgu (1991) a research design is a plan or blue print, which specifies how data relating to a given problem should be collected and analysed. In the same light, Amin (2005) and Nana (2015) maintained that a research design provides the researcher with a particular framework for tackling a specific or well-defined problem. This study was a descriptive survey research because it permitted the description of the prevailing aspects and activities involved in the management of generated waste in the study area from survey fallouts. This is consistent with the opinion of Ogomaka (2004) that a descriptive survey is an investigation geared towards establishing the situation on contemporary happenings over a sizable population and under a large setting without control or manipulation. Per Nworgu (1991), descriptive surveys are studies, which aim at collecting data on, and describing in a systematic manner, the characteristic features or facts about a given population. Therefore, this study used a descriptive survey design to identify and establish the amount of waste generated in Imo State, Nigeria, the waste management techniques as well as the impact of such techniques on the environment.

3.2 Study sites and population

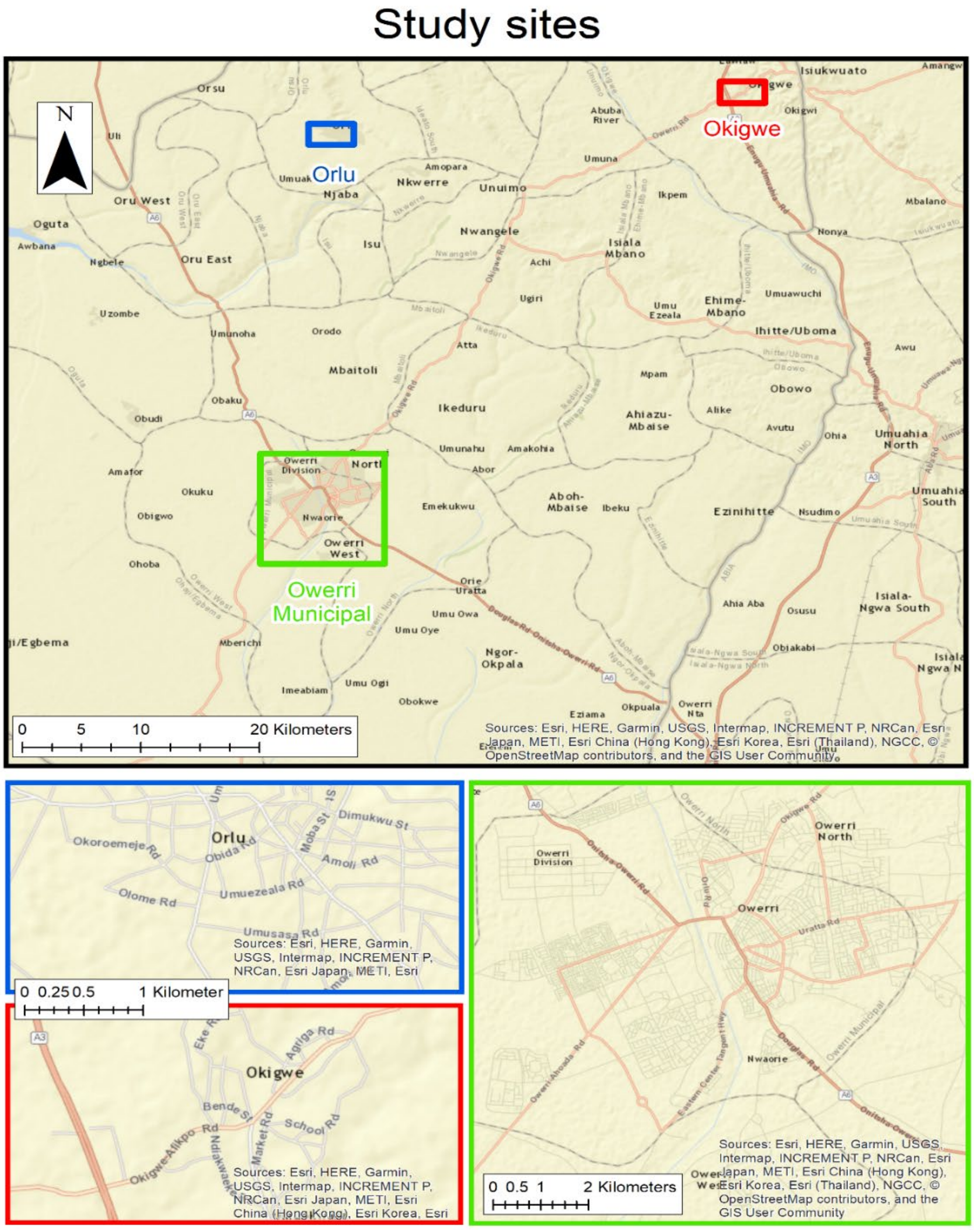


Figure 3.2 Over view of study sites.
(Modified from Esri basemap Streets 03.12.2018)

The three senatorial zones/headquarters in Imo State (5,288.0 Square Kilometres – 2,065.63 Square miles (NBS, 2010a) are – Owerri zone (104 km^2) Orlu and Okigwe zones also constitute the major towns in the State. These headquarters are also Local Government Areas – LGAs themselves. The study was centred in these areas.

3.2.1 Owerri Metropolis

The study at this site spanned from the city centre (Douglas (*A6 Federal road*) *–Ekeonuwa* street) to some10 km outwards. It engulfed 25 Districts or sub-areas of this zone. These included parts of Akwakuma, Amakohia and Aladinma extensions, Douglas, Egbu/Egbu extension, Federal low-cost housing estates, Ikenegbu and Ikenegbu extensions, Irete, MCC/Uratta Road, Naze, Nekede old road, Njemanze and Njeribeakor streets, Okigwe Road, Orji, Prefab, Rotibi street, Umuguma town, Wetheral, Works layout and World Bank housing estates/New Owerri. (Figure 3.2). These areas are collectively referred to in this work as Owerri Metropolis since the State's waste management services are extended to these areas, and, not all are within Owerri Municipal LGA.

3.2.2 Orlu LGA

The Orlu LGA, located within the coordinates 05°47'47'N and 07°02'20'E is the State's second largest town has an estimated population of about 420,000 (NBS, 2010a). Per Achebe (2012) Egbokhore & Oyetade (2002), Ekwe-Ekwe (1990) and Olawoyin (1971) this town played a critical role as it served as the headquarters of the OAU's Humanitarian Relief Agencies during the Nigeria/Biafra civil war[36]. The study was centred at the heart of this town stretching from the junction/intersection of Ihiala-Orlu road and Nkwerre road (approximately 250 meters away from the Orlu LGA headquarters). From here, it spanned 5km outwards engulfing parts of 21 sub-areas. These were by Aji road, by Alhaji Tijani road, Amaifeke, Amaigbo, Amaorie, Amike Road, Beach Street, Bishop Shanahan College – BSC road, Dimukwu street, Emezike Street, Ihial-Orlu road, Ihioma, Mgbee Road, Nkwerre road, Oduma road, Ogi-Ike street, Okorie street, Orji street, Orlu teaching hospital – OTH road, Umuezeal and Umuna/Umuna road sub-areas. (See Figure 3.2).

[36] Also known as the Nigerian Civil War and better described as the Biafra War, it spanned from 6 July 1967 to 15 January 1970. Stemming from politico-economic, ethnic, cultural and religious tensions, the war recorded over 145,000 deaths (over 2million Biafrans died from post-war starvation), displaced more than 6.5million persons and left over 3.5million refugees. Hence, Imo State located at the heart of the war zone was chosen to be the headquarters of the OAU's Humanitarian Relief Agencies and Orlu was the site.

3.2.3 Okigwe LGA

The Okigwe LGA is the third largest town in the study area with an estimated population of about 250,000 inhabitants (2006 estimate). Okigwe town lies between the Port Harcourt-Enugu-Maiduguri railway line. The town has therefore grown into a major passage and cattle transit area for the Southeast and South sub regions of the country. Okigwe town was also the poineer host of the Imo State university (now Abia State University – *Utturu* campus). The bearing at this study site was taken from 'Okigwe 4-corners' (Okigwe-Owerri junction); which is the crossroad and intersection of Ozubulu-Okigwe Road, Enugu-Umuahia road and Okigwe-Afikpo Road. Like at the Orlu study site, Okigwe's spanned 5km from the Okigwe-Owerri junction covering parts of 19 Districts. These were Bende and Bishop Ilonu streets, Eke-Okigwe quarter, Enugu-Umuahia and Ike sub-areas, Isiba and Lomara lanes, along Okigwe-Abba-Omega roads, Okigwe town and old park sub-areas, Onyejekwe and Rev. Manii lanes, school road and UBA streets, along Ubahu and Umuchima roads. (Figure 3.2).

At the above-established sites, the emphasis was placed on major waste generating sources like households, commercial enterprises like shops (both at the market squares and along the streets); schools (Nursery, primary and secondary), and hotels/guesthouses/restaurants. All these constituted the sample population of the study. To obtain these data, selected areas/cases that were conveniently available after Singleton et al. (1988). These areas were all visited and questionnaires administered based on the convenience sampling method as used by Afon (2012) and suggested by Ilker et al., (2016).

Table 3.1 shows a rundown of the population of the study sites and the distribution of questionnaires.From the total number (3,075 copies) of the instrument facets given out, 2,751 copies (89%) were retrieved but, 13% of the latter was not useful as they were incomplete while 87.09% (2,396 copies) were useful. However, of the total given out, 2,396 copies (77.92%) were useful. Prior to the commencement of the actual survey, a pilot study was carried out in order to provide a basis for the validation of the main survey. The population sample for the pilot study was drawn from six districts in Owerri metropolis and three districts in both the Orlu and Okigwe study sites (Table 3.2).

Table 3.1 ***Population and category of study sites*** *(Author's findings, 2018)*

Questionnaire facets		Owerri metropolis	Orlu LGA	Okigwe LGA	Subtotal	Total
Given out	Households	1,300	700	600	2,600	3075
	Shops	180	120	90	390	
	Schools	22	15	08	45	
	Waste pickers	40	--	--	40	
Retrieved	Households	1,148	630	561	2,339	2,751
	Shops	150	104	81	335	
	Schools	20	12	07	39	
	Waste pickers	38	--	--	38	
Not retrieved	Households	152	70	39	261	324
	Shops	30	16	09	55	
	Schools	02	03	01	06	
	Waste pickers	02	--	--	02	
Retrieved but not useful	Households	164	90	33	287	355
	Shops	28	22	13	63	
	Schools	00	00	00	00	
	Waste pickers	05	00	00	05	
Retrieved and useful	Households	984	540	528	2,052	Grand total used 2,396
	Shops	122	82	68	272	
	Schools	20	12	07	39	
	Waste pickers	33	--	--	33	

The pilot study

Twenty (20) households and ten (10) shops were visited at the Owerri study site, ten (10) households and five (5) shops each at the Orlu and Okigwe study sites. At the Owerri metropolis study site, two wastes pickers, two waste truck drivers, two officers of the Imo waste management agency, two Imo Environmental Transformation Commission (ENTRACO) officials as well as the Owerri waste dump site supervisor/manager were contacted. These later persons have contextual knowledge of waste management in the study area. Of the 60 copies administered, 51 responses were returned (33 from households and 18 from shops) i.e. 85% response rate. Six of the retrieved copies were incomplete hence could not be used. Thus, there was an 88% correctly completed from the retrieved copies; thereby giving a 75% useful copies from the total given out. (Table 3.2). The response rate was satisfactory in order to check the clarity of the questions, eliminating difficulties or ambiguities and an estimation of the duration a respondent would take to complete the questionnaires (after Ott & Longnecker, 2001). The results obtained provided an opportunity for a revision of the questions in designing the questionnaires for the main survey and the validation of the final outcomes of this research. The questionnaires took approximately eighteen and twelve minutes for households and shops respectively to be completed. Some revisions were made to take account of the educational level of the respondents.

Table 3.2 Population of pilot study *(Author's findings, 2018)*

Questionnaire facets		Owerri metropolis	Orlu zone	Okigwe zone	Subtotal	Total
Given out	Households	20	10	10	40	
	Shops	10	5	5	20	60
Retrieved	Households	18	08	07	33	
	Shops	09	05	04	18	51
Not retrieved	Households	02	02	03	07	
	Shops	01	00	01	02	09
Retrieved but not useful	Households	02	01	00	03	
	Shops	02	01	00	03	06
Retrieved and useful	Households	16	07	07	30	Total used
	Shops	07	04	04	15	45

3.3 Sample and sampling technique

The convenience random sampling method was used. This method ensured that there was no bias in the selection of the population who were part of the sample. Household questionnaires were either completed by the head of the household or a responsible adult in his/her absence. Questionnaires for shops were completed either by the shop owner or sales' person (shop attendant). For the schools, the Headteacher/Principal, Assistant/Deputy or staff in charge of sanitation and environmental completed the questionnaire. The 30 members of the Imo Scrap Union Association – ISUA (waste pickers) and 10 non-members were each handed a copy of the questionnaire.

Sample size calculation

Sample size was estimated using sample calculation for one proportion with the support of Epi Info 6.04d (CDC 2001) as explained by Nana (2015).

$$n=\frac{NZ^2P(1-P)}{d^2(N-1)+Z^2P(1-P)}$$

Where N=total population;

Z= Z value corresponding to the confidence level;

d= absolute precision;

P=expected proportion in the population;

n effective=n*design effect (DEFF).

The total population considered in this study was 934,800. The following additional parameters were used to estimate the sample size:

d= 2.5%. This margin of error or precision is far below the tolerated 5%, thus implying that the researcher targeted results that are highly representative of the population.

P=50% for optimal sample size assuming equally probability for a scenario to take place or not.

DEFF=1.5 given that convenience random sampling was used. In fact, higher design effects are necessary when simple random sampling is not used as to correct the bias and improve the variability. This DEFF is equally good for clustered randomized sampling approach. It increases the initial potential internal sample's variability by half thus reducing the bias deriving from the fact that a strictly randomized sampling technique such as simple random sampling was not used. In fact, in a context like Imo State, Nigeria whereby there does not exist a standard population data base (containing every citizen's names, contact number, street and house number), it was very difficult to implement a simple random approach.

Confidence interval=95% giving a $Z\alpha/2 = 1.96$. This type I error probability is generally used and considered satisfactory given that only 5% chance for committing this error is allowed.

The calculated sample size was 2,302, thus implying that in this study; one had to work with at least 2,302 participants. Prospecting 10%, at least 2,532 questionnaires were expected to be sent to the field. But in the context of this study, 3,075 questionnaires were sent to field given that in community-based survey, the rate of missing is generally high, as to increase the chance of not falling below the calculated sample size at the end. Hence, at the end of the study and following exploratory statistics, a total of 2,396 cases were validated for analysis making a return rate of 104.8% (with regards to calculated sample), which is good news for the sample representativeness.

Questionnaires were administered to four categories of respondents: household residents, shop owners/attendants, school Principals/Head teachers and the waste pickers. In addition, guided interviews and discussions were conducted with those who directly or indirectly dealt with waste items. The rationale for the highest selection of households was based on the following reasons:

- The household is one of the most significant establishments in the society and within which the gender norms are expressed, reinforced and mirrored in large institutions of the society.
- A household is a basic unit of the society where individuals both cooperate and compete for resources (World Bank, 1999). Hence, an understanding of the effects of socio-cultural and politico-economic factors on service programs can be explored through households.
- Every individual comes from a household.

3.4. Secondary data collection

A detailed review of secondary information was very useful for this work. An explicit desk work involving the consultation of scientific journals, institutional/official reports, population census and statistics, media and government documentation (after Laha, 2015) as well as internet sources and unpublished literature. This was in a bid to present an assessment of the existing waste management system towards a sustainable Imo State environment. Baseline information, especially in relation to data on the socio-cultural, politico-economic, legislative, regulative and environmental status as well as waste management were identified.

3.5 Primary data collection - instruments

The study consisted of the handling of generated waste by Imolites and the governments' in-situ. It is based on primary data survey in 2017 during which questionnaires were administered, interviews made, observations made and other field operation runs carried out (after Kaseva et al., 2002). (Figure 3.1 above).

3.5.1 Self-completion questionnaires – SCQs

Self-completion questionnaires were administered to four strata of the sample population. The items of the questionnaires were developed after a series of exploratory interactions with some senior waste management experts at the Imo State University (IMSU) and Federal University of Technology Owerri (FUTO) both in Imo State, Nigeria; urban planning and environmental expert from the Universities of Douala and Bamenda both in Cameroon and the guidance, constructive criticism of my mainstream Supervisor here at the JMU Würzburg.

Given the pros of open-ended questionnaire opined by Seliger & Shohamy (1989) and its cons after (Zohrabi, 2013) on the one hand, and, the strengths of open-ended questionnaires as argued by Gillham (2000, p. 5) as well as the usefulness of such qualitative data after (Alderson & Scott, 1996, S. 53), I resorted to the use of a mixture of both in this study. Well-designed and appropriately developed questionnaires have many pluses as postulated by these authors: (Brown, 2001; Gillham, 2000; Lynch, 1996; Nunan, 1999; Robinson P. C., 1991; Seliger & Shohamy, 1989). Questionnaires, however, have setbacks as recorded by Gillham (2000), Brown (2001) and Leedy & Ormrod (2001; 2010). This was one of the reasons of the multiplicity of instruments used in this work.

The first set of the questionnaire designated for households consisted of personal and socio-demographic characteristics of respondents. The instrument was also delineated into two major sections representing pertinent issues of waste management and environmental sustainability in Imo State, Nigeria. It had designed to measure the variables and distributed as follows:

(a) Educational and occupational status
(b) Source/idea of waste management knowledge
(c) Waste types and collection vessel
(d) Waste quantity and disposal
(e) Nearness to dump site and evacuation
(f) State of bins and charges
(g) Waste valorization or nuisance
(h) Waste treatment options and choice
(i) Wastewater quantity and treatment
(j) Participation in the monthly sanitation & environmental sustainability awareness
(k) Environmental pollution and health impact of waste
(l) Features at dump sites
(m) Interval of stationing waste bins
(n) Waste and environmental sensitization
(o) Past and current environmental state.

The questionnaire designed for shops consisted of shop's location, type and duration. Also divided into two major parts, it had items designed to measure the variables and distributed as follows:

(a) Waste types and collection vessel
(b) Waste quantity and disposal frequency
(c) Frequency of dump site clearance, state of bins and charges

(d) WMA and state of waste collection
(e) Will of source separation
(f) Waste water quantity and treatment
(g) Market pollution and health impact of waste
(h) Waste and market environmental sensitization
(i) Past and current environmental state of the market.

The questionnaire given out to primary and secondary schools' heads contained the name, location, duration of existence and population of the school. It comprised of items formulated to measure the variables. It was distributed as follows:
(a) Waste types, quantity and collection vessel
(b) Waste disposal place, means of conveying and time
(c) Waste evacuation levy and compost practice
(d) Environmental studies and day/week
(e) Will of source separation
(f) Waste minimization and waste remedy options.

Another stratum of the population, - the waste pickers received questionnaires which encompassed personal data, family status and duration in the city. The instrument was segmented into two and had items measuring pertinent issues about waste management. Like the other questionnaires, it was distributed thus:
(a) Duration and time of work
(b) Types and quantity of items sorted
(c) Use and sale of sorted items
(d) Parallel job and earnings
(e) Educational level and job portrayal
(f) Waste pickers organization and functions
(g) Reason(s) for choice of job and challenges
(h) Possible work improvement options.

Given the discussion centres (in churches and schools) and the convenience to get to the households, the researcher carefully administered the instruments to individuals. This method provided the researcher with a platform for clarification and detailed explanation of the items of the instrument. As suggested by Brown (2001, p. 6) in his division of questionnaire administration methods, the return was relatively high and fast (as compared to mailed out questionnaires) since the researcher could explain any unclear questions and knew the conditions under which the questionnaires were completed.

At the Nekede Old Road landfill site, waste pickers were issued a questionnaire each. During the short gathering, explanations and clarifications were also made about the instrument's items. I observed one major setback in this process: some of the waste pickers could not adequately understand English. I handled it complemented by one of the waste pickers and some of the items were explained in Igbo language and in Pidgin English. Though the face-to-face administration as asserted by Gillham (2000), made room for high return rate and clarification of any ambiguous question(s), the method was nevertheless any guarantee of hundred percent return rate.

3.5.2 Interviews

Questionnaire administration was complemented by interviews. This instrument like others has strengths and weaknesses (Johnson & Turner, 2003, p. 308) as well as exist in types per (Burns, 1999, p. 119; Patton, 1990, pp. 288-9). Being a person-to-person format, the semi-structured interview - SSI (after Bryman, 2012, p. 471; Burns, 1999) an equivalent of the interview guide approach (after Patton, 1990) was chosen. This is because it is the midpoint interview type, besides, the specified topics and questions can be made flexible in any sequence based on the situation, and the collected information can be compared and contrasted later (Fraenkel & Wallen, 2003, p. 456). Also, since they are a popular and widely used means of collecting qualitative data (after Bryman, 2012; Burns, 1999), the tool was used in order to gain individual perspectives of selected categories about waste management and the sustainability of the State's environment. As firsthand information was needed from some knowledgeable persons involved with waste management, I had to investigate what was going on in the respondents' minds.

Furthermore, as remarked by Merriam (1998) since the researcher cannot observe the respondents' feelings and thinking, the interview is a necessary contrivance to understand what and how the populations perceive and construe the waste and waste treatment measures around them. It is also advantageous (Flick, 2006, p. 160) as it reveals the purpose of the existing knowledge in a way that can be expressed in the form of answers, thus become accessible to interpretation. Being analytical interviews (Kreiner & Mouritsen, 2005), it is consistent wth the ontological and epistemological assumptions with the purpose not only to learn about "a priori knowledge" but to engage in knowledge construction with the respondent in action research.

Kreiner & Mouritsen (2005) therefore stated that when the analytical interviewing succeeds, both the interviewer and interviewee are theorists, collaborating on the construction of new knowledge. Given its strengths, Zohrabi (2013, p. 256) affirmed that semi-structured interview guide approach is clearly the most preferred type of interview; the major reasons for the choice.

With an interview guide as explained by Bryman (2012), dialogues were conducted with hotel/guesthouse managers and the over-all chairman of Hotels Association of Nigeria - Imo State chapter, the Owerri landfill site manager/supervisor, three members of the families who own the piece of land that is used as Landfill site, five landfill site residents and two waste traders (those who buy and resell waste items). This was an opportunity to ask questions adapted to the interviewee and collected different thoughts, attitudes and concerns about waste treatment in the State. Two of the three landowners maintained that they have to be at the site daily to make sure that no corpses were dumped there and no big sealed containers for fear of the content being poisonous.

Since with interviews, it is not possible to guarantee the honesty of the interviewee and since the flexibility (which allows new insights to emerge) of this method might reduce reliability, I needed improved skills to understand the verbal and even body language of the interviewee; had to remain objective in order not to influence the interviewees' responses. However, notes were taken down to ensure coherence, proper treatment afterwards.

3.5.3 Non-participant observation – NPO

From the term, it describes a situation in which a researcher on the field observes what is going on in a social setting but does not participate in it (Bryman, 2012, p. 273). The NPO like other means of data acquisition has pros and cons. Focusing on the strengths such as objectivity and neutrality, command respect and cooperation, careful analysis and freedom from groups (after Lui & Maitlis, 2010). It was therefore used to gather qualitative data on the field as confirmed by Cargan (2007, p. 147) that a non-participant observer usually watches a structured event on the field without being part of the scene or its activities. In addition, since there was a need to understand and obtain scientific and practical knowledge on waste management practices and environmental concerns, I had to spend more time on the field. Hence, much information was obtained regarding waste disposal, collection vessels and systems, transportation means, disposal time, waste types, sources and perceptions of the local communities. The observation played an important role in the study as information gathered from self-completion questionnaires and semi-structured interviews could be cross-checked. Also, observation helped to appraise the environmental quality especially in the domain of water bodies, dumping sites and the landfill, streets and roads littering as well as waste-related flooding. These findings were recorded on photographs, texts, numeric and video formats.

3.5.4 Focus group discussions – FGDs

Focus groups have been described as carefully planned series of discussions designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment (Krueger, 1988; 1998; Krueger & Casey, 2000; Nyumba, et al., 2018). Many writers have provided meanings to the same term; for instance, in the works of Goss & Leinbach (1996), Kitzinger (1994), Kitzinger & Barbour (1999), Morgan (1988; 1993; 1998), Morgan & Krueger (1993), Powell et al. (1996), Powell & Single (1996), etc. In all, some assured traits cut across the definitions for instance organised discussions (Kitzinger, 1994; Krueger & Casey, 2000), collective activity (Powell et al., 1996), social events (Goss & Leinbach, 1996) and interaction (Kitzinger 1995; Morgan 1998): all these make it a plausible means of obtaining information in a social science research. In addition, given the economical, fast and efficiency of focus groups in obtaining data from multiple participants (Krueger & Casey 2000), there is the potential increase in the overall number of participants in a socially oriented environment (Krueger 1998). Furthermore, Peters (1993) stated that the sense of belonging to a group could increase participants' awareness of cohesiveness as well as aid them feel safe to share information. More so, Morgan (1993) alleged that interactions amongst partakers can yield essential data. Besides creating more spontaneous responses (Buttler, 1996), focus groups offer a milieu where participants can deliberate personal glitches and proffer promising solutions (Duggleby, 2005).

Being conversant with the above pillars of focus groups, discussions were carried out with structured and flexible questions at five locations at the three study sites of the State between January and February 2017. These were at the Claretian Institute of Philosophy - CIP Nekede, and Claret Academy, Area A, World Bank Housing Estate, both at the Owerri metropolis study site; at the Holy Rosary Girls' Secondary School Ihioma (commonly referred to as *Ihioma Girls*) and Bishop Shanahan College (BSC) Orlu and at the Federal Government College – FGC Okigwe. These areas were chosen for different reasons; but, all had one similarity: they are famous for cleanliness, routine environmental sanitation and tidiness. Besides, CIP Nekede is the oldest (higher) educational establishment in this district and is situated along (3km away from) the Old Road Landfill. Claret Academy is also owned by the Claretian Missionaries and is one of the biggest Academies in the district with the same famous trait. Ihioma Girls and BSC are two of the oldest Catholic secondary schools in Orlu situated at opposite directions (east and west of Orlu respectively) with the latter established in 1949. Owned by the Catholic Church and I being a catholic and having thought in a catholic school and a major seminary, it was easy to reach the public during Masses and other church services. The FGC Okigwe is a Federal Government institution, is almost centrally located (2 km from the heart of the town), it is the biggest and oldest Federal college in this LGA.

During such discussions, to get qualitative and quantitative data, the CLEAR model[37] was used especially for self-evaluation and partaking. Lowndes et al. (2006) maintained that this model identifies five factors that buttress citizens' uneven response to participation and argued that particiaption is most effective where citizens: can do, like to, enabled to, asked to, and responded to (Table 3.3). Lowndes et al. (2006) upheld that 'responded to' reflects citizens cognisance of the prospect that communal action will have an impact.

Table 3.3 Involvement dynamics and potential policy representative set reactions
(Adapted from Lowndes et al., 2006)

Involvement dynamics	Possible policy Indicative set responses *(ifs)*
Can do	Have the resources and knowledge to involve
Like to	Have a sense of add-on that reimburses involvement
Enabled to	Are provided with the opportunity for involvement
Asked to	Are mobilised through public agencies and civic channels
Responded to	See evidence that their views have been considered.

3.6 Field Survey

Field survey was done at different habitat levels with the goal of ascertaining the operational rudiments prevailing within the treatment of generated waste in Imo State, Nigeria and to investigate waste management practices. These were the households, neighbourhood/community and the city/town levels. The survey also included visits to old and current dumpsites and visits to schools, hotels/guesthouses, eateries and health units. Klundert & Anschutz (1999) identified three habitat levels as preliminary options for an integrated

[37] It is a model created my Peter Hawkins in the early 80s and has been used extensively to train and supervise coaches. It stands for Contract, Listen, Explore, Action and Review (A Guide To Coaching & Being Coached, n.d.). The model has been revised and used in different socio-political and socio-economic domains.

sustainable waste management system at any level of governance. Per the authors, each habitat level has various collection, disposal and recovery options. (Table 3.4). However, the actual activities depend on the local situation. Thus, this was an insight during field survey as will be seen in the later part of this work.

Table 3.4 Habitat levels & potentials for integrated sustainable waste management systems
(Adapted from Klundert & Anschutz, 1999).

Habitat scale	Collection and disposal system	Resource recovery system
Household level	Storage at generation point	-Prevention -Source separation -Reuse at source
Community/neighbourhood level	-Primary collection -Temporary storage	-Primary collection -Sorting and pre-treatment -Reuse -Recycling -Composting
City/town level	-Secondary collection -Transfer storage -Tertiary collection -Final disposal & -Treatment	-Sorting and pre-treatment -Secondary collection -Reuse -Recycling -Composting

3.6.1 Waste generation and composition - Landfilling in Imo

Data on the daily/monthly generation of waste in the State were not available at the waste management and ENTRACO offices. To fill this gap, and for practical observation and appraisal, the Old Road Landfill was the referal point. Landfilling of waste in Imo State, Nigeria (when compared with landfilling in Würzburg, Bayern, Germany) from the siting of the landfill to the activities in and around such sites seems to have no guiding principles or rules (Figure 3.3). This view is buttressed by Ademiju & Ukaegbu (2017) who opined that in Nigeria, the selection of suitable landfill sites that combine social, economic and environmental factors has been recognized as a major issue in planning and construction. They maintained that the cost of doing detailed analyses and queries for conventional methods such as ground surveys may be too exorbitant to embark on and thus has discouraged the governments from doing so due to limited funds. These are some of the setbacks that help facilitate the wrong siting and practice involved in landfilling and dumping in Nigeria. Ahiarakwem (2012, 2013) stated that landfills in the country are ordinary and are mostly abandoned quarries and burrow pits and that these constitute a variety of environmental risks. Nzeadibe et al. (2010) also maintained that there are no treatment facilities and sanitary landfills for environmentally safe handling of waste in the Owerri city. The works of Ademiju and Ukaegbu (2017) proved that improperly sited landfills (the example of Owerri with four landfills (Table 3.5) are undesirable and have adverse effects on human, plant and animal health.

Table 3.5 Landfills in Owerri metropolis *(Adapted from Ademiju and Ukaegbu 2017)*

Landfill location	Latitudes	Longitudes	Altitudes (m)	Status
Avu	5° 26' 36.59" N	6° 59' 10.80" E	84	Filled/not active
Aladinma	5° 29' 50.96" N	7° 2' 53.41" E	85	Filled/not active
Aba Road	5° 28' 10.86" N	7° 2' 15.27" E	99	Filled/not active
Nekede Old Road	5° 27' 52.66" N	7° 1' 46.43" E	83	Filled/not active
Aba Road	Na	Na	Na	Active/not filled

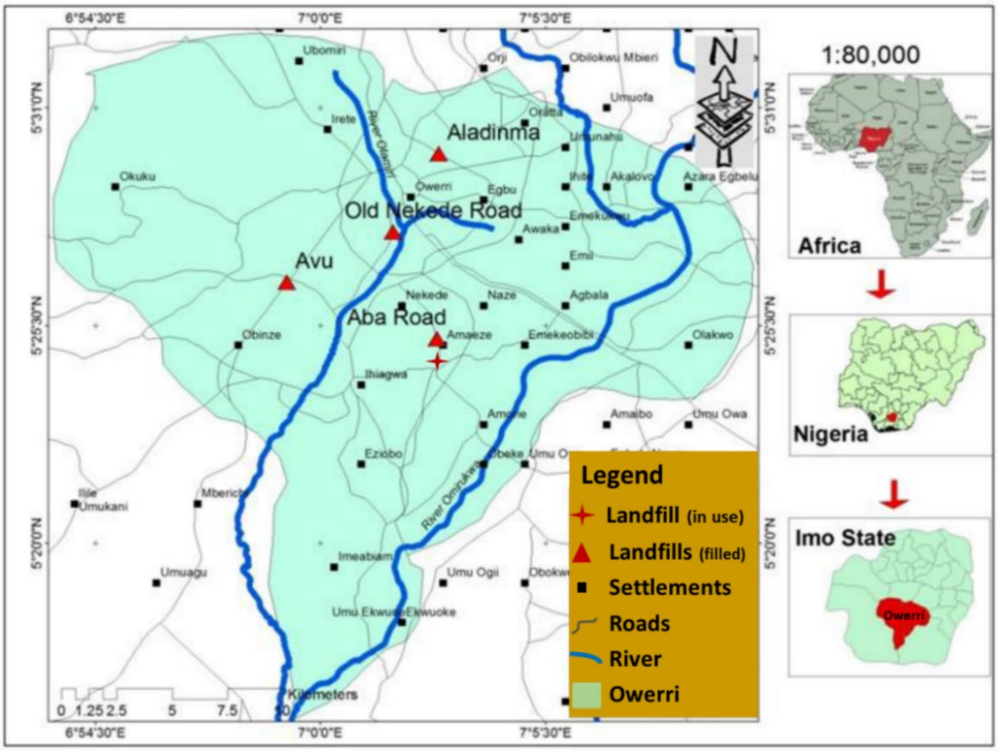


Figure 3.3 Owerri metropolis showing landfills' locations.
(Modified after Ademiju and Ukaegbu, 2017)

Based on the short-comings of poorly sited landfills in the State, Ademiju and Ukaegbu (2017) worked on the suitability of landfill siting in this study area. Their study indicated that landfills should be suitable around Awaka, Obinze, Amone, Okuku, Irete, Amaeze, Ihiagwa and Imeabam respectively with index numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 (Figure 3.4). This

Figure indicates that out of the proposed suitable landfill sites, 60% (i.e. index number 2, 4, 5, 6, 7 and 10) are located at Owerri West LGA while 40% (i.e. index number 1, 3, 8 and 9) are located at the Owerri Norht LGA. Ironically, Owerri municipal which has no suitable proposed landfill sites has been the area where all the landfills (now filled and inactive) have been located.

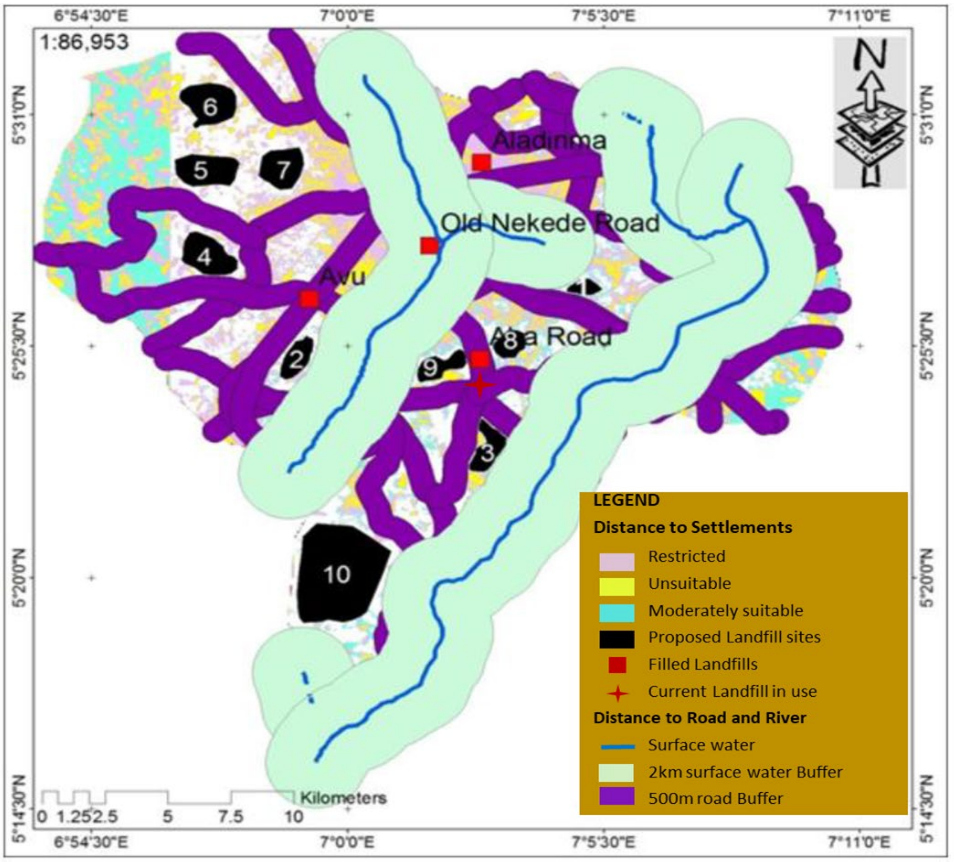


Figure 3.4 Proposed suitable sites for landfills in Owerri metropolis
(Modified after Ademiju and Ukaegbu 2017)

The suitability of the above proposed sites was based on land use and land cover (Ademiju & Ukaegbu, 2017), which was at least 3,000 m from an environmentally sensitive area, suitability of slope (after Oyinloye, 2014) who maintained that areas with slopes between 4% - 10% are highly suitable for solid waste dumping; suitability of distance from settlements (Babalola & Busu, 2011) of at least a buffer of 3,000 m and at least 2,000 m (Ademiju & Ukaegbu, 2017); the latter authors also maintained the latter buffer for proximity for major and minor roads. Meanwhile, Tirusew & Amare (2013) established that to maintain environmental health of water bodies, at least 2,000 m buffered distance should be observed.

A detailed discussion with the Old Road Landfill supervisor (C.C. Anyamele, personal communication, January 12, 2017) revealed that the site was chosen because of its topography: a trough close to a stream (the *Nwoarie* stream). Accordingly, a 'white American'[38] carried out a feasibility studies on this site in 2011 under the auspices of the Governor (Rochas Okoroacha) with the intention of constructing a recycling plant downstream so that when the waste materials are dumped, they will be pushed directly into the tunnel where they will be separated, sieved and finally crushed before recycling. The project was never undertaken as the Governor considered the results of the feasibility studies too complex and costly. Hence, sorted items from here are transported to Anambra and Lagos States for recycling. Also, instead of buying the the piece of land as stated by the Governor before the feasibility studies, the latter went into a lease with the land owners. By it, the government pays each family 1.8million Naira annually while filling it with waste. When filled, the families will reclaim their land. The Landfill (the depression) measures 125 metres long, 113 metres wide and 18 metres deep. The filling of this trough started in 2012 and by February 2017, 12 metres have been filled up. A recent discussion via phone with the Old Road Landfill surpervisor (C. C. Anyamele, personal communication, July 18, 2018) revealed that the trough has been filled since March, 2018 and a new Landfill site has been opened along Aba Road. However, this new site has not been measured; but he stated that the trough is bigger than the Old Road Landfill. Following the agreement, the contract with the families is terminated and they can carry on construction projects.

The Old Road Landfill is also where all the waste materials collected by the State's collection trucks in the metropolis are dumped. At this site, the different categories of waste collection trucks (roll-offs, compactors, mark trucks and seno trucks) were weighed using a weighbridge. The weight of the loaded truck was recorded (weight one). After offloading the waste, the trucks were weighed again (weight two). Weight two was subtracted from weight one to get the actual weight of the waste. This activity went on throughout the duration of the field work (5 weeks).

3.6.2 Waste collection/evacuation trucks and waste bins

Different categories of trucks carried waste from the metropolis and transport to the Landfill.

- ✓ The rolloff trucks were five and each carried a bin of 15 tons. Daily, each of these trucks transported the waste bins ten times to the Landfill. They picked up the filled public bins from the metropolis and emptied them at the Landfill, then went back and re-

[38] He did not mention the name and details of the 'White American'.

stationed them. Each of the trucks had one driver and one handler (males who help in loading the trucks especially with items not in the bins).

- ✓ There were five compactors (though only four were functional), each having a bin of 8 tons. Each of them had four handlers and these had defined areas of official and unofficial collection points (See Table 3.8). Compactors only made two trips daily to the Landfill.
- ✓ The Mark & Seno trucks were five in number and loaded up to 20 tons each. They made two trips daily to the Landfill and each has four handlers.
- ✓ The site has one bulldozer and two pay loaders (machines that push the wastes further into the landfill and compress them). (Field work and personal communication with the landfill supervisor, January & February 2017).

The metropolis had a total of fifty waste bins stationed at 'strategic' areas according to the IWMA's directives. These areas are not fixed, as they are changed from time to time. Therefore, the total amount of waste dumped at the Landfill daily is calculated to be 1,014 tons (Table 3.6).

Table 3.6 Amount of waste dumped daily on the Old Road Landfill.
(Own research January & February, 2017).

Truck type	Nº of trucks	Nº of trips daily	Tonnage of each truck	Total nº of tons that enter the Landfill daily
Rolloffs	5	10	15	750 tons
Compactors	4	2	8	64 tons
Mark & Seno	5	2	20	200 tons
Grand total				1,014 tons

On clean up days (the last Saturday of every month), more trucks are hired: four pay loaders and one bull dozer to complement the compaction of waste at the Landfill. On a general note, twenty-five trucks are hired: ten Mark & Seno trucks and fifteen rolloffs and each of these trucks makes at least eight trips to the Landfill between 8.00 am and 6.00 pm on such days. The environmental sanitation exercise spans from 7.00 am to 10.00 am during which there is no circulation of vehicles (except the waste management trucks), no commercial activities, everyone is expected to clean his/her surrounding and the streets in the vicinity. Consequently, huge amount of wastes and of various sizes ranging from construction and demolition materials, electrical and electronic wastes, household wastes, wastes from offices, market areas, shops, etc are brought out and dumped along the streets, in and around the bins, at the middle of the pavement, on open plots of land and in front of buildings.

The site manager further explained that the hired trucks also make at least eight trips the whole Saturday night till Sunday morning. Though the waste at collection points is greatly reduced by Sunday morning, the streets and some collection points are never completely evacuated. This leaves the streets littered and roads and water channels blocked with heaps of garbage. The cleaning (sweeping) of the roads and streets are done manualy (with locally made brooms[39]) between 5:30 am and 7.00 am. The dirt is further dumped into water channels contributing to the blockage of such water ways. Eventhough the State owned compactors carry out their routine work even on clean up days, the amount of waste reaching the Landfill as a result of such days is greatly increased. It is calculated as seen on Table 3.7.

Table 3.7 Quantity of waste dumped at the Landfill after monthly sanitation in Owerri metropolis. *(Own research January & February, 2017)*

Truck type	**№ of trucks**	**№ of trips on clean-up**	**Tonnage of each truck**	**Total nº of tons that enter the Landfill after clean-up**
Rolloffs (routine)	5	10	15	750
Hired rolloffs	15	16	15	3600
Mark & Seno(routine)	5	2	20	200
Hired Mark & Seno	10	16	20	3,200
Grand total				**7,750 tons**

Records on waste composition do not also exist at the State's waste management office since the State does not practice waste separation. Da Silva et al. (2005) lamented that in many (Developing) Countries, hazardous and medical waste are still handled and disposed together with domestic waste, thereby creating a great risk to municipal workers, the public and the environment. This view is corroborated by Ali et al. (2017) who went further that when it comes to safe management of hospital wastes, deveoping countries are resource-constrained, an assessment backed up by Al-Khatib et al. (2009) and Eleyan et al. (2013). The case in Imo State, Nigeria is not different from the above view as a greater risk is created for the waste pickers who are in contact with these discarded items. However, the different types of waste

[39] These come from palm trees: i.e. the midrib or main veins of palm fronds when the lamina is cleaned off, the little sticks (main veins or midribs) constitute broomsticks. Many them put together make up a bundle used for sweeping.

materials were observed at the site and recorded under eight categories: E-waste, food/organic waste, plastics, paper/carton/cardboard, metals, textile, glass, and other/residual waste. This was aided by the activities of the waste pickers at the site who also retrieve(d) resource items in similar categories. However, the quantity or sources of each category could not be determined since waste is not separated, a setback of waste management in developing countries expressed by Ali et al. (2017) and the same truck picks up waste dumped at different collection points. At the Landfill, the waste is emptied on top of the pre-existing piles: it is immediately visited by those who sort, then compressed and set on fire immediately (Figure 3.5). This made it impossible to sort and measure the quantity of each category from each of the trucks or bins.

Figure 3.5 Waste pickers rush to sort from the just-off loaded waste at the Old Road Landfill.

(Photo Ache, 08.02.2017)

3.6.3 Description of waste collection points

Temporary collection points (official and unofficial) were used as waste collection sites where the waste evacuation trucks picked up the accumulated discarded items. At some of these sites were public waste bins (official since the bins are placed by the IWMA) while at some there were no bins but were still evacuated by the same IWMA trucks. These temporary sites were characterised by waste fluctuations, especially at the unofficial and illegal collection points. This is because the sites could be closed at any time by the authority but the same disposal/collection points re-appear after some time (the time of re-appearance could not be determined or measured since waste fly-tipping is unofficial, not measured and highly clandestine).

Table 3.8 Temporal collection points, description and location
(Modified from Klundert & Anschutz, 1999)

Temporal collection points	Description	Location
Official temporal storage/collection sites	Sites assigned by the IWMA with or without bins and the trucks are obliged to evacuate the accumulated wastes.	Market squares, car parks, some public organisations and some roadsides.
Unofficial temporal storage/collection sites (Figure 3.6a)	Sites not assigned by the IWMA but are used by the populace to dump waste; the IWMA trucks however from time to time clear up such sites.	Along unrecognised places as roads, open spaces, near the official bins, near constructed water channels.
Illegal dump sites (Figure 3.6b)	Sites where people dump waste and the waste is not picked up by the IWMA trucks. It is left to rot or burnt, both of which create a serious nuisance to the (adjacent) community.	Beside unrecognised places like footpaths, on open spaces, inside/in front of uncompleted properties, on open vegetation, inside/beside old/uninhabited properties, etc.

Figure 3.6a
An unofficial collection site.

Figure 3.6b
An illegal dumpsite: road blocked by waste

(Photos Ache 08.02.2017)

3.7 Instrument validation

Mungenda & Mungenda (2003) contended that a major concern in research is the validity of the procedures and conclusions. Thus, validity articulates the accomplishment of a rationale for which the investigating instrument is designed to measure. In other words, Smith (1991) stated that it is the degree to which the researcher has measured what he/she set out to measure. Amin

(2005), Gay & Airasian (2002) and Kimberlin & Winterstein (2008, p. 3) brought more clarifications that validity is the quality of a data gathering instrument or procedure that enables it to measure what it is supposed to measure. Babbie (2010) substantiated that, it is the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration.

3.8 Instrument reliability

Reliability (Worthen et al., 1993) is the measure of how stable, trustworthy, dependable and consistent an instrument is in measuring the same thing repeatedly. Also, Nunan (1999) stated that reliability entails the consistency, dependability and replicability of the results obtained from a piece of study or research. Nworgu (1991) corroborated that it deals with the uniformity with which an instrument measures whatever it measures. Hence, the reliability of the instrument for this study was estimated using the test, re-test method. A pilot study was carried out at the three study sites during which the same instrument was administered twice to the same respondents at an interlude of fourteen days. The purpose was to establish that the research instrument was easily understood as reflected in the level of the consistency of the same respondents. Thus, the reliability of the research instrument was established by the correlation coefficient. The instrument was administered to sixty respondents in Owerri, Orlu and Okigwe zones (Table 3.2).

3.9 Data processing and analysis

Review and Labelling of Questionnaires

Questionnaires that were not properly and completely filled were sorted out. The questionnaires were then attributed serial numbers that could help match them to the data base, if there was need for cross-verification.

Data Entry and Clean-Up

Data were entered using Microsoft Office Excel, explored and analysed using the Statistical Package for Social Sciences (SPSS) Standard version, Release 21.0 (IBM Inc. 2012). Data clean-up (content clean-up and exploratory statistics). Exploratory statistics is an integrated part of data clean-up. Variables were explored to identify questionable entries, inconsistency in responses, missing responses, and their validity discussed to make the necessary corrections (Nana, 2015).

Data were made essentially of categorical variables. They were analysed using descriptive statistics to present the distribution of subjects between and within subsets using frequencies and proportions. The association between categorical variables was measured using the Cramer's V test. This uses the Chi-Square distribution as well and so far appreciates the conservative nature of Chi-Square that makes the power and the reliability of the test. However, Chi-Square may reveal that two different associations with the same P-Values are significant but will not determine which of the associations or relationships is stronger. Cramer's V deciphers this hitch.

Cramer's V is a measure of association tests directly integrated with cross-tabulation. But generally, we are faced with a situation where we have to build a contingency table from several sub-outputs and determine the extent of association between the row and column categories. Direct computation of measures of association test with SPSS in such context is not possible or is more strenuous, thus compelling us to resolve to use another statistical package like the Epi Info 6.04d. For this reason, the computation of the Chi-Square test for summary/composite contingency tables was effected with the support of Epi Info 6.04d (CDC 2001).

Using these measures of association, for instance, we could measure the extent to which education on proper waste disposal was associated with the site or the level of school attainment, the dependence between the quality of the environment and site, etc.

The data, however, had a scale variable, which was 'quantity of waste generated'. Described using measures of central tendency (Mean and Median) and measures of dispersion (Minimum and Maximum values), this variable was screened for normality. In all the contexts, the normality assumption was violated (Kolmogorov-Smirnov and Shapiro-Wilk tests for normality: $P<0.05$) and the non-parametric Kruskal Wallis test was then used to compare groups for the significant differences. In fact, there are two groups of tests that can be used to compare groups for significant difference, which are parametric (i.e. t-Test and ANOVA) and non-parametric (Wilcoxon test and Kruskal Wallis test). Kolmogorov-Smirnov and Shapiro-Wilk Tests for normality plot the real distribution of the data against the assumed theoretical normal distribution estimated from the measures of central tendency and dispersion of the data set. The test assumes a non-significant P-Value ($P>0.05$) to resolve that the real distribution does not depart from the theoretically assumed normal distribution. If it is the case, then a parametric test can be used, otherwise, one shall use the non-parametric counterpart, as it is the case in this study.

Test of hypotheses

The Logistic Regression model was employed to test the hypotheses. The explanatory power of individual conceptual component was calculated using the Cox & Snell R-Square and that of individual indicators was also appraised using the Likelihood Ratio test.

The Ordinary Least Squares (OLS) estimation in multiple regressions is to obtain coefficient estimates and the usual best fit of the model to the data, but when confounders are involved, OLS no longer applies with the same efficiency. Logistic Regression uses maximum likelihood estimation to fit the model. It is one of the suitable alternative models when dealing with multiple categorical predictors in a given outcome variable that preferably should be categorical as well. Maximum likelihood produces β values that maximize the likelihood function (LF).

A chi-square test between the baseline model and the LLF is to assess the significance of the difference between the estimated and the baseline models. Consequently, if a series of nested models with varying independent variables are used, the change in the LLF and the resultant x^2 change can assess which model is better.

The Pseudo R-squared is similar to the adjusted R-squared in the traditional OLS analysis. However, Pseudo R^2 used to measure the reduction of error between the baseline and estimated models can also measure fit.

In the context of this study, the significance of the variability explained by the model was appraised using the Omnibus Tests of Model Coefficients, the magnitude of this variability explained by the model using the Cox & Snell R^2 and the effects of individual predictors using the Likelihood Ratio test.

Qualitative Data Analysis

In this study a mixed-method approach was used; data gathered from open-ended items in the questionnaire, observation, interviews, and documents, supplement each other as part of the data analysis process. They were analysed using the process of thematic analysis whereby concepts or ideas were grouped under umbrella terms or keywords. The first stage involved deciding on the level of analysis. At this level, single words, clauses, and sets of words or phrases were coded. The researcher did not initially decide on how many different concepts to code and for this reason, a pre-defined or interactive set of concepts categories was not initially developed and concepts or umbrella terms were to emerge from the data. To be more specific, the researcher did not have an initial code list earlier developed based on the major indicators of the study and umbrella terms or codes were generated following the standard process of thematic analysis. The primary documents of textual data were coded for existence and for the frequency of concepts by coding for every independent idea as it emerged from the data. During the coding, it was assumed that any idea that emerged at least once was relevant given that the qualitative dimension was prioritized in the interpretation of the theoretical perspective. The existence of ideas was therefore considered more important than frequency or grounding. However, the frequency or grounding in some instances reflected how many times a concept emerged and was a major indicator of emphasis (Nana, 2015). In the context of this study, thematic analysis consisted for instance in depicting why waste management is perceived as important or not, suggestions to improve or resolve the waste management issues, why waste is perceived a problem in schools etc.

4 FINDINGS

Introduction

This chapter presents findings from the data collected and analysed as explained in Chapter three.

The results are presented in various sections according to the specific research questions and hypotheses. Five research questions were formulated for this study as follows:

i. How do Environmental awareness and education affect environmental sustainability in Imo State, Nigeria?
ii. In what way does waste quantity and waste distribution affect environmental sustainability in Imo State, Nigeria?
iii. To what extent does wealth contribute to affect environmental sustainability in Imo State, Nigeria?
iv. How does employment and poverty reduction opportunities impact the environmental sustainability in Imo State, Nigeria?
v. To what extent does waste disposal affect environmental sustainability in Imo State, Nigeria?

Each of these specific research questions were substantiated by a specific hypothesis for the study as follows:

i. H_0: Environmental awareness and education do not affect environmental sustainability in Imo State, Nigeria

   Ha: Environmental awareness and education affect environmental sustainability in Imo State, Nigeria.
ii. H_0: Waste quantity and its distribution have no significant relationship with environmental sustainability in Imo State, Nigeria.

   H_a: Waste quantity and its distribution have a significant relationship with environmental sustainability in Imo State, Nigeria.
iii. H_0: Wealth has no significant relationship with environmental sustainability in Imo State, Nigeria.

   H_a: Wealth has a significant relationship with environmental sustainability in Imo State, Nigeria.

iv. H_0: Employment and poverty reduction opportunities pertaining to waste management have no significant relationship with environmental sustainability in Imo State, Nigeria.

H_a: Employment and poverty reduction opportunities pertaining to waste management have a significant relationship with environmental sustainability in Imo State, Nigeria.

v. H_0: Waste disposal in Imo State, Nigeria has no significant relationship with environmental sustainability.

H_a: Waste disposal in Imo State, Nigeria has a significant relationship with environmental sustainability.

This section starts with the socio-demographic characteristics of participants (in Owerri metropolis, Orlu and Okigwe senatorial headquarters) which are important to situate the findings in their socio-cultural and economic contexts (Nana, 2015).

Sample size calculation

Sample size was estimated using sample calculation for one proportion with the support of Epi Info 6.04d (CDC 2001) as explained by Nana (2015).

$$n=\frac{NZ^2P(1-P)}{d^2(N-1)+Z^2P(1-P)}$$

Where N=total population;

Z= Z value corresponding to the confidence level;

d= absolute precision;

P=expected proportion in the population;

n effective=n*design effect (DEFF).

The total population considered in this study was 934,800. The following additional parameters were used to estimate the sample size:

d= 2.5%: this margin of error or precision is far below the tolerated 5%, implying the researcher targeted results that are highly representative of the population.

P=50%: for optimal sample size assuming equal probability for a scenario to take place or not.

DEFF=1.5: given that convenience random sampling was used. In fact, higher design effects are necessary when simple random sampling is not used as to correct the bias and improve the variability. This DEFF is equally good for clustered randomized sampling approach. It increases the initial potential of the internal sample's variability by half thus reducing the bias deriving from the fact that a strictly randomized sampling technique such as simple random sampling was not used. In fact, in a context like Nigeria whereby there does not exist a standard population data base (containing every citizen's names, contact number, street and house number), it is very difficult to implement a simple random approach.

Confidence interval=95% giving a $Z\alpha/2 = 1.96$. This type I error probability is generally used and considered satisfactory given that only 5% chance for committing this error is allowed.

The calculated sample size was 2,302, implying that in this study, one had to work with at least 2,302 participants. Prospecting 10%, at least 2,532 questionnaires were intended to be sent to the field.

However, 3,075 questionnaires were sent to field (Table 4.1) given that in a community-based survey, the rate of missing is generally high. This was to increase the chance of not falling below the calculated sample size at the end. Hence, at the end of the process and following exploratory statistics, a total of 2,396 cases were validated for analysis making a return rate of 104.8%, (of the calculated sample) which is good news for the sample representativeness. A return rate of 77.92% (when compared to what was given out), equal to the usually recommended threshold of 80%. Data are presented using tables, charts and prose writing.

Table 4.1 Sample Flow Table *(Author's findings, 2018)*

Questionnaire targets		Owerri metropolis	Orlu study site	Okigwe study site	Subtotal	Total
Given out	Households	1,300	700	600	2,600	3,075
	Shops	180	120	90	390	
	Schools	22	15	08	45	
	Waste pickers	40	--	--	40	
Retrieved	Households	1,148	630	561	2,339	2,751
	Shops	150	104	81	335	
	Schools	20	12	07	39	
	Waste pickers	38	--	--	38	
Not retrieved	Households	152	70	39	261	324
	Shops	30	16	09	55	
	Schools	02	03	01	06	
	Waste pickers	02	--	--	02	
Retrieved but not useful	Households	164	90	33	287	355
	Shops	28	22	13	63	
	Schools	00	00	00	00	
	Waste pickers	05	00	00	05	
Retrieved and useful	Households	984	540	528	2,052	Grand total used 2,396
	Shops	122	82	68	272	
	Schools	20	12	07	39	
	Waste pickers	33	--	--	33	
Validated for analysis following exploratory statistics	Households	984	540	528	2,052	2,396
	Shops	122	82	68	272	
	Schools	20	12	7	39	
	Waste pickers	33	-	-	33	

4.1 Characterization of participants

4.1.1 Description of households

Three sampling sites were considered for this study ranging from semi urban to the urban Owerri metropolis (Table 4.2).

Table 4.2 Distribution of sample by study sites *(Author's findings, 2018)*

Study sites	Frequency	Percent
Okigwe	528	25.7
Orlu	540	26.3
Owerri metropolis	984	48.0
Total	2,052	100.0

Localities

For each study site, there were localities of interest. For the Okigwe study site, some 18 localities were taken into consideration (Table 4.2.1).

Table 4.2.1 Localities of Okigwe *(Author's findings, 2018)*

Okigwe study site	Frequency	Percent
Bende Street	32	6.1
Bishop Ilonu Street	27	5.1
Eke-Okigwe Road	43	8.1
Enugu-Umuahia Road	39	7.4
Ike Road	29	5.5
Isiba Lane	32	6.1
Lemora Lane	27	5.1
Ndiakwaeke Road	17	3.2
Okigwe-Abba Omega Road	37	7.0
Okigwe town	21	4.0
Okpara Road	20	3.8
Old Park	25	4.7
Onyejekwe Lane	34	6.4
Rev. Manii Street	21	4.0
School Road	26	4.9
UBA Street	38	7.2
Ubahu Road	22	4.2
Umuchima Road	38	7.2
Total	528	100.0

For the Orlu study site, some 22 localities were taken into consideration (Table 4.2.2).

Table 4.2.2 Localities of Orlu *(Author's findings, 2018)*

Orlu study site	Frequency	Percent
Aji Road	21	3.9
Alhaji Tijani Road	24	4.4
Amaifeke	24	4.4
Amaigbo	50	9.3
Amaorie	54	10.0
Amike Road	21	3.9
Beach Street	24	4.4
BSC Road	24	4.4
Dimukwu	27	5.0
Emezike Street	24	4.4
Ihiala-Orlu Road	21	3.9
Ihioma	15	2.8
Mgbee Road	22	4.1
Nkwerre Road	24	4.4
Oduma Road	21	3.9
Ogi-Ike Street	21	3.9

Okorie Street	24	4.4
Orji Street	21	3.9
Orlu Teaching Hospital Road	27	5.0
Umuezeala	6	1.1
Umuna	27	5.0
Umuzeala	18	3.3
Total	540	100.0

Meanwhile for the Owerri metropolis study site, more localities (27) were taken into consideration (Table 4.2.3).

Table 4.2.3 Localities of Owerri metropolis *(Author's findings, 2018)*

Owerri metropolis	Frequency	Percent
Akwakuma	49	5.0
Aladinma	41	4.2
Amakohia	54	5.5
Douglas Road	21	2.1
Egbu	27	2.7
Federal Housing Estate	30	3.0
Ikenegbu	44	4.5
Ikenegbu extension	13	1.3
Imo Housing	24	2.4
Irete	42	4.3
MCC Uratta	54	5.5
Naze	21	2.1
Nekede Old Road	48	4.9
Njemanze Street	42	4.3
Njeribeako Street	48	4.9
Okigwe Road	27	2.7
Orji	21	2.1
Prefab	27	2.7
Rotibi Street	24	2.4
Umuguma	33	3.4
WBHE[40] Area A	51	5.2
WBHE Area B	18	1.8
WBHE Area L	48	4.9
WBHE Area M	57	5.8
WBHE Area N	39	4.0
Wetheral	48	4.9
Works layout	33	3.4
Total	984	100.0

[40]WBHE are quarters in new Owerri based on a World Bank project launched in Imo State in 1986 with objectives to upgrade components in Owerri and Abia (Abia State was before 1976 part of Imo State). Infrastructure and sanitation, improvement including flood control and storm drainage, improved roads, water supply and electricity; land development or site and services component; home construction and improvement loans as well as urban services and institutional development (World Bank, 1994).

Household size

In this study and overall, households were found to have about 6 persons on average. When categorized, the trend indicates that 9.4% of the households had 1-3 persons, 49.0% 4-6 people while 41.6% had 7 persons and above.

Table 4.3 Distribution of household size *(Author's findings, 2018)*

Household size	Frequency	Percent	Cumulative Percent
1-3	193	9.4	9.4
4-6	1,006	49.0	58.4
7+	853	41.6	100.0
Total	2,052	100.0	

Duration of stay at the study site

The duration of respondent stay in the place of study was found to be a major determinant of the opinion they would have during the time vis-à-vis waste and environmental issues. This duration was computed in terms of years spent so that the respondents be aware of the seasonality and fluctuations involved in waste issues (Table 4.4).

Table 4.4 Distribution of participants based on the duration of stay in the city
(Author's findings, 2018)

Duration of stay in the city	Frequency	Percent	Cumulative Percent
<5 years	366	17.8	17.8
5-10 years	576	28.1	45.9
11-20 years	707	34.5	80.4
21-30 years	212	10.3	90.7
31-40 years	126	6.1	96.8
>40 years	65	3.2	100.0
Total	2,052	100.0	

Only a few participants had stayed in the community for less than 5 years with proportion 17.8% (366) and cumulatively less than half had stayed 10 years and below. This was good for the validity of the sample as it was meaningful to work mostly with those that had acceptable living experience and/or integration in the community. With these, they could better comprehend the contextual reality of the theme of this work and other socio-economic, physico-cultural as well as politico-administrative realities of the State.

Highest level of education

The educational level of the respondents was found to determine their community and self-literacy levels towards waste and environmental issues (Table 4.5).

Table 4.5 Distribution of participants based on highest level of school attainment
(Author's findings, 2018)

Highest level of school attainment	Frequency	Percent
No school certificate	47	2.3
Primary (First School Leaving Certificate - FSLC[41])	64	3.1
Junior Secondary School Examination (JSCE)	129	6.3
Senior School Certificate Examination (SSCE)	450	21.9
Vocational certificate	134	6.5
First university degree	648	31.6
Master's degree	326	15.9
Ph.D.	105	5.1
Others	149	7.3
Total	2,052	100.0

The above levels revealed an unequal spatial representation according to each of the three study sites (Figure 4.1a).

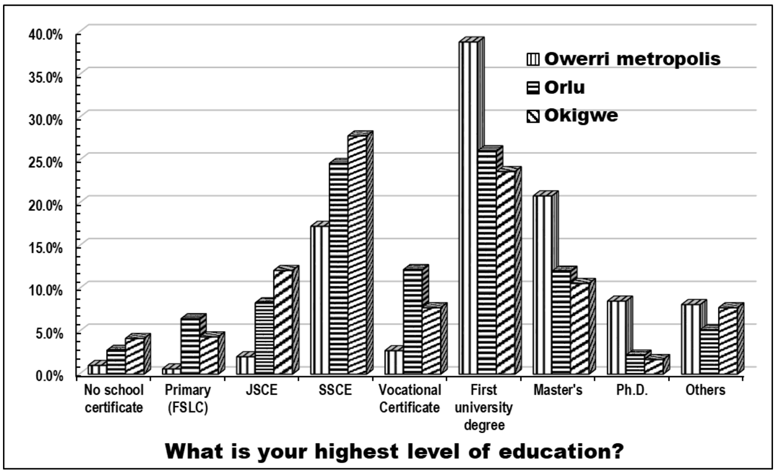


Figure 4.1a Educational attainment level of community members
(Author's findings, 2018)

The level of educational exposure gives the community a better understanding of waste treatment measures and they were diversified in their level of school attainment. Table 4.5

[41] FSLC is obtained at the end of Primary school. JSCE is obtained after three years in the Secondary school. SSCE or West African Senior School Certificate, governed by WAEC is an equivalent of the NECO Exams and the GCE O/Levels in Anglophone West African countries like Ghana, Liberia, the Gambia, and Sierra Leone. A pass in this exam is a pre-requisite for admission into Nigerian tertiary institutions of learning.

above indicates only 2.3% had no school certificate; a percentage not significantly large enough to affect the outcome of the study. This means 97.7% were literates, of which, 3.1% had acquired the FSLC, 6.3% JSCE, 21.9% SSCE, 6.5% had acquired a vocational certificate. Community members with a first university degree had the highest proportion (31.6% - making it the mode), 15.9% had a Master's degree, 5.1% a Ph.D., while 7.3% had acquired other education types/levels not specified.

The high percentage of literacy of the respondents confirmed the assertion/adage in the country that 'education and hotel business are the two most important 'industries' in Imo State'. Available statistics in the country (FME, 2015; NBS, 2010c; 2015; NBS and JAMB, 2017; NBS and UBEC, 2016)[42] indicate that the country's adult literacy rate in English stands at 57% as against 76% for the youths. More so, the South-East zone, to which Imo State belongs is second in literacy rate, i.e. 73.8% to the South-South zone with 74 %. Figure 4.1b presents Imo State's leading involvement and priority in education. This implies that any information, sensitization campaign or policy development and subsequent implementation awareness that uses schools or educational institutions as a medium will reach the population at large and efficiently.

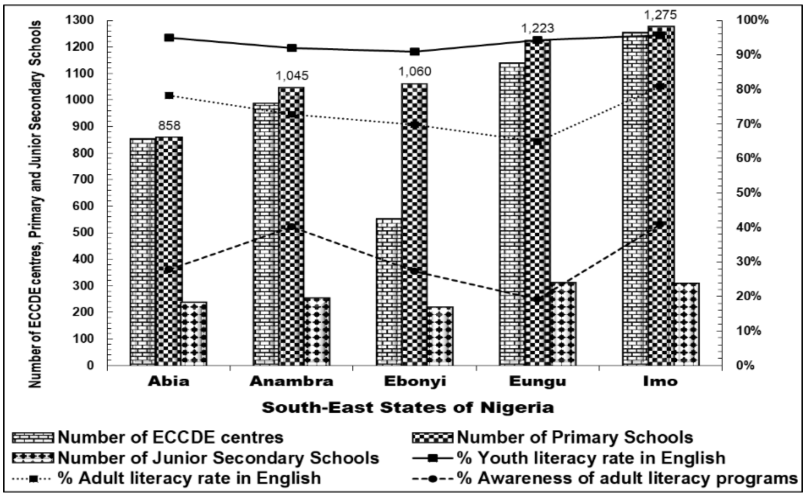


Figure 4.1b Imo State's leading involvement in education
(Data sources: NBS & UBEC, 2016)

[42] JAMB – The Joint Admissions and Matriculation Board was established by the Federal Government of Nigeria by Act N0. 2 of 13th February, 1978 to centralize and sanitize the admission process into Nigerian universities, polytechnics and Colleges of Education. A pass in SSCE is a pre-requisite to sit for JAMB.

Imo State does not only stand out within the South-East geopolitical zone: it has the highest literacy rate in the country with adults having 80.8% and youths 95.7% (NBS, 2010c). Even though the State is the thirty-fifth largest in terms of surface area and the thirteenth largest in terms of population in the Federation (NBS, 2010a), records indicate that the State has over the years been leading in the domain of education. In addition, the State recorded the highest number of applicants into tertiary institutions as well as the highest number of those admitted. (NBS and JAMB, 2017; NBS and UBEC, 2016).

Imolites pay great attention to and have much concern for activities that go on within educational prayer institutions. This is one important reason why the group discussions for this study were held in educational institutions, most of which had churches within the premises. The people's willingness, even as adults to learn provides an important medium for information dissemination in general and waste management strategies and sensitization.

Major occupation

The activities of the people not only determine their waste output but how they consider the environmental consequences of the waste (Table 4.6).

Table 4.6 Distribution of participants based on their major occupations
(Author's findings, 2018)

Major occupation	Frequency	Percent
Farming	70	3.4
Business	781	38.1
Teaching	351	17.1
Lecturing	110	5.4
Other civil services	456	22.2
Others	284	13.8
Total	2,052	100.0

The mode major occupation was business, implying that inhabitants were dominantly into trade and commerce with a proportion of 38.1%, followed by other civil services 22.2% and teaching 17.1%. Even though Owerri metropolis houses the State's capital, with its oldest market, the Orlu senatorial headquarter, is the seat of the State's 'international market'. This is explained by the highest percentage (44%) of businessmen and women from this site (Figure 4.2). Owerri metropolis houses more civil servants. Orlu and Okigwe study sites are new and emerging towns as they (still) practice farming activities more than Owerri metropolis (Figure 4.2).

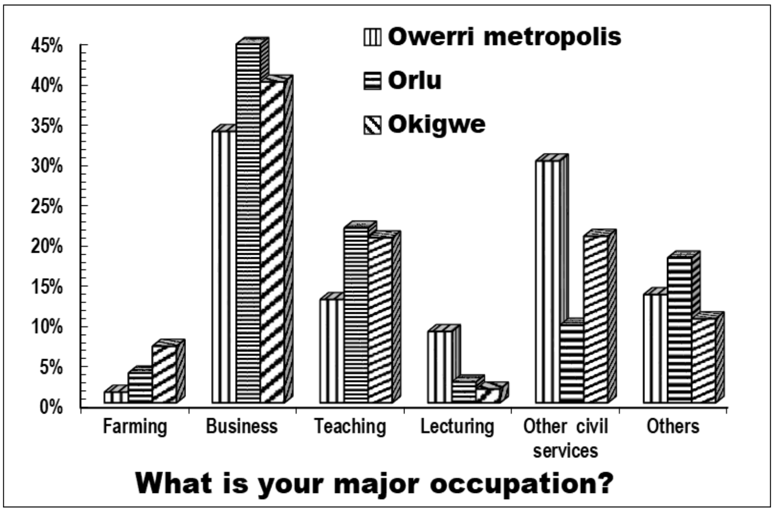


Figure 4.2 Major occupation of community members
(Author's findings, 2018)

Monthly income

This item was designed to investigate if there is a correlation between the level of wealth and quantity of waste generated. Available literature indicates that on a global regional scale, high-income level countries (the OECD), which make up the richest region, generate the highest quantity of waste with a per capita generation of 2.2kg/day (Bhada-Tata & Hoornweg, 2012). In the poorest regions – Sub-Saharan Africa (in which is the study area) and South-Asia region, they generate respectively an average of 0.46 and 0.52 kg/capita/day and a minimum of 0.11 and 0.17 kg/capita/day (Silpa et al., 2018, p. 22). Table 4.7 presents the cumulative percentage of community members' monthly income range while Figure 4.3 exhibits the monthly salary of Imolites.

Table 4.7 Monthly income of respondents *(Author's findings, 2018)*

Monthly income (Naira)	Frequency	Percent	Cumulative Percent
<50,000	940	45.8	45.8
51-100,000	504	24.6	70.4
101-150,000	248	12.1	82.5
151-200,000	87	4.2	86.7
201-250,000	82	4.0	90.7
251-300,000	51	2.5	93.2
301-350,000	41	2.0	95.2
>350,000	99	4.8	100.0
Total	2,052	100.0	

The dominant share of participants earned less than 50,000 Naira and cumulatively 70.4% of them earned 100,000 Naira or less per month. This implies that the population had relatively low income. This finding is in line with the National Bureau of Statistics' estimate (NBS, 2010a) that the State's poverty level is high (74%) while that of the entire Federation is 70%.

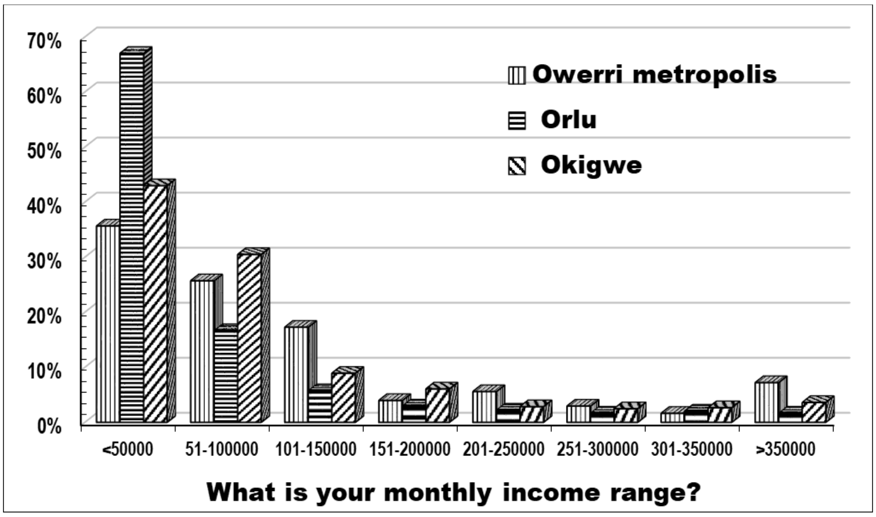


Figure 4.3 Monthly income range of respondents
(Author's findings, 2018)

4.1.2 Description of schools

Table 4.8.1 Distribution of schools by study site *(Author's findings, 2018)*

Study sites	Frequency	Percent
Owerri metropolis	20	51.3
Orlu	12	30.8
Okigwe	7	17.9
Total	39	100.0

Out of the 39 schools, 51.3% were sampled in Owerri metropolis, 30.8% in Orlu and 17.9% in Okigwe.

Table 4.8.2 Sampled schools at study sites *(Author's findings, 2018)*

Number	Owerri metropolis	Orlu	Okigwe
1.	APS	APS Amaike	CCNPSS
2.	CANPS	BSC Orlu	FGC Okigwe
3.	CASS	CPS Amaike	Mercy GSS
4.	CDSS	CS Eziachi	QASS
5.	CNPSUN	ESS Amaike	SMNPS
6.	CSSN	GSS Orlu	St. Peter's Seminary
7.	DMRCNPS	HRSS Ihioma	Urban Primary School
8.	FCNPS	ISS Orlu	
9.	FGGC Owerri	OMSS	
10.	GSS Ikenegbu	OPS Ihioma	
11.	LSHS	TCHS	

12.	MACNPS	USS Amaike	
13.	MHS		
14.	MMSS		
15.	MNPS		
16.	MSPS		
17.	Rosy Kids		
18.	SOEDSS (Alvanna)		
19.	St. MJSSUN		
20.	UPS		
Total	**20**	**12**	**7**
Percentage	**51.28**	**30.76**	**17.94**

In average, schools had 814 pupils/students. The least populated school had 220 pupils/students while the most populated had 2,800.

The age of the of school in Imo State

The schools had been in Imo State between 6 and 60 years and this was good as such duration indicates that they are sufficiently integrated in the local life and contextual realities.

4.1.3 Description of shops

Table 4.9 Distribution of shops by study sites *(Author's findings, 2018)*

Study sites	Frequency	Percent
Owerri metropolis	122	44.9
Orlu	82	30.1
Okigwe	68	25.0
Total	272	100.0

Out of the 272 shops, 44.9% were sampled in Owerri metropolis, 30.1% in Orlu and 25.0% in Okigwe.

Market squares/areas

Table 4.9.1 Market areas sampled in Owerri metropolis *(Author's findings, 2018)*

Market areas in Owerri metropolis	Frequency	Percent
Douglas Street Shops	15	12.3
Eke-Onuwa (Owerri Main Market)	23	18.9
Naze auto Market	10	8.2
New Market	18	14.8
Ogbosisi Umuguma	7	5.7
Relief Market	16	13.1
World Bank Market	13	10.7
World Bank street shops	12	9.8
Wetheral street shops	8	6.6
Total	122	100.0

Table 4.9.2 Market squares sampled in Orlu *(Author's findings, 2018)*

Market areas in Orlu	Frequency	Percent
Afor Ndida	8	9.8
Afor Ogidi	7	8.5
Afor Ukwu	5	6.1
Eke Eziachi	11	13.4
International Market Orlu	26	31.7
Nkwo Market	10	12.2
Orlu old market	6	7.3
Street shops	9	11.0
Total	82	100.0

Table 4.9.3 Market squares sampled in Okigwe *(Author's findings, 2018)*

Market areas in Okigwe	Frequency	Percent
Eke Okigwe	29	42.6
Shops along Eke-Okigwe Road	11	16.2
Shops along Enugu-Umuahia Road	8	11.8
Shops along Okigwe-Afikpo Road	11	16.2
Shops along Owerri-Okigwe Junction	9	13.2
Total	68	100.0

Longevity of respondents within the market square

The shop owners/attendants had been in the market for at least a year. The average duration was 8.5 years, the median was 6 years and the oldest had been in the market for 40 years.

4.1.4 Waste pickers

State of origin

The persons who salvaged and sorted waste items appeared to not have been all originally from Imo State but had come from the neighbouring States (Table 4.10)

Table 4.10 Distribution of waste pickers according to State of origin
(Author's findings, 2018)

State of origin	Frequency	Percent
Abia	5	15.2
Abia	1	3.0
Abia (Sec.)	1	3.0
Adamawa	2	6.1
Akwa Ibom	2	6.1
Anambra	2	6.1
Borno	2	6.1
Cross River	2	6.1
Ebonyi	6	18.2
Enugu	6	18.2
Imo	1	3.0

Imo (Chairman)	1	3.0
Imo	1	3.0
Yobe	1	3.0
Total	33	100.0

Family status and number of children

The marital status of waste pickers (Table 4.10.1) determines the pressure they each face in their survival and thus directly determines their involvement in the waste business. Besides, the number of children they have to cater for also increases their determination and involvement. (Table 4.10.2).

Table 4.10.1 Distribution of waste pickers' Marital Status and number of children *(Author's findings, 2018)*

Marital status	Number of children	Frequency	Percent	Cumulative Percent
Single, unmarried	0	4	12.1	12.1
Married	2	5	15.2	27.3
Married	3	8	24.2	51.5
Married	4	9	27.3	78.8
Married	5	5	15.2	93.9
Married	6	2	6.1	100.0
Total		33	100.0	

The Table also indicates that waste pickers had an average of 4 children while only 12.1% of them had no kid.

Table 4.10.2 Description of waste pickers' duration of stay in the city and doing the work *(Author's findings, 2018)*

	Duration of stay in the city (Years)	Duration doing the work (Years)
N	33	33
Mean	10.79	9.61
Median	11.00	8.00
Minimum	1	3
Maximum	26	35

Duration of stay in the city and work by sorting waste

Waste pickers had lived in the city an average of 11 years, the median duration of stay was 11 years, the least was 1 year and the highest 26 years. Meanwhile, these informal workers have worked in average 10 years; the median was at 8 years, the minimum 3 years and the maximum 35 years. Minimum duration of work of 3 years and 1 year for staying indicates that they had enough experience and were reasonably integrated to provide meaningful information. The waste pickers, however, worked the whole day from morning until evening and six days in a week - Monday to Saturday.

Table 4.10.3 Highest level of education attained *(Author's findings, 2018)*

Highest level of school attained	Frequency	Percent	Cumulative Percent
No school certificate	3	9.1	9.1
Primary (FSLC)	18	54.5	63.6
JSCE	10	30.3	93.9
SSCE	1	3.0	97.0
Tertiary education (OND[43])	1	3.0	100.0
Total	33	100.0	

The mode highest level of education attained by waste pickers was primary school level completion with First School Leaving Certificate with a proportion of 54.5%, followed by Junior Secondary Certificate Examination 30.3%. While 9.1% of them had no school certificate, 3.0% obtained the Senior School Certificate Examination – SSCE and the same number had acquired some tertiary education; i.e. the Ordinary National Diploma (OND) and he was the only one who had the intention of going back to school to complete his first university degree program if he gathers enough funds.

The Old Road Landfill site residents and waste traders

Five of the residents at the Old Road Landfill site who were available and willing were interviewed to ascertain why they choose to live at such a site. It was also meant to appraise their interaction and activities at the site. An interview with the waste traders was also to appreciate the choice of their activities and their interaction and remuneration from such commerce.

4.1.5 Hotels/guesthouses and restaurants

Recreation institutions, as well as public accommodation houses are major consumers of material input into human agglomerations, and, so are also major sources of the output of these materials in the form of waste. During fieldwork, I visited the following: (Table 4.11).

[43] The OND is not an equivalent of a Bachelor's degree. It is known in Sub-Saharan Africa under different lexicons; for instance, in French Cameroon and Mali it is referred to as *Brevet de technician*, in Madagascar as *Baccalauréat de l'enseignement technique* while in England, Wales and Northern Ireland, it is equal to the Advanced-Levels.

Table 4.11 Sampled hotels/guesthouses with their restaurants *(Author's findings, 2017)*

S/N	Name	Class (Star)	Created	Guests per day
1	City global hotel	3	2011	60
2	Starplex	Guest house	2015	4
3	Dreamland hotel	3	2005	7
4	New Castle hotel	3	1999	17
5	Lodan international	3	2002	20
6	Ideal suites	3	2007	20
7	Bombolino	2	2003	25
8	Full moon	4	2015	30
9	Links hotel	3	1993	25
10	Star arrivals	3	2012	25

A total of 10 hotels/guesthouses with their restaurants were sampled. This was complemented by a detailed interview and discussion with the managers and the Chairman of the Nigerian Hotels' Association - NHA, Imo State chapter.

4.2 Presentation of findings based on specific research questions and hypotheses.

4.2.1 Research question one: How do environmental awareness and education affect environmental sustainability in Imo State, Nigeria?

Awareness of waste management

Household level

This item was introduced to verify primarily if community members have heard/read about the current and important theme - '*waste management*' and if yes through what means. This was to help substantiate if the respondent is familiar with the subsequent items of the instrument and that the lexicons used are not completely new. The medium via which the population heard /read more could help analyse if such means should be improved upon or maintained, the reason(s) why other media are not used and if new ones should be introduced. Community members generally knew about waste management with a proportion of 94.1% as against 5.8% that did not.

Table 4.12 Awareness of waste management by study sites *(Author's findings, 2018)*

Study sites	Stats	Have ever heard about waste management?		Total
		Yes	No	
Okigwe	n	500	28	528
	%	94.7%	5.3%	100.0%
Orlu	n	503	37	540
	%	93.1%	6.9%	100.0%
Owerri metropolis	n	927	57	984
	%	94.2%	5.8%	100.0%
Total	n	1,930	122	2,052
	%	94.1%	5.9%	100.0%

Cramer's V: V=0.024; P=0.542.

Comparing among the three study sites

There was no significant difference among the three study sites (P>0.05) as far as awareness of waste management was concerned. There were 94.7% in Okigwe, 93.1% in Orlu and 94.2% in Owerri metropolis. The population was not only aware of waste management; it equally considered the theme to be important (93.5%). The population gave reasons for considering waste management an important concept (Figure 4.4).

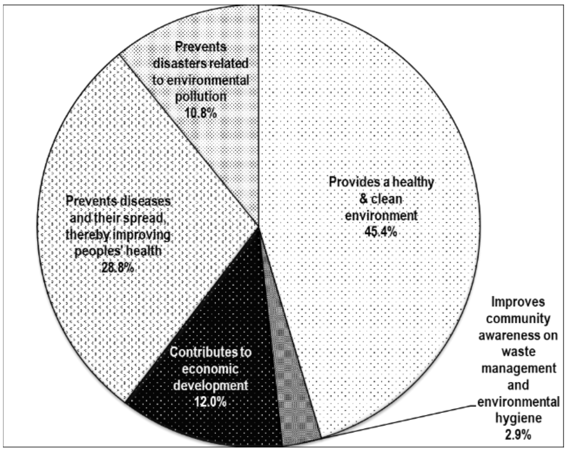
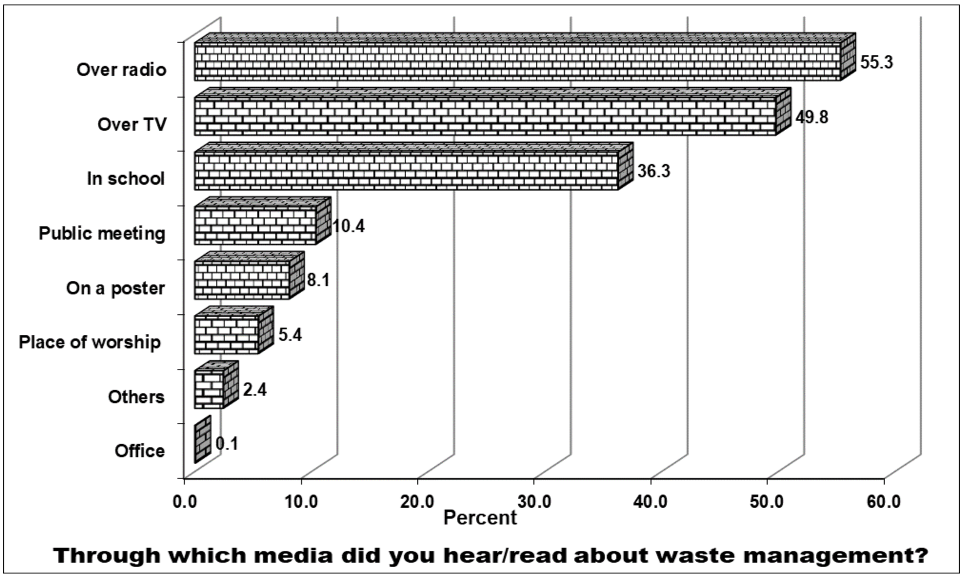


Figure 4.4 Households' justifications for the importance of waste management in Imo State.
(Author's findings, 2018)

The population maintained that waste management was important because it provides a healthy environment by preventing pollution, offensive odour and filthy landscape (45.4%), prevents diseases as dumping sites can serve as breeding grounds for insects' /disease vectors or parasites that can be dispersed by water or air, and by so doing, improves on people's health (28.8%). The population continued that waste management contributes to economic development, as waste can be recycled and be valued economically as well as generate income and employment (12.0%). It prevents disasters related to environmental and chemical pollution as well as floods and fires (10.8%), improves community awareness on more waste management tips and environmental hygiene as it helps in waste reduction and leads to proper or good ways to dispose of waste (2.9%).

Sources of awareness on waste management

There exist a wide variety of environmental awareness raising structures in Imo State with radio communication taking the lead (Figure 4.5a).



N=1,930.

Figure 4.5a Sources of awareness on waste management

(Author's findings, 2018)

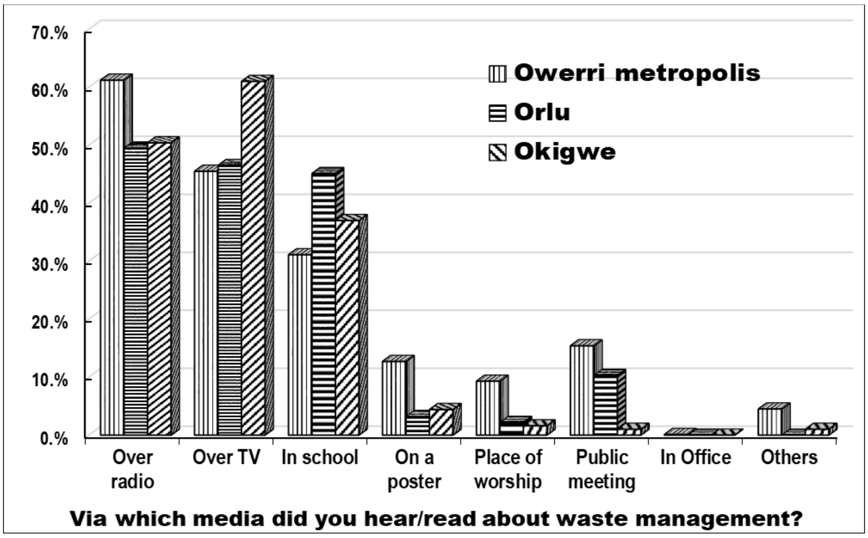
Community members got to know about waste management over the radio with a weight of 55.3%, followed by the TV (49.8%), in school (36.3%), etc. Meanwhile, Table 4.13 shows that at the three sites, the three main sources of information on waste management were radio, television and in the schools. In Okigwe, it was mainly TV (61.0%), followed by Radio (50.4%), then in schools (37.0%). In Orlu and Owerri metropolis, it was mainly via the radio 49.5% and 61.2%, followed by the TV 46.5% and 45.5%, then the schools 45.1% and 31.1% respectively. Posters and public meetings were used more in Owerri metropolis and these account for the significant difference observed among the sites ($P<0.05$). Owerri metropolis houses the State's higher institutions of learning (with only affiliates/extensions or branches at the other two sites); hence the use of posters to disseminate information (which is common amongst student communities) is conspicuously higher (Figure 4.5b). Considering radio, TV, and school, this difference was not significant ($\chi2=6.54$; df=4; $P=0.162$). In the Federation, information is disseminated not only in the official national language – English but also in all major dialects and the *'Nigerian Pidgin English*[44]*'*.

[44] Commonly referred to as '*Broken*' (pronounced '*Brokin*'), it is an English-based pidgin and creole language spoken as a lingua franca across Nigeria and other parts of Central and West Africa. It is used as an easy means of communication since there exist many dialects.

Table 4.13 Comparing source of information on waste management among the sites
(Author's findings, 2018)

Source of information	Stats	Study Sites: Okigwe	Orlu	Owerri	Total
Over the radio	n	252	249	567	1,068
	%	50.4%	49.5%	61.2%	
Over the TV	n	305	234	422	961
	%	61.0%	46.5%	45.5%	
In school	n	185	227	288	700
	%	37.0%	45.1%	31.1%	
On a poster	n	22	16	118	156
	%	4.4%	3.2%	12.7%	
In place of worship like a church or mosque	n	8	11	86	105
	%	1.6%	2.2%	9.3%	
In a public meeting or gathering	n	5	52	143	200
	%	1.0%	10.3%	15.4%	
Other	n	5	0	42	47
	%	1.0%	0.0%	4.5%	
Office	n	0	0	1	1
	%	0.0%	0.0%	0.1%	
Total	Count	500	503	927	1,930

$\chi 2$-test: $\chi 2$=33.06; df=10; P=0.000.



Valid N=1,930; Not eligible = 122.

Figure 4.5b Comparing sources of waste management information among the sites
(Author's findings, 2018)

Education on proper waste disposal by the authorities

Household level

This item was to verify if the authorities (State and/or Local or even the community government) have/had educated/sensitized Imolites on hygienic waste disposal methods that adhere to environmental concerns. It was also to ascertain if sustainable waste treatment measures and an enhanced clean environment are important aspects of the governments' agenda. The results indicate that households to a moderate extent were educated on proper waste disposal manners with a proportion of 58.0% as against 42.0% for those that were not sensitized.

Table 4.14 Education on proper waste disposal by the authorities *(Author's findings, 2018)*

Study sites	Stats	Have you been educated on proper waste disposal by the State/Local Government?		Total
		Yes	No	
Okigwe	n	339	189	528
	%	64.2%	35.8%	100.0%
Orlu	n	251	289	540
	%	46.5%	53.5%	100.0%
Owerri metropolis	n	600	384	984
	%	61.0%	39.0%	100.0%
Total	n	1,190	862	2,052
	%	58.0%	42.0%	100.0%

Cramer's V: V=0.142; P=0.000.

Community members' education on proper waste disposal manners differed significantly ($P<0.05$) among the three sites, whereby Okigwe had the highest proportion of those who were sensitized about proper waste disposal measures 64.2%, Owerri metropolis 61.0% while Orlu had the lowest proportion of 46.5%. Though the smallest of the three study sites, Okigwe had the highest proportion of those who had been sensitized on proper waste disposal perhaps because the last Governor voted out of office in 2011 (Chief Ikedi Ohakim[45]) was from this zone and during his tenure, he launched the 'Clean and green initiative' in August 2007, just three months into office. Through this, Imolites were informed about the necessity for a clean and green environment, which is free of littering and haphazard waste dumps. This campaign and initiative had a stronger hold in his home zone – Okigwe as Imolites in this zone were moved to support the good initiative of their 'son'. An initiative that was well received and

[45] The fourth civilian governor of Imo State, chief Ikedi Ohakim (29.05.2007 - 29.05.2011) launched the Clean and Green Initiative to restore the State's glory it had when Samuel O. Mbakwe (01.10.1979 - 31.12.1983) served as the first civilian governor of the State. During this time, trees and grass lawns were planted as well as street cleaning was improved, dredging of the Nwaorie River, over 3000 nasty billboards pulled down and over 1000 abandoned vehicles evacuated. These activities however took a different turn when he was voted out of office on 06.05.2011; the incumbent governor had another motto completely different from what was going on: 'the rescue mission'.
Retrieved from https://www.thenigerianvoice.com/news/412/ikedi-ohakims-two-years-in-office.html
Accessed: April 10, 2018.

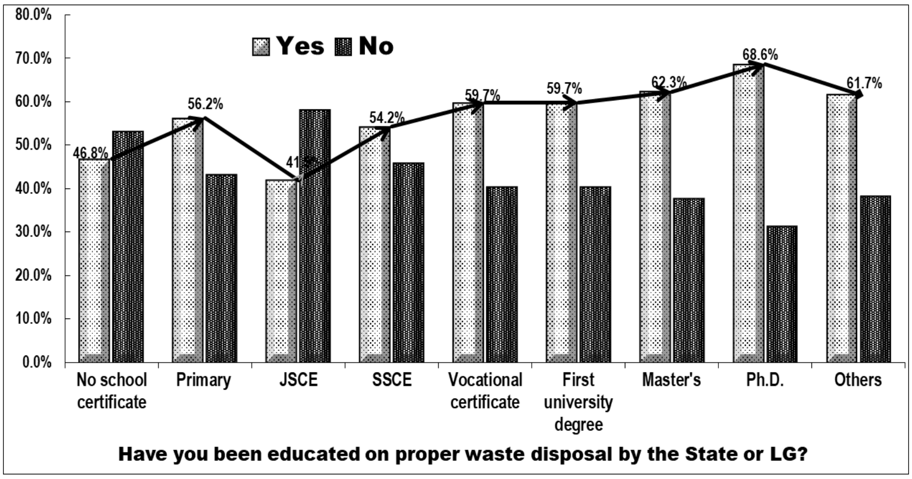
applauded and Imolites branded it 'the new face of Imo'. Orlu zone stood lowest; though the current governor is from this zone, the slogan of his administration is 'Imo rescue mission'. This conspicuously sent environmental concerns to the background, as it is during his tenure that the State (capital) was labeled a 'garbage capital' and a 'dunghill'.

Table 4.14.1 Education on waste management and highest level of school attained
(Author's findings, 2018)

Highest level of school attainment	stats	Have you been educated on proper waste disposal by the State or Local Government?		Total
		Yes	No	
No school certificate	n	22	25	47
	%	46.8%	53.2%	100%
Primary school	n	36	28	64
	%	56.2%	43.8%	100%
JSCE	n	54	75	129
	%	41.9%	58.1%	100%
SSCE	n	244	206	450
	%	54.2%	45.8%	100%
Vocational certificate	n	80	54	134
	%	59.7%	40.3%	100%
First university degree	n	387	261	648
	%	59.7%	40.3%	100%
Master's degree	n	203	123	326
	%	62.3%	37.7%	100%
Ph.D.	n	72	33	105
	%	68.6%	31.4%	100%
Other	n	92	57	149
	%	61.7%	38.3%	100%
Total	n	1,190	862	2,052
	%	58.0%	40.3%	100%

Cramer's V: V=0.117; P=0.000.

There was a significant ($P<0.05$) association between education on waste management and level of school attainment. The statistical trend indicates that the number of those that were educated on proper waste disposal measures increased with level of education attained. It ranged from 46.8% for those that had no school certificate to 56.2% for those that had acquired primary education. Even though the percentage lessened to 41.9% for those that had attained the Junior Secondary School, a steady rise is observed from that level to the Ph.D. level (Figure 4.6).



N=2,052

Figure 4.6a Comparison between educational level and education on proper waste disposal

(Author's findings, 2018)

Table 4.14.2 Education on waste management by household size *(Author's findings, 2018)*

Household size categorized	**Stats**	**Have you been educated on proper waste disposal by the State or Local Government?**		**Total**
		Yes	**No**	
1-3 persons	n	107	86	193
	%	55.4%	44.6%	100.0%
4-6 persons	n	601	405	1,006
	%	59.7%	40.3%	100.0%
7+ persons	n	482	371	853
	%	56.5%	43.5%	100.0%
Total	n	1,190	862	2,052
	%	58.0%	42.0%	100.0%

Cramer's V: V=0.035; P=0.279.

All the households, irrespective of their sizes had equal exposure to proper waste disposal measures (P>0.05).

Table 4.14.3 Education on waste management by major occupation

(Author's findings, 2018)

Major occupation	**Stats**	**Have you been educated on proper waste disposal by the State or LG?**		**Total**
		Yes	**No**	
Farming	n	22	48	70
	%	31.4%	68.6%	100.0%
Business	n	451	330	781
	%	57.7%	42.3%	100.0%
Teaching	n	181	170	351
	%	51.6%	48.4%	100.0%

Lecturing	n	74	36	110
	%	67.3%	32.7%	100.0%
Other civil services	n	308	148	456
	%	67.5%	32.5%	100.0%
Others	n	154	130	284
	%	54.2%	45.8%	100.0%
Total	n	1,190	862	2,052
	%	58.0%	42.0%	100.0%

Cramer's V: V=0.154; P=0.000.

Based on occupation, and in relation to education on waste disposal, farmers significantly (P<0.05) had the lowest proportion of those that were educated on proper waste disposal (31.4%) while those in other civil services and lecturers were the highest with proportions of 67.5% and 67.3% respectively.

Table 4.14.4 Education on waste management by the duration of stay in the city
(Author's findings, 2018)

Duration of stay in the city (years)	**Stats**	**Have ever been educated on proper waste disposal by the State or LG**		**Total**
		Yes	**No**	
Less than 5	n	12	354	366
	%	3.3%	96.7%	100.0%
5-10	n	304	272	576
	%	52.8%	47.2%	100.0%
11-20	n	523	184	707
	%	74.0%	26.0%	100.0%
21-30	n	169	43	212
	%	79.7%	20.3%	100.0%
31-40	n	118	8	126
	%	93.7%	6.3%	100.0%
More than 40	n	64	1	65
	%	98.5%	1.5%	100.0%
Total	n	1,190	862	2,052
	%	58.0%	42.0%	100.0%

Cramer's V: V=0.576; P=0.000.

There was a significant association between being educated on waste management and duration of stay in the community (P<0.05). In fact, the longer one had stayed in the community, the higher the likelihood that he/she had been educated on proper waste disposal measures. Figure 4.6b illustrates the trend. It should be recalled that Owerri, the Imo State capital territory was adjudged the cleanest State capital in the federation in 1980. This is sequel to the fact that, between 1st October 1979 and 31st December 1983 (the tenure of the State's first civilian Governor – Samuel Onunaka Mbakwe), the Imo State government established the

Environmental Sanitation Authority in 1980, during which collaborative links were established with the German waste bin production company – SULO. The latter supplied waste bins with rollers to the State and these were stationed in its urban spheres and environs. Imolites, coming out of a military rule were sensitised on the use of the public bins and they made use of them.

Things took another turn when the Governor was out of office and the State plunged back into military rule; the contract with SULO was not sustained. The available public bins gradually were damaged and were not replaced. Though several measures were and have been taken to maintain as well as improve on the State's cleanliness, the State's environment deteriorated gradually, passing through what was described as 'the shame of Owerri' (Onyekakeyah, 2015) till October 1st, 2016 when it reached the peak and earned it the name 'Garbage capital' (Punch, 2016a; The Scoop, 2016).

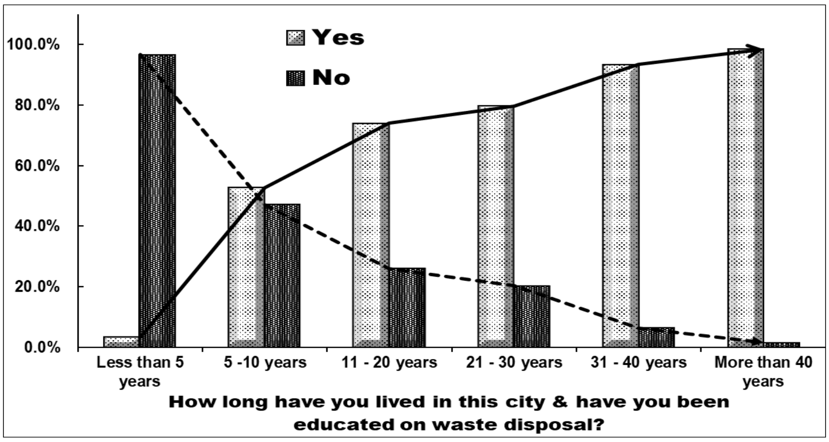


Figure 4.6b Relationship between duration of stay in the city and education on proper waste disposal.
N=2,052
(Author's findings, 2018)

Table 4.15 Respondents' suggestions to improve waste management
(Author's findings, 2018)

Suggestions for proper waste management in the State	Okigwe		Orlu		Owerri		Total	
	n	%*	n	%*	n	%*	n	%*
Government to provide enough waste bins of adequate sizes or suitable dumping sites	110	31.8	118	33.4	38	6.0	266	20.0
Government to ensure regular evacuation of waste, and mostly daily	37	10.7	74	21.0	142	22.4	253	19.0
Government to provide evacuation trucks	22	6.4	46	13.0	10	1.6	78	5.9
Government to build incinerators or waste recycling and energy recovery plants, for instance, gas can be produced from waste	42	12.1	44	12.5	31	4.9	117	8.8

Government to employ waste pickers to contribute to recycling or workers to help in waste collection or management	51	14.7	0	0.0	5	0.8	56	4.2
Government to ensure measures to make sure that waste is not burnt	0	0.0	0	0.0	22	3.5	22	1.7
Education and sensitization on waste management	25	7.2	47	13.3	29	4.6	101	7.6
Enact a WM law and enforcing them with punitive/reward measures (for instance monitoring to make sure people dispose of their waste at the right places)	22	6.4	9	2.5	153	24.1	184	13.8
Clean-up campaign by community members, could be done weekly or forth-nightly or monthly	0	0.0	0	0.0	1	0.2	1	0.1
Government to endeavour to regularly clean the environment and drainage channels, and removing waste from them	37	10.7	0	0.0	0	0.0	37	2.8
Introduce environmental education, specifically waste management in schools	0	0.0	12	3.4	0	0.0	12	0.9
Government to encourage waste re-use and recycling, as compost can be used as manure	0	0.0	3	0.8	2	0.3	5	0.4
Build drainage or water channels	0	0.0	0	0.0	36	5.7	36	2.7
The government should employ competent workers, improve on the training, functionality, and funding of environmental management agencies plus good and regular remuneration for the workers besides adequately providing them with equipment	0	0.0	0	0.0	157	24.8	157	11.8
House to house collection of waste	0	0.0	0	0.0	1	0.2	1	0.1
WM Philanthropists to come in and help	0	0.0	0	0.0	1	0.2	1	0.1
Research also creates awareness thanks to the questionnaire we are exposed to WM	0	0.0	0	0.0	1	0.2	1	0.1
Private agency involvement in waste management	0	0.0	0	0.0	2	0.3	2	0.2
Periodical research to propose adequate response measures to waste management problems	0	0.0	0	0.0	1	0.2	1	0.1
Government to promote waste sorting/separation	0	0.0	0	0.0	2	0.3	2	0.2
Total responses	346	100.0	353	100.0	634	100.0	1,333	100.0

*Weighted by responses

Community members highlighted a number of aspects that they identified could improve on waste management if implemented. The three most recurrent suggestions were:

- government to provide enough waste bins of adequate sizes or suitable dumping sites,
- government to ensure regular evacuation of waste, and most daily and
- the need to enact a Waste Management (WM) laws and enforce them with punitive/reward measures (for instance monitoring to make sure people dispose of their waste at the right place).

School level

Schools generally integrated environmental education in their program with a proportion of 82.1%.

Environmental impact and sustainability

Households' perspective

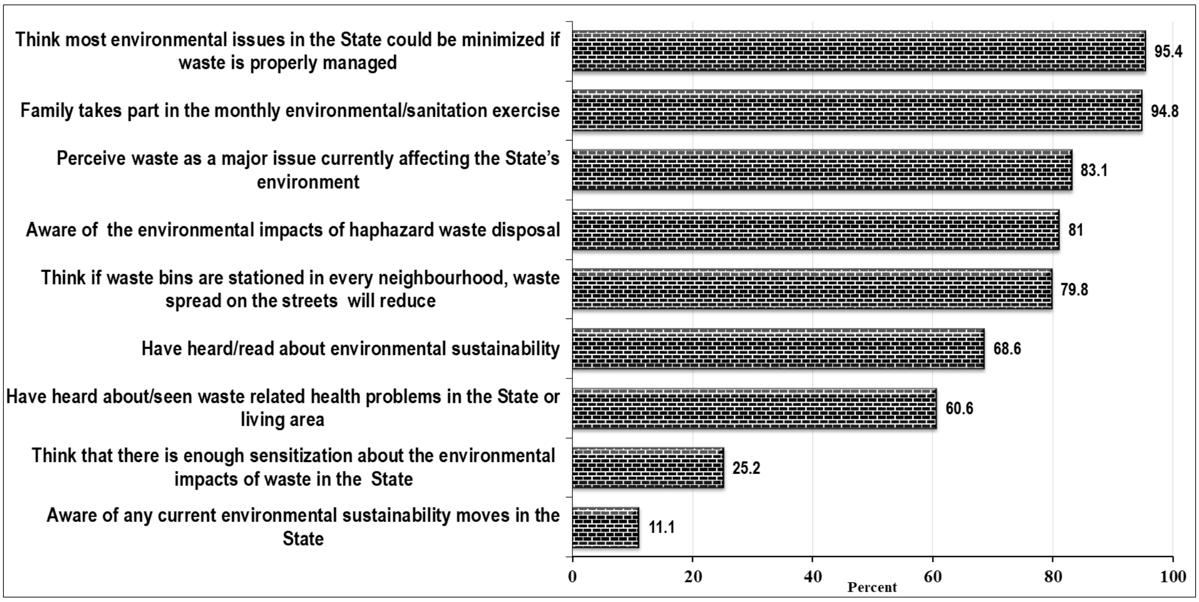


Figure 4.7 Households' awareness of environmental sustainability
(Author's findings, 2018)

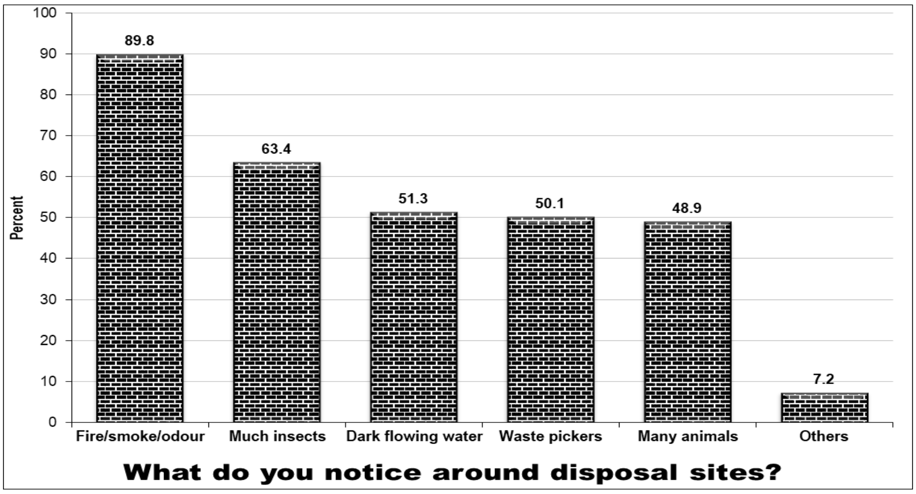
Many community members were of the opinion that environmental issues in the State could be minimized if waste is properly managed (95.4%), some 94.8% maintained that their families took part in the monthly environmental/sanitation exercise while 83.1% mentioned waste as a major issue currently affecting the State's environment. Some 81.0% knew about the environmental impact of haphazard waste disposal, 79.8% thought that if waste bins are stationed at every neighbourhood in the State, the rate of waste spread on the streets and roads will be reduced. A strong majority of the households (68.6%) had heard/read about environmental sustainability, 60.6% had heard or seen waste related health problems in the State or their vicinity, just 25.2% thought that there is enough information/sensitization about the environmental impacts of waste in the State. A very few (11.1%) were aware of any current environmental sustainability moves in the State.

Table 4.16 Awareness of environmental sustainability indicators by study sites (Author's findings, 2018)

Study sites	Have heard of Environmen-tal Sustainability	The family takes part in the monthly environmental/ sanitation exercise	Aware of any current environmental sustainability moves in the State	Know about the environmental impact of haphazard waste disposal	Have heard about/seen waste related health problems in the State or your area	n
Okigwe	65.2% (344)	98.7% (521)	7.6% (40)	78.0% (412)	74.2% (392)	528
Orlu	59.8% (323)	94.4% (510)	9.1% (49)	90.7% (490)	58.7% (317)	540
Owerri metropolis	75.2% (740)	93.0% (915)	14.0% (138)	77.3% (761)	54.4% (535)	984
Cramer's V	V=0.143 P=0.000	V=0.076 P=0.000	V=0.067 P=0.001	V=0.148 P=0.000	V=0.120 P=0.000	

There was an observable ($P<0.05$) inconsistency in the awareness of environmental sustainability among the sites. Owerri metropolis had the highest proportion of people who were aware (75.2%), then Okigwe (65.2%) and Orlu (59.8%). There was a very strong proportion ($P<0.05$) of family participation in the monthly sanitation/environmental exercise at all the sites; the highest recorded in Okigwe (98.7%), Orlu (94.4%) and then Owerri metropolis (93.0%). The population expressed a very weak ($P<0.05$) level of awareness of any current environmental sustainability moves in the State; the weakest in Okigwe (7.6%), followed by Orlu (9.1%) then Owerri metropolis (14.0%). With regards to knowledge of the environmental impact of haphazard waste disposal, the proportions were very strong at all the sites, ranging from 90.7% in Orlu, 78.0% in Okigwe, and 77.3% in Owerri metropolis being noticeably the lowest ($P<0.05$). In relation to having heard about/seen waste related health problems in the State or the respondent's vicinity, Okigwe perceptibly ($P<0.05$) had the highest number of those that were aware (74.2%), followed by Orlu (58.7%) and Owerri metropolis (54.4%).

Observable features around disposal sites



N=2,052.

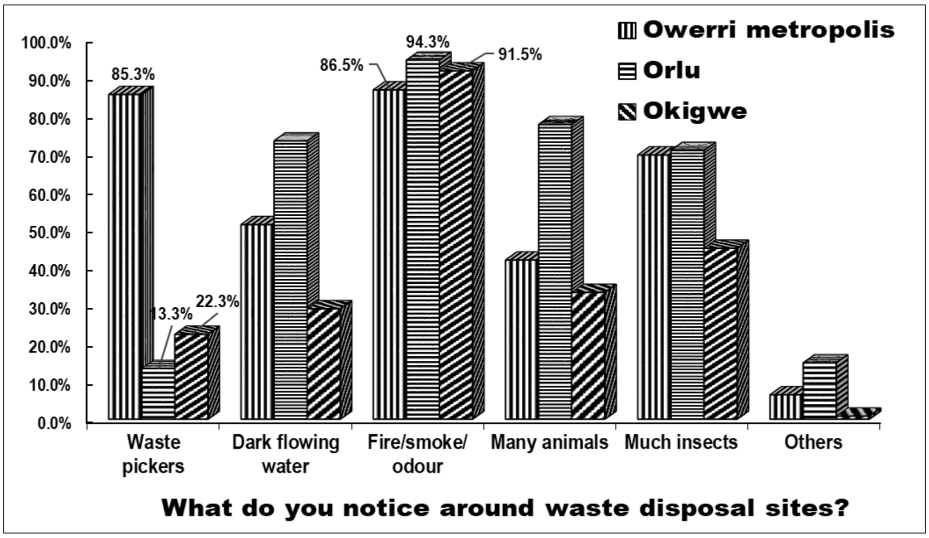
Figure 4.8a Community's noticeable traits around disposal sites
(Author's findings, 2018)

Community members mostly notice fire with its smoke as well as odour (89.8%) around waste disposal sites. This indicates Imolites more frequently burnt waste. They also noticed the presence of many insects (63.4%), dark flowing water (51.3%), waste gatherers (50.1%), many animals (48.9%) and other features not clearly specified.

Table 4.17 Features observed around disposal sites: comparing by sites
(Author's findings, 2018)

Observed features at the disposal areas	Stats	Sites			Total
		Okigwe	Orlu	Owerri metropolis	
Waste pickers	n	118	72	839	1,029
	%	22.3%	13.3%	85.3%	
Dark flowing water	n	153	395	505	1,053
	%	29.0%	73.1%	51.3%	
Fire/smoke/odour	n	483	509	851	1,843
	%	91.5%	94.3%	86.5%	
Many animals	n	175	418	411	1,004
	%	33.1%	77.4%	41.8%	
Much insects	n	237	381	683	1,301
	%	44.9%	70.6%	69.4%	
Others	n	4	80	63	147
	%	0.8%	14.8%	6.4%	
	Total	528	540	984	2,052

χ^2-test: χ^2=90.19; df=8; P=0.000.



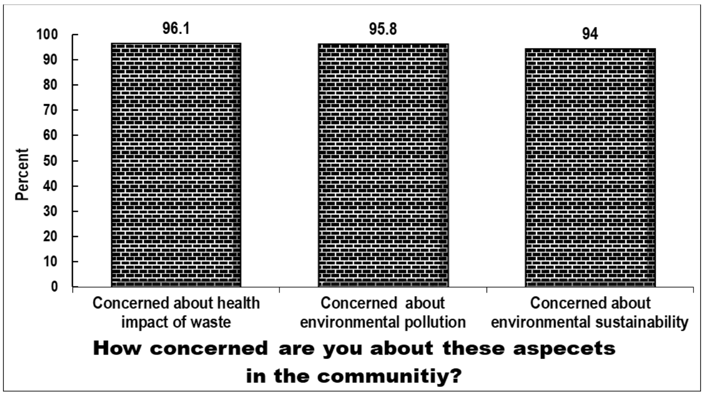
N=2,052

Features 4.8b Features observed around disposal sites per study site

(Author's findings, 2018)

At the sites, fire and its attributes were the most present around waste disposal sites with proportions of 91.5%, 94.3% and 86.5% respectively for Okigwe, Orlu and Owerri metropolis. The latter had significantly the highest proportion of waste pickers found around waste deposit 85.3% while many animals were mostly found around disposal sites in Orlu (77.4%), the same with dark flowing water (73.1%) and much insects (70.6%). The discrepancy among the sites was significant ($P<0.05$). The high number of waste gatherers around disposal sites in Owerri metropolis is linked to the fact that it has the biggest landfill where they sorting is done. These waste pickers have an association and the sorted items have a readier market as the State's capital is easily accessible by Imolites, other States as well as prospective buyers of the recovered waste items.

Concerned about environmental issues



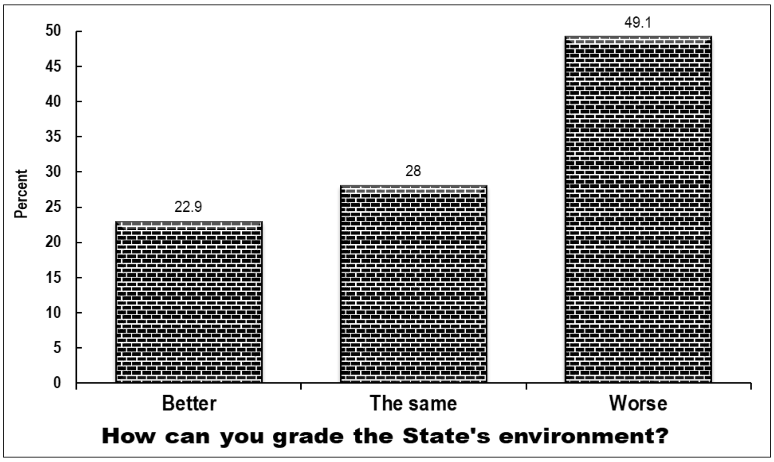
N=2,052

Figure 4.9a Community's concerns about environmental issues

(Author's findings, 2018)

Community members were generally concerned about the health impact of waste 96.1% environmental pollution 95.8% and environmental sustainability 94.0%.

Community grading of environmental quality



N=2,051

Figure 4.9b Community's rating of the environment as compared to it about 10 years' back.

(Author's findings, 2018)

To a very weak extent (22.9%) community members remarked that the quality of the State's environment as compared to it about 10 years' back was better. They (49.1%) mostly alleged that the situation was worse while 28.0% remarked that the situation has not changed (Figure 4.10).

Table 4.18.1 Households' rating of the State's environment as compared to it about 10 years' back: stretched *(Author's findings, 2018)*

Sites	Stats	Overall, how would you rate the environmental quality of the State as compared to it about 10 years' back?					Total
		Much better	A little better	The same	A little worse	Much worse	
Okigwe	n	115	152	31	147	82	527
	%	21.8%	28.8%	5.9%	27.9%	15.6%	100.0%
Orlu	n	28	108	240	132	32	540
	%	5.2%	20.0%	44.4%	24.4%	5.9%	100.0%
Owerri metropolis	n	1	66	303	256	358	984
	%	0.1%	6.7%	30.8%	26.0%	36.4%	100.0%
Total	n	144	326	574	535	472	2,051
	%	7.0%	15.9%	28.0%	26.1%	23.0%	100.0%

Cramer's V: V=0.399; P=0.000.

Table 4.18.2 Imo State environmental perception as compared to it about 10 Years' back: collapsed *(Author's findings, 2018)*

Sites	Stats	Overall, how would you rate the quality of the environment in the State as compared to it about 10 years back?			Total
		Better	The same	Worse	
Okigwe	n	267	31	229	527
	%	50.7%	5.9%	43.5%	100.0%
Orlu	n	136	240	164	540
	%	25.2%	44.4%	30.4%	100.0%
Owerri	n	67	303	614	984
	%	6.8%	30.8%	62.4%	100.0%
Total	n	470	574	1,007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.354; P=0.000.

The environmental situation was perceived the worst in Owerri metropolis (62.4%), followed by Okigwe (43.5%), then Orlu (30.4%).

Shops' perspective

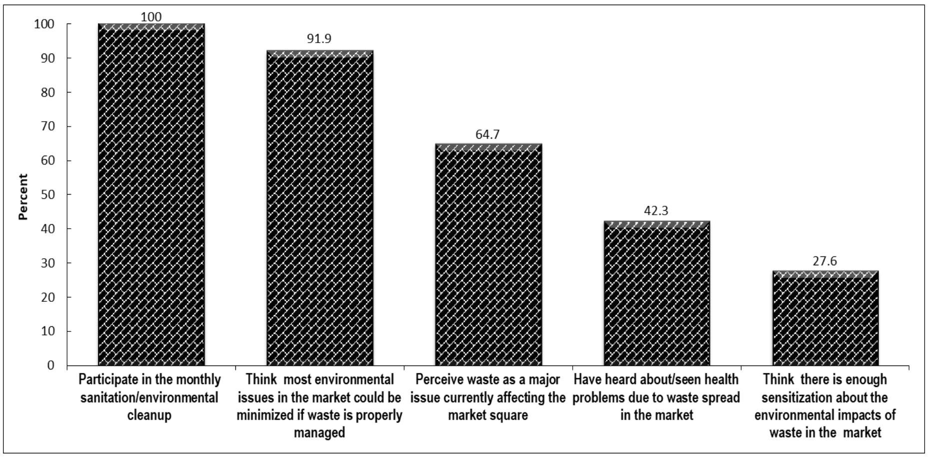


Figure 4.10a Shop owners' perception of waste and environmental issues at the market
(Author's findings, 2018)

All the shop owners/attendants participated in the monthly sanitation exercise. 91.9% of them maintained that most environmental issues in the market could be minimised if waste materials are properly managed and 64.7% recognized waste as a major issue currently affecting the market square. 42.3% had heard about or seen health problems due to waste spread in the market while just 27.6% think that there is enough information/sensitization about the environmental impacts of waste in the market or commercial areas.

Table 4.19 Shops' awareness of environmental sustainability indicators by study sites
(Author's findings, 2018)

Study sites	Have heard about/seen health problems due to waste spread in the market	Perceived waste as a major issue currently affecting the market square	Participate in the monthly environment al/ sanitation exercise	Think that there is enough sensitization about the environmental impacts of wastes in the market	Think that most environmental issues in the market could be minimized if waste is properly managed	n
Owerri metropolis	32.8% (40)	94.3% (115)	100% (122)	18.9% (23)	97.5%(119)	528
Orlu	51.2% (42)	37.8%(31)	100% (82)	30.5% (25)	79.3%(65)	540
Okigwe	48.5% (33)	44.1%(30)	100% (68)	39.7% (27)	97.1%(66)	984
Cramer's V	V=0.174 P=0.016	V=0.560 P=0.000	-	V=0.192 P=0.007	V=0.231 P=0.000	

Waste related health problems apparently (P<0.05) were distinguished more pronounced in Orlu (51.2%), followed by Okigwe (48.5%) and was the least (32.8%) in Owerri metropolis.

Since waste is more frequently being burnt at the Okigwe and Orlu study sites, it is logical that health problems be more pronounced at these two sites; especially respiratory problems as well as air and water-borne health problems. In Owerri metropolis, shop owners/attendants the most identified waste as a major issue currently affecting the market squares (94.3%) than in Okigwe (44.1%) and Orlu (37.8%). At all the sites, all the shop owners/attendants participated in the monthly sanitation exercise. To a weak extent, shop owners/attendants think that there is enough information/sensitization about the environmental impacts of waste in the market area with proportions ranging from 18.9% in Owerri metropolis, 30.5% in Orlu and 39.7% in Okigwe. Largely, shop owners/attendants remarked that environmental issues in the market could be minimised if waste materials are properly managed with proportions of 97.5% in Owerri metropolis, 97.1% in Okigwe and 76.8% in Orlu.

Shops owners/attendants' grading of the market environment

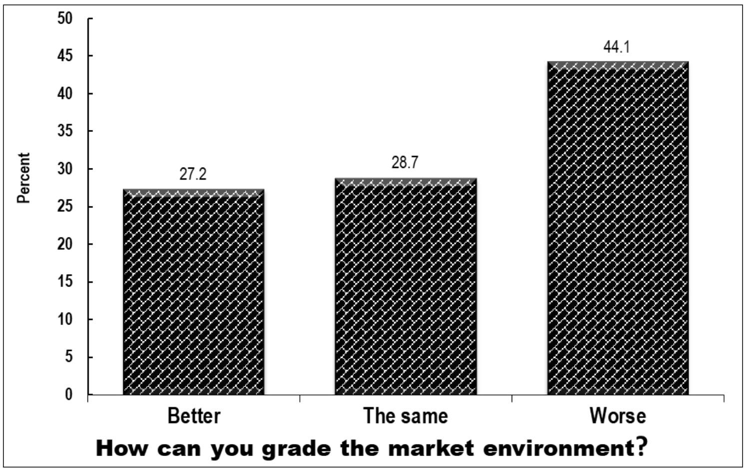


Figure 4.10b Shop owners' rating of the markets' environmental quality as compared to it about 10 years' back
(Author's findings, 2018)

Shop attendants/owners mostly (44.1%) perceived that the market environmental quality had gotten worse as compared to the situation 10 years' back. While 28.7% maintained that the situation has not changed, 27.2% upheld that the environmental situation is currently better than it was 10 years' back.

Table 4.19.1 Shop attendants' rating of the markets' environment as compared to the situation about 10 years' back: Stretched *(Author's findings, 2018)*

Sites	Stats	Overall, how would you rate the quality of the market environment as compared to it about 10 years' back?					Total
		Much better	A little better	The same	A little worse	Much worse	
Owerri metropolis	n	0	0	34	68	20	122
	%	0.0%	0.0%	27.9%	55.7%	16.4%	100.0%
Orlu	n	17	38	23	1	3	82
	%	20.7%	46.3%	28.0%	1.2%	3.7%	100.0%
Okigwe	n	0	19	21	19	9	68
	%	0.0%	27.9%	30.9%	27.9%	13.2%	100.0%
Total	n	17	57	78	88	32	272
	%	6.2%	21.0%	28.7%	32.4%	11.8%	100.0%

Cramer's V: V=0.515; P=0.000.

Table 4.19.2 Shop attendants' rating of the markets' environment as compared to it about 10 years' back: collapsed *(Author's findings, 2018)*

Sites	Stats	Overall, how would you rate the quality of the market environment in the State as compared to it about 10 years' back?			Total
		Better	The same	Worse	
Owerri metropolis	n	0	34	88	122
	%	0.0%	27.9%	72.1%	100.0%
Orlu	n	55	23	4	82
	%	67.1%	28.0%	4.9%	100.0%
Okigwe	n	19	21	28	68
	%	27.9%	30.9%	41.2%	100.0%
Total	n	74	78	120	272
	%	27.2%	28.7%	44.1%	100.0%

Cramer's V: V=0.492; P=0.000.

The current markets' environmental situation was perceived as worse in Owerri metropolis (72.1%), followed by Okigwe (41.2%) and much better in Orlu as just 4.9% perceived it as worse as against the majority (67.1%) that alleged it was better.

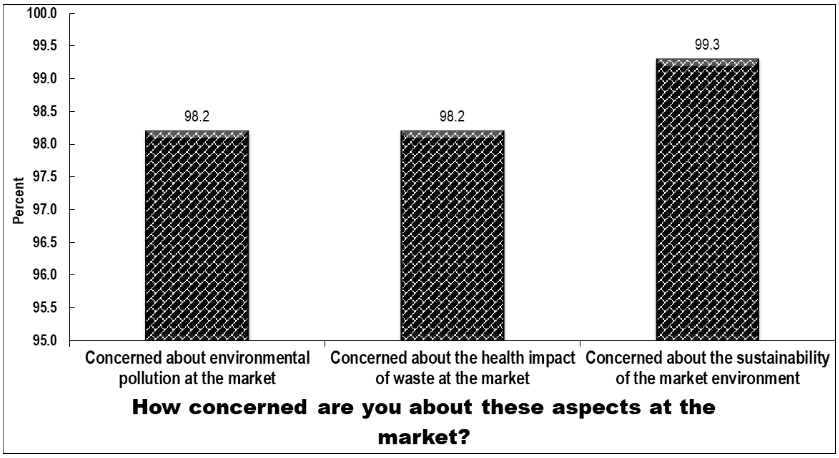


Figure 4.10c Shop owners' concerns about environmental issues in the market
(Author's findings, 2018)

Shop owners/attendants were generally concerned about environmental pollution at the market squares and the health impact of waste spread/disposal in the market (98.2%), while almost all of them were concerned about the sustainability of the market environment (99.3%).

Waste related health problems in the market areas

Shop owners/attendants highlighted many health issues they believe are waste related. These are typhoid, Malaria, respiratory problems (cough, catarrh, asthma: i.e. risk to asthmatic patients), Lassa fever, dysentery, diarrhea, cholera, measles and skin diseases such as eczema, itches, rashes, etc.

Suggestions for improving Waste Management – WM at the market areas

Table 4.20 Suggestions for improving WM at the market areas *(Author's findings, 2018)*

Suggestions for improving WM at the market areas	Okigwe		Orlu		Owerri metropolis		Total n cases
	n	% responses	n	% responses	n	% responses	
Government to provide waste bins of adequate sizes or suitable dumping sites	25	25.5	30	29.1	52	24.4	107
Government to ensure regular evacuation of waste from markets	25	25.5	30	29.1	52	24.4	107
Government to provide evacuation trucks	15	15.3	11	10.7	52	24.4	78
Government to build incinerator or waste recycling plant	6	6.1	12	11.7	0	0.0	18
Government to employ waste pickers to contribute to recycling or workers to help in waste management	6	6.1	0	0.0	17	8.0	23
Government to take measures to ensure that wastes are not burnt in the markets	9	9.2	0	0.0	0	0.0	09

Dirty water should not be poured indiscriminately on top of the waste, anyone found dumping waste or pouring dirty water on the street should be penalised	12	12.2	0	0.0	7	3.3	19
Education and sensitization on waste management	0	0.0	11	10.7	5	2.3	16
Enact a WM law & each shop should have waste bin	0	0.0	9	8.7	5	2.3	14
Collaborative waste management (Government and population)	0	0.0	0	0.0	5	2.3	05
Clean-up campaign in markets (Government should appoint a waste manager in each market and the Waste Management Office should fix a day in a week or month during which all traders come and clean)	0	0.0	0	0.0	18	8.5	18
Total responses	98	100.0	103	100.0	213	100.0	414

The three most highlighted suggestions that cut across the three study sites were:

- ✓ government to provide waste bins of adequate sizes or suitable dumping sites;
- ✓ government to ensure regular evacuation of waste and
- ✓ government to provide evacuation trucks

Other suggestions were:

- ➢ Government to employ waste pickers to contribute to recycling or workers to help in waste management.
- ➢ Dirty water should not be poured indiscriminately on top of the waste, anyone found dumping waste or pouring dirty water on the street should be penalised.
- ➢ Government to build an incinerator or waste recycling plant.
- ➢ Clean-up campaign in markets (Government should appoint a waste manager in each market and the Waste Management Office should fix a day in a week or month during which all traders come and clean).
- ➢ Government should take measures to ensure that waste materials are not burnt in the market.
- ➢ Education and sensitization on waste management.
- ➢ Enact a WM law & each shop should have waste bin.
- ➢ Collaborative waste management (Government and population).

Comparing households and shop owners' rating of the State's environmental quality as compared to it about 10 years' back.

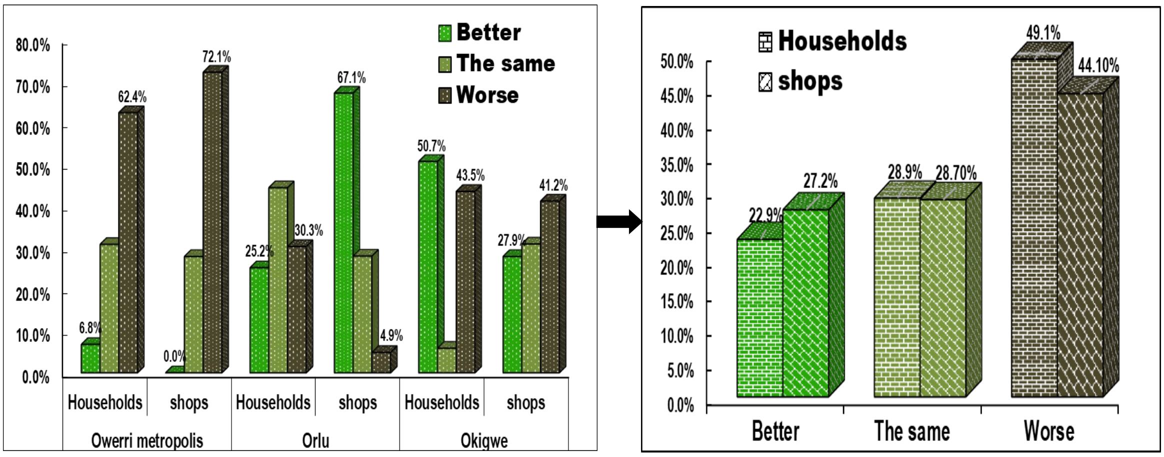


Figure 4.11. Population's rating of the environment
(Author's findings, 2018)

The entire population mostly perceived that the quality of the environment has worsened as compared to the situation 10 years' back. In fact, just 22.9% of households described the situation as better while this proportion was equally weak (27.2%) for the shop owners/attendants.

School level perspective

Waste management and environmental awareness in schools

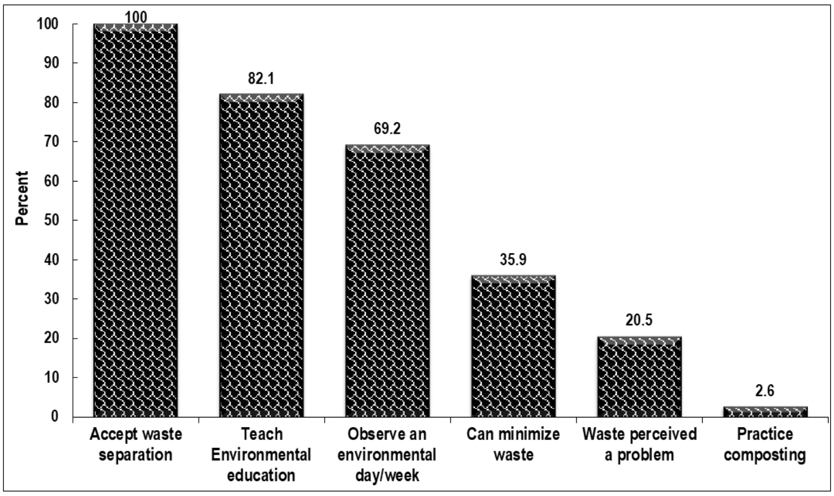


Figure 4.12 Schools' waste management and environmental awareness aspects
(Author's findings, 2018)

While all the schools accepted to separate waste if such a scheme were to be launched, they also generally taught Environmental Education (82.1%). More than half of the schools attested that waste minimization was not possible as only 35.9% maintained that such a strategy is promising. Few of the schools (21.6%) observed that waste was a challenge. More so, a strong majority of the schools observed an environmental day/week with a proportion of 69.2%. Environmental day/week was observed by all the schools in Orlu and Okigwe and less than half in Owerri metropolis (40.0%).

Table 4.21 Schools' observance of an environmental day: comparing among study sites
(Author's findings, 2018)

			Observe an environmental day /week		Total
			Yes	**No**	
Study sites	Owerri metropolis	n	8	12	20
		%	40.0%	60.0%	100.0%
	Orlu	n	12	0	12
		%	100.0%	0.0%	100.0%
	Okigwe	n	7	0	7
		%	100.0%	0.0%	100.0%
Total		n	27	12	39
		%	69.2%	30.8%	100.0%

Cramer's V: V=0.650; P=0.000.

4.2.2 Research hypothesis one: Environmental awareness and education do not affect environmental sustainability in Imo State, Nigeria.

To respond to this hypothesis, it was paramount to generate a composite variable that aggregates environmental sustainability score or identify one variable that characterizes environmental sustainability. The variable ‘Overall, how would you rate the quality of the environment in the State as compared to it about 10 years back?’ was deemed suitable to be used as dependent/outcome variable that characterizes environmental sustainability. The description of this variable indicates a reasonable internal variability, which makes it suitable for statistical modelling. This variable had 5 categories that were subsequently collapsed into three as to reduce the abstraction of the distribution of scores. The three categories were ‘better’, ‘the same’ and ‘worse’ and later into ‘improvement’ and no ‘improvement’. Considering the dichotomous outcome variable, Binary Logistic Regression was used to appraise the influence of environmental awareness and education on environmental sustainability. The effect of individual predictor was appraised using the Log-Likelihood Ratio test while the effect of a predictor controlled for other predictors was appraised using the Wald Statistics.

Model validation

The influence of Environmental awareness and education on environmental sustainability was appraised using Logistic Regression Model. All the cases were considered by the model making a percent inclusion of 100. The variability explained by this model was significant (Omnibus Tests of Model Coefficients: $\chi 2=42.742$; $P=0.014$). One of the variables was removed from the analysis, that is ‘Have you ever heard about waste management?’ since it was constant for the selected cases. In fact, the internal variability of this variable was basically null as almost everybody answered ‘yes’ to this question.

Table 4.22.1 Case Processing Summary *(Author’s findings, 2018)*

Unweighted Cases[a]		**N**	**Percent**
Selected Cases	Included in Analysis	1,929	94.0
	Missing Cases	123	6.0
	Total	2,052	100.0
Unselected Cases		0	.0
	Total	2,052	100.0

a. If weight is in effect, see classification table for the total number of cases.

b. The variable ‘Have ever heard about waste management?’ was constant for the selected cases. Since a constant term was specified, the variable is removed from the analysis.

***Table 4.22.2 Omnibus Tests of Model Coefficients** (Author's findings, 2018)*

		Chi-square	df	Sig.
Step 1	Step	42.742	10	.000
	Block	42.742	10	.000
	Model	42.742	10	.000

The validity of the model is also supported by the Wald statistics ($P<0.05$) thus indicating that the effect of the predictors was significant. Mindful that the aggregate effects of the predictions were significant as indicated by the Wald statistics, it would be important to determine if the predictors contributed significantly or non-significantly. The Likelihood Model test was used to determine the influence of individual predictors of environmental awareness and education on environmental sustainability. This test equally revealed that the overall effect of the predictors was significant ($P<0.05$), and that out of the 10 predictors that made up the predictive component, three significantly predicted environmental sustainability. They were:
'Your family takes part in the monthly environmental/sanitation exercise' ($P<0.05$);
'Have heard about/seen waste related health problems in the State or vicinity' ($P<0.05$) and
'Think that there is enough information/sensitization about the environmental impacts of waste in the State or your LGA' ($P<0.05$), thus rejecting the hypothesis here stated.

Table 4.22.3 Log-Likelihood ratio test depicting the influence of individual predictors of environmental awareness and education on environmental sustainability
(Author's findings, 2018)

Predictors	Score	df	Sig.
Source of awareness on waste management	.409	1	.523
Have ever been educated on proper waste disposal by the LG/State	1.438	1	.230
Your family takes part in the monthly environmental/sanitation exercise	9.649	1	.002
You are aware of any current environmental sustainability moves in the State	2.572	1	.109
You know about the environmental impact of haphazard waste disposal	.054	1	.816
Have heard/seen waste related health problems in your LGA/State	9.981	1	.002
How concerned are you about environmental pollution in the LGA/State?	2.307	1	.129
How concerned are you about the health impact of waste?	.133	1	.716
How concerned are you about environmental sustainability?	.702	1	.402
Think that there is enough information/sensitization about the environmental impact of waste in your LGA/State?	9.026	1	.003
Overall Statistics	40.266	10	.000

When controlled for each other as depicted by the Wald statistics, the same three variables still surfaced as the significant predictors of environmental sustainability, thus confirming their obvious impact.

Table 4.22.4 Wald Test depicting the influence of individual predictors of environmental awareness and education controlled for other predictors on environmental sustainability *(Author's findings, 2018)*

Predictors	B	S.E.	Wald	df	Sig.	Exp(B)
Source of awareness on waste management	.035	.041	.726	1	.394	1.036
Have ever been educated on proper waste disposal by the LG/ State	-.192	.113	2.886	1	.089	.825
Your family takes part in the monthly environmental /sanitation exercise	1.165	.383	9.239	1	.002	3.206
You are aware of any current environmental sustainability moves in the State	-.296	.185	2.553	1	.110	.744
You know about the environmental impact of haphazard waste disposal	-.066	.146	.202	1	.653	.936
Have heard about/seen waste related health problems in your LGA/State	.366	.117	9.787	1	.002	1.442
How concerned are you about environmental pollution in the State?	-.633	.340	3.473	1	.062	.531
How concerned are you about the health impact of wastes?	.380	.403	.888	1	.346	1.462
How concerned are you about environmental sustainability?	-.216	.259	.697	1	.404	.805
Think that there is enough information/sensitization about the environmental impact of wastes in your LGA/State	.433	.123	12.409	1	.000	1.542

Table 4.22.5 Association between family participation in the monthly environmental/sanitation exercise and overall rating of the State's environmental quality as compared to it about 10 years' back *(Author's findings, 2018)*

Your family takes part in the monthly environmental/sanitation exercise	Stats	Overall, how would you the State's environmental quality as compared to it about 10 years' back?		Total
		Improvement	No improvement	
Yes	n	458	1487	1945
	%	23.5%	76.5%	100.0%
No	n	12	93	105
	%	11.4%	88.6%	100.0%
Not sure	n	0	1	1
	%	0.0%	100.0%	100.0%
Total	n	470	1581	2051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.065; P=0.014.

It was statistically obvious (P<0.05) that in areas where families took part in the monthly environmental/sanitation exercise, improvement in the quality of the environment was more perceptible with a proportion of 23.5% as against roughly half of it 11.4% in areas where the family did not participate.

Table 4.22.6 Association between having heard about/seen waste related health problems and overall rating of the environmental quality in the State as compared to it about 10 years' back *(Author's findings, 2018)*

Have you heard/seen waste related health problems in the State or your area?	**Stats**	**Overall, how would you rate State's environmental quality as compared to it about 10 years' back?**		**Total**
		Improvement	**No improvement**	
Yes	n	319	924	1,243
	%	25.7%	74.3%	100.0%
No	n	151	656	807
	%	18.7%	81.3%	100.0%
Not sure	n	0	1	1
	%	0.0%	100.0%	100.0%
Total	n	470	1,581	2,051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.082; P=0.001.

It was equally statistically evident (P<0.05) that in areas where people were aware of waste related health problems, improvement in the quality of the environment was more perceptible with proportion of 25.7% as against almost half of it (18.7%) in areas where they were not aware.

Table 4.22.7 Association between thinking that there is enough information/sensitization about the environmental impact of waste in the LGA/State and overall rating of the environmental quality of the State as compared to it about 10 years' back
(Author's findings, 2018)

Do you think that there is enough information/ sensitization about the environmental impact of waste in your LGA/State?	**Stats**	**Overall, how would you rate State's environmental quality as compared to it about 10 years' back?**		**Total**
		Improvement	**No improvement**	
Yes	n	147	370	517
	%	28.4%	71.6%	100.0%
No	n	323	1211	1,534
	%	21.1%	78.9%	100.0%
Total	n	470	1,581	2,051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.0076; P=0.001.

It was equally statistically proven ($P<0.05$) that in areas where people were aware of the problems caused by inadequate management of waste, improvement in the quality of the environment was more perceptible with proportion of 28.4% as against 21.1% in areas where they were not aware.

4.2.3 Research question two: In what way does waste quantity and its distribution affect environmental sustainability in Imo State, Nigeria?

Waste composition and generation

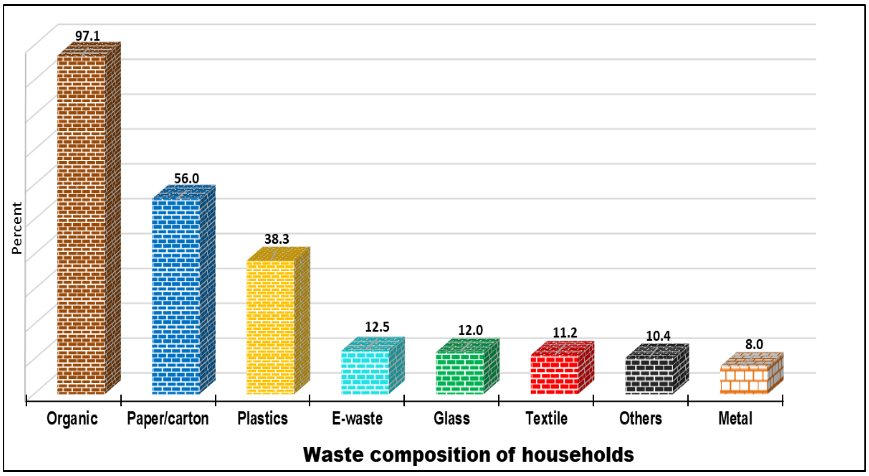
At household level

Households use a great amount of products and are known to generate different categories of waste materials from and after the use of such products. The case of Imo State, Nigeria can be seen below (Table 4.23).

Table 4.23 Comparing waste types from households among the three sites
(Author's findings, 2018)

Waste types	Stats	Sites			Total
		Okigwe	Orlu	Owerri metropolis	
Electrical/electronic materials	n	39	30	187	256
	%	7.4%	5.6%	19.0%	
Organic waste	n	525	523	945	1,993
	%	99.4%	96.9%	96.0%	
Plastics	n	388	83	315	786
	%	73.5%	15.4%	32.0%	
Paper/cardboard	n	414	250	486	1,150
	%	78.4%	46.3%	49.4%	
Metal	n	33	30	102	165
	%	6.2%	5.6%	10.4%	
Textile	n	25	28	177	230
	%	4.7%	5.2%	18.0%	
Glass	n	30	61	156	247
	%	5.7%	11.3%	15.9%	
Others	n	104	31	79	214
	%	19.7%	5.7%	8.0%	
Total		528	540	984	2,052

At the study sites, the three most generated waste types were organic, plastics and paper/carton. Organic waste was the most generated waste type with proportions of 99.4%, 96.9% and 96.0% respectively for Okigwe, Orlu and Owerri metropolis. Electrical/electronic waste was highly generated in Okigwe (73.5%), far more than in Owerri metropolis (32.0%) and in Orlu (15.4%), the same with paper and carton with proportions of 78.4% in Okigwe and far less in Orlu 46.3% and Owerri metropolis 49.4%. Summarily, the study site generated waste as seen on Figure 4.13.



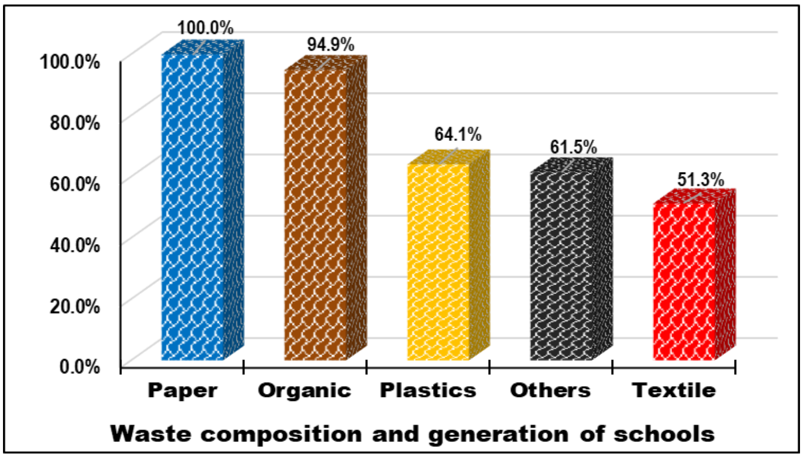
N=2,052

Figure 4.13 Waste composition and generation of households

(Author's findings, 2018)

School level

All the schools generated paper/cardboard/carton, 94.9% food/organic waste, 64.1% plastics, while 51.3% generated textile waste. A good number (61.5%) produced other types of waste not precisely defined. Schools neither generate glass nor metal as well as E-waste (Figure 4.14). This is partly because in most of these institutions (especially lay private and Catholic schools), the pupils are prohibited from using any glass container for food or drinks as well as the use of electronics is not allowed in these institutions. More so, plastic containers are cheaper and readily available in the markets, unlike metal and glass containers.



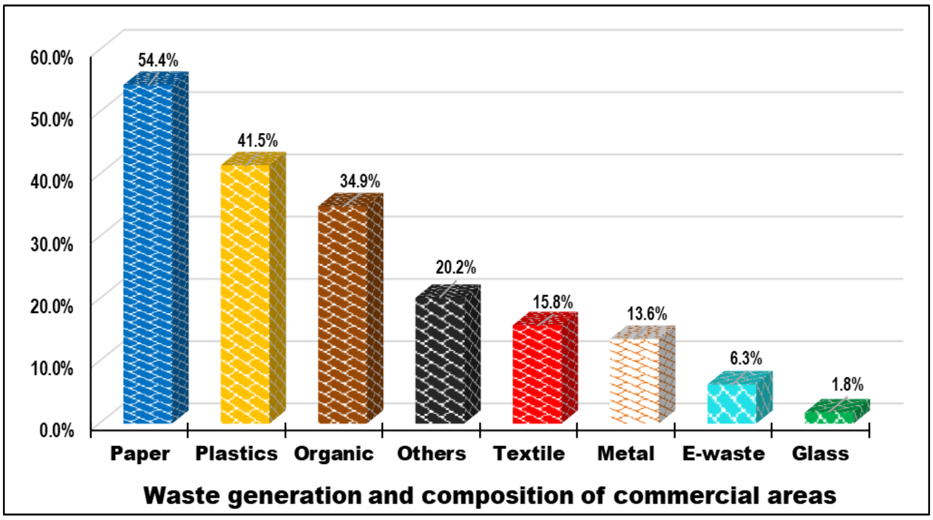
N=39.

Figure 4.14 Waste composition and generation of schools

(Author's findings, 2018)

The high amount of paper and cardboard waste emanating from schools (Figure 4.14), especially when compared with the other population strata (Figure 4.16a), is in line with the occupants of these institutions. The nursery, primary and secondary institutions of learning in the State are visited and occupied by children between the ages of four to sixteen, who mostly due to carelessness tear and throw books away. In this light, Snowman et al. (2012) maintained that physically, children between the ages of six to the onset of adolescence are still very active. They are frequently required to participate in sedentary pursuits; energy is often released in the form of nervous habits. For instance, pencil chewing, fingernail biting, tearing of books, throwing of scrap papers at one another and general fidgeting. Hence, in most cases, the books, papers and other learning materials are torn and abandoned on the floors and fields and are mostly soaked by the heavy rains that are characteristic of this region (in the rainy season). This renders such items useless to the pupils who no longer care about them and they end up in the waste bins.

Shops' level



N=272.

Figure 4.15 Waste composition and generation of shops

(Author's findings, 2018)

Mainly paper/carton/cardboard waste (54.4%) came out of commercial areas, followed by plastics/packaging waste (41.5%), food/organic waste (34.9%), textile (15.8%), metal (13.6%) waste electrical/electronic materials (6.3%), glass waste (1.8%) while 20.2% were other waste types not defined.

Comparing waste types generated amongst households, shops and schools

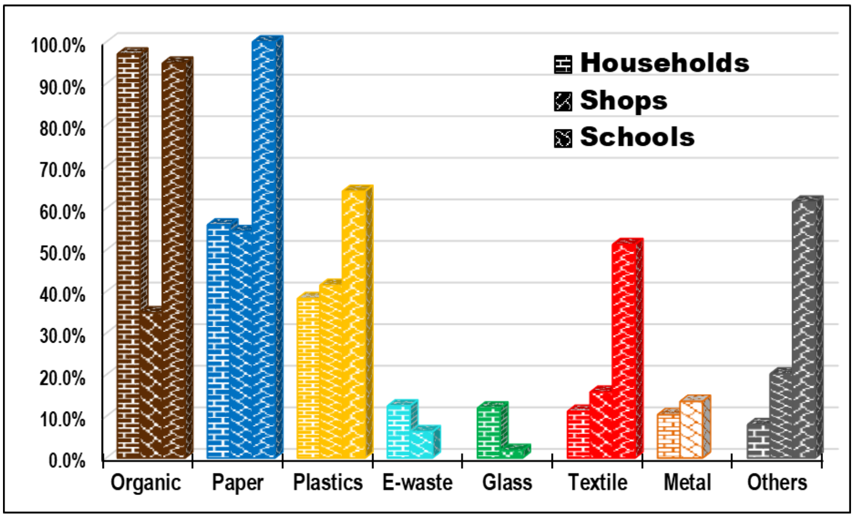


Figure 4.16 Waste generation and composition by population strata
(Author's findings, 2018)

While households generate the highest proportion of organic waste (97.1%) as against 34.9% and 94.9% for shops and schools respectively, schools generate mostly paper/cardboard waste (100%) as compared to just 56.0% and 54.4% respectively for households and shops. This indicates that the study area generally generates more of organic waste. Existing sources (Achebe, 1958; Basden, 1966; Floyd, 1969; Forde & Jones, 1950; Okeke et al., 2009a; Okeke et al., 2009b) reveal that most staple foods in Igboland like yam (*Dioscorea* spp.), maize (*Zea mays*), cassava *(Manihot esculanta*.), cocoyam (*Colocassia* spp.) as well as non-leafy (okra, garden egg) and leafy vegetables like the stem vegetable referred to as '*ugu'* (*Pennisetum* spp.), bitter leaf (*Vernonia amygdalina*), green (*Amaranthus)*, the strong/hard vegetable '*okazi'* (*Gnetum africanum*), garden egg *"añàra"* leaf (*Solanum* spp), pumkin - "*anya-azu"* (*Psychotria* spp.), "*ujuju"* (*myrianthus arboreus*), etc. are per Okeke, et al. (2009b) available and consumed throughout the year. These items are harvested and conveyed in whole (in most cases with the stems) to the households and market squares.

Heavy fruits like pawpaw, mango, orange, breadfruit (*Treculia* sp.), African pear (*Dacrodes* sp.), oil bean seed (*Irvingia* sp. and *Pentaclethra macrophylla*), etc. are also carried to the homes and local markets in whole. With little or no preservation means, coupled with the warm humid climatic conditions of the area, most of the items get rotten and are no longer consumable. Also, while it is common to see sales persons slicing/chopping vegetables and peeling fruits in the market before selling (in order to attract 'lazy' customers, thereby selling more), most customers on the one hand insist that the vegetables be sliced and fruits peeled in front of them while others insist to see the commodity with stems (a proof that is it still fresh) before they can buy.

Most of the whole grains like maize, beans, peas, rice, millet, groundnut, melon seeds (referred to as *Egusi*) are also peeled, sieved, blown and some grinded in the market. This daily practice such activities leaves the stalls, shops and the entire market areas with large heaps of garbage constituting an eye-sore (Figure 4.17) oozing horrible odour. The above-stated finding is also in line with earlier works of the Oil Resource and Allied Limited (2008) who maintained that degradable waste (54%) in Owerri has a higher proportion than non-degradable wastes (46%). Imam et al. (2008) stated that the main components of waste generated in Abuja are food residues, plastics, paper as well as glass. He added that the waste composition and quantity are influenced by local culture, time of the year, traditions and personal income.

Figure 4.17 Waste heap in front of Owerri main market, Douglas road.
Photos taken along Douglas road, Owerri, Imo State, Nigeria
(Photos Ache, 13.02.2017)

The comparatively high proportion of plastic (bags)/packaging waste from schools and shops is attributed to the fact that these items are used as free shopping bags nation-wide. While other African countries have banned or taxed the use of plastic shopping bags, the use of these in Nigeria is still very rampant and considered an expression of pride depending on the logo or what is written on them. Households generate a relatively lower proportion of plastics because most these items (especially used shopping bags/packaging) are used again as a temporal waste collection container for easy evacuation and/tip-off.

Glass materials stand out as the lowest proportion (4.6%) of waste generated by the study population because used glass (especially empty bottles of foreign drinks) are mostly recovered and reused. These are mostly bottles of drinks like whisky, wine, rum or other beers that are resold (between 10-30 Naira per bottle) by the citizens to retailers who in turn use them to sell dry and roasted grains like groundnuts, cashew nuts; liquids like kitchen oil, fuel, kerosene, palm wine, local gin/home distilled snaps (*ogogoro*) etc. Furthermore, when these bottles are still relatively new (i.e. with the label or writings of the original product on them intact), they are sold back (between 50-100 Naira per bottle) to the company producing the content of the bottle and others who produce the fake content clandestinely. Hence, the demand for these items is high especially in Owerri metropolis, thereby making those in need to resort to the smaller towns (Orlu and Okigwe) where they are comparatively cheap with a low demand. This is one reason why it is hard to find glass (bottles) amongst waste items; broken glasses are however present but are not picked since glass is not recycled in the State.

Waste types generated by hotels/guesthouses and their restaurants

The hotels/guesthouses with their restaurants produced food/organic waste, plastics (mostly bags and bottles), cartons/cardboard, textile and glass. A detailed interview/discussion with the managers of some hotels in Owerri metropolis and the over-all manager – Imo State Chairman of Hotels Association[46], confirmed this sample. Though the frequency (quantity) of each waste type is/was not recorded (and so could not be estimated by the interviewer), a general estimate of all is/was made (by the interviewee) weekly since all the waste types go into the same container and is evacuated by the same truck.

This study found out that the three most generated waste types were food/organic waste, paper/carton/cardboard and plastics/packaging waste. This is similar to the global waste generation and composition with organic spearheading, followed by paper and thirdly plastics (Figure 4.18a) (Bhada-Tata & Hoornweg, 2012). Available data indicate that the Sub-Saharan African region (Figure 4.18b) cum Nigeria (Figure 4.18c) generate more of plastics than paper; but, organic waste still stands out highest, even for Imo State (Figure 4.18d) whose data was computed without input from its hotels/guesthouse with their restaurants.

[46] Chief Dr Nweke Ishmael Emeka was the Chairman of Nigerian Hotel Association, Imo State chapter. He was responsible for the management of all registered hotels in the town at inception until two or three months after which he has to appoint a new manager. Interview was held at the Lodan International hotel, on 14 February 2017 between 1:20 pm-2:40 pm.

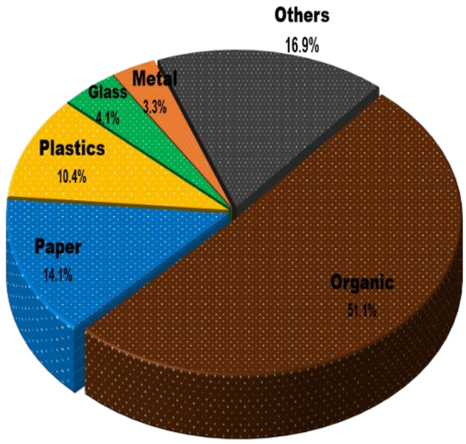


Figure 4.18a Waste generation and composition of the globe.
Data source (Bhada-Tata & Hoornweg, 2012)

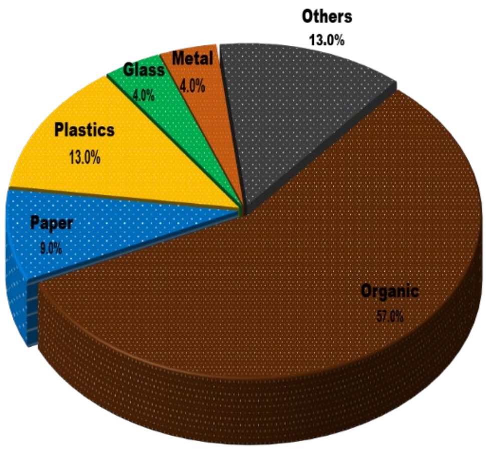


Figure 4.18b Waste generation and composition of sub-Saharan Africa.
Data source (Bhada-Tata & Hoornweg, 2012)

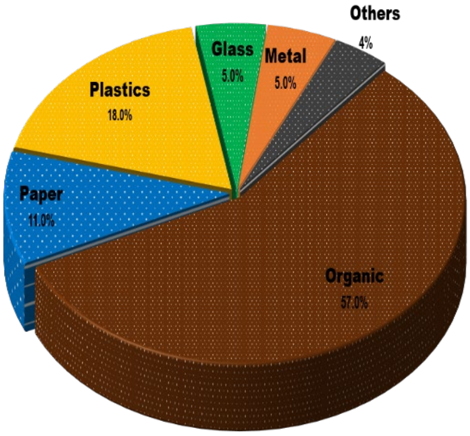


Figure 4.18c Waste generation and composition of Nigeria.
Data source (Imam et al., 2008).

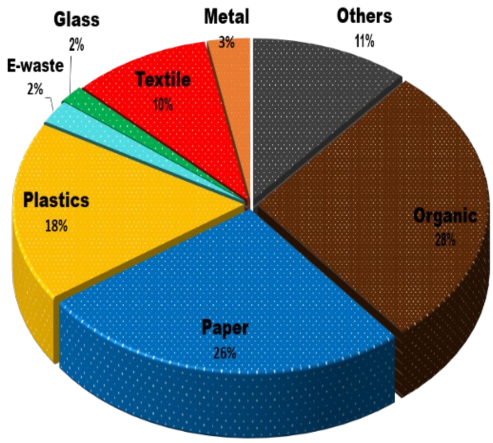
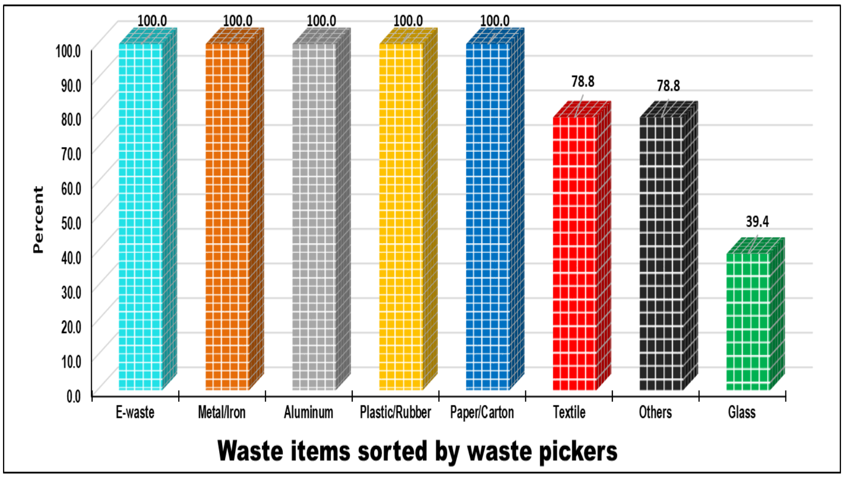


Figure 4.18d Waste generation and composition in Imo State, Nigeria.
Data source (Author's findings, 2018)

Types of waste items sorted by waste pickers

The waste pickers all gathered up copper (from E-waste), metal/iron, aluminum, plastic/rubber and paper/carton. A majority sorted textile (78.8%) and 39.4% sorted glass while 78.8% sorted other types of waste not specified (Figure 4.19). Waste items obtained by waste pickers were mostly electronic items and metals for their high recycling and economic values.



N=33.

Figure 4.19 Types of waste items sorted by waste pickers
(Author's findings, 2018)

Quantity of waste generated

Households

Table 4.24 Households' knowledge of waste quantity generated *(Author's findings, 2018)*

Frequency	*Number of households that knew waste quantity generated*	*Number of households that did not know*	*Total*	*% known*	*% Don't know*
Owerri metropolis	432	552	984	43.9%	56.1%
Orlu	166	374	540	30.7%	69.3%
Okigwe	124	404	528	23.5%	76.5%
Total	722	1,330	2,052	35.2%	64.8%

Only 722 households making a proportion of 35.2% could state the amount of waste they produced per day while the rest did not know. In average, households generated 2.7 kg of waste per day the median was 3.5 kg. Screening for normality, the normality assumption was violated for this variable (Kolmogorov-Smirnov and Shapiro-Wilk tests for normality: $P<0.05$) and the non-parametric Kruskal Wallis test thus indicates that the difference was very significant among three sites ($H=30.310$; $P=0.000$).

Table 4.24.1 Quantity (kg) of waste generated in the household per day by study sites *(Author's findings, 2018)*

Sites	N	Mean	Median	Minimum	Maximum
Okigwe	124	2.1	1.5	1.5	3.5
Orlu	166	3.0	3.5	1.5	5.5
Owerri metropolis	432	2.7	3.5	1.5	5.5
Total	722	2.7	3.5	1.5	5.5

Kruskal Wallis: H=30.310; P=0.000.

Orlu had the highest quantity of waste generated per day and per household with an average of 3.0 kg, followed by Owerri metropolis (2.7 kg) while Okigwe had 2.1 kg and this difference was significant (P<0.05).

Table 4.24.2 Quantity of waste generated in the household by size *(Author's findings, 2018)*

Household size categorized	N	Mean	Median	Minimum	Maximum
1-3 persons	4	1.5	1.5	1.5	1.5
4-6 persons	304	1.5	1.5	1.5	5.5
7+ persons	414	3.5	3.5	1.5	5.5
Total	722	2.7	3.5	1.5	5.5

Kruskal Wallis: H=486.969; P=0.000.

There was a strong D=0.741 (D here is equivalent to the correlation coefficient 'R') and significant (P<0.05) positive (the sign of D is positive) association between household size and waste quantity generated in the household, thus implying the more the people in the household, the more the quantity of waste generated. In fact, it is clear that the highest amount of waste generated was recorded in households with 7 persons or more (3.5 kg) while the least was from households with 1-3 people (1.5 kg).

Shops

In average, shops produced 6.0 kg of waste per day; the median was 6.5 kg while the minimum was 2.5 kg. Screening for normality, the normality assumption was violated for this variable (Kolmogorov-Smirnov and Shapiro-Wilk tests for normality: P<0.05) and the non-parametric Kruskal Wallis test thus indicates that the difference was not significant among three sites (H=0.913; P=0.634). The mean quantity of waste generated per day was 5.9 kg in Owerri metropolis, 6.3 kg in Orlu and 5.7 kg in Okigwe. The median was lowest in Okigwe indicating that this site had more people generating waste below the average and few people producing huge amount of waste.

Table 4.25 Quantity (in kg) of waste generated by shops at study sites *(Author's findings, 2018)*

Study sites	N	Mean	Median	Minimum	Maximum
Owerri metropolis	116	5.9	6.5	2.5	10.5
Orlu	56	6.3	6.5	2.5	10.5
Okigwe	45	5.7	2.5	2.5	10.5
Total	217	6.0	6.5	2.5	10.5

Kruskal Wallis H=0.913; P=0.634.

Comparing amount of waste generation in households and shops

Statistically, households and shops in Owerri metropolis did not only produce less waste but also accounted for waste generated more than those at the other two sites. This result challenges why this State capital was described as *'Gold to Dunghill'* (Onyekakeyah, 2013) and recently as *'Garbage capital'* (Njoku C. I., 2016). It could therefore be that the issue of waste in the State capital is not only as a result of the quantity generated; but what Mangundu et al. (2013), Parnham & Rispin (2001) and held that the schemes for collection, evacuation and disposal have not been sufficient, realistic or effective.

Waste quantity generated by hotels/guesthouse and their restaurants

Table 4.26 Waste quantity generated by hotels/guesthouses *(Author's findings, 2018)*

			Waste Quantity generated per hotel per Week (kg)			Waste generated per hotel per day (kg)	Total generated by hotels per day (kg)
Study Sites	**Category of hotels**	**Number of hotels**	**Monday to Thursday**	**Friday to Sunday**	**Total per week**	**i.e. Total per week/7**	**i.e. Total/day * Nº of hotels**
Owerri metropolis	A	21	70	90	160	23	480
	B	12	60	75	135	19	231
	C & D	31	50	70	120	17	531
	E & F	24	40	60	100	14	343
	G & H	25	30	50	80	11	286
Orlu	G & H	11	30	50	80	11	126
Okigwe	G & H	12	30	50	80	11	137
Totals		136	310	445	755	108	2,134

An interview with managers of hotels and the Chairman of the Imo State Chapter of the Nigerian Hotel Association (NHA) permitted this study to realize that Imo State has about

244 commercial accommodation houses (hotels, motels, inns, lodges, guesthouses and rest houses). Following international standards and the criteria set up by the Nigerian Tourism Development Corporation Act (NTDCA), Imo State has no five-star hotel though could be grouped into categories A – H as a function of price per night, degree of patronage and amount of waste generated as well as the subsequent evacuation by the IWMA/ENTRANCO (Nweke I., personal communication, February 14, 2017).

Owerri metropolis has a total 113 hotels while the Orlu and Okigwe study sites respectively have 11 and 12. Categories A-F hotels are only found in Owerri metropolis while Orlu and Okigwe have hotels belonging to categories G and H. Category 'A' hotels patronized mostly by VIPs (i.e., top government officials and business tycoons) generated between Mondays and Thursdays about 70 kg of waste while between Fridays and Sundays the quantity increases to between 90 and 160 kg per week. (Table 4.26). Fridays to Sundays are known as the 'boom days' in the hotel business or management as they receive many guests as well as customers patronizing their restaurants and bars being the major reason for the increase in the amount of waste just within three days. Owerri metropolis as the seat for 113 hotels (88%) out of the 136, accounts for the highest proportion of generated waste (1,871kg/day; i.e. 1.87tons/day) while hotels in Orlu and Okigwe generate only 126 kg/day and 137 kg/day respectively, corresponding to 6 percent for both (Figure 4.20).

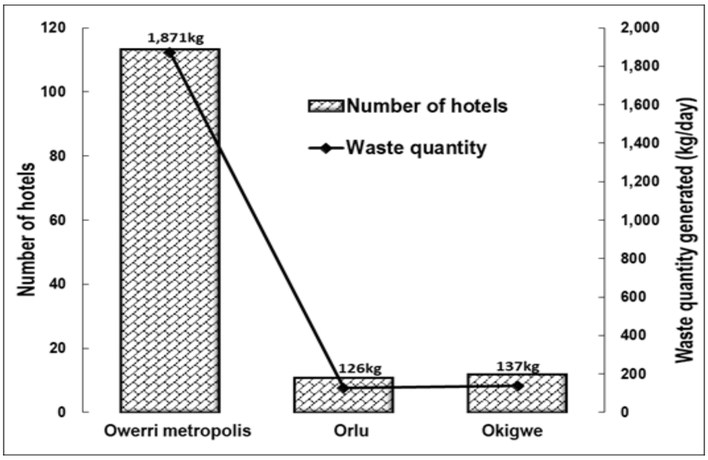


Figure 4.20 Waste generation of hotels/guesthouses in Imo State, Nigeria
(Author's findings, 2018)

Table 4.27 Waste types and disposal methods used by Imolites *(Author's findings, 2018)*

Waste type	Action mostly carried on it	Reason(s)
Organic: - when edible	-Consumed (eaten)	-It might be still good/hunger
- when not edible	-Dumped/burnt/buried	-Not needed/out of sight
Paper	-Dumped/buried/burnt	-Not needed/out of sight
	-Sold	-For recycling
Plastics: - if it's a bottle & still good	-Cleaned & used -Sold	-For storage/sell of liquids/grains
- if not good condition	-Dumped/burnt/used as fuel for cooking	-Not needed/out of sight -Lack of fuel/firewood
E-waste: -When it contains copper/brass	-Crushed/burnt for retrieval -Recovered & used or sold	-Copper/brass very lucrative -For the manufacturing of jewelries
- When in good state	-Dumped/burnt	-Not needed/out of sight
Glass: - when broken	-Dumped	-Not needed/out of sight
- If not broken (bottles)	-Recovered & sold/used	-For storage/covert production of the product/ to sell other products
Textile: - If thorn/dirty	-Dumped/burnt	-Not needed/cheaper to get a new one
- if clean/in good state	-Recovered/ used again	-New one too expensive
Metal	-Recovered/pressed/sold	-Production of jewelries
	-Burnt	-Not needed/out of sight

NB: Woody items were not considered as waste items in this work because such items are not discarded and wood is a major source of domestic and commercial energy.

4.2.4 Research hypothesis two: Waste quantity and its distribution have no significant relationship with environmental sustainability in Imo State, Nigeria.

Table 4.28 Association between perceived environmental quality and quantity of waste generated in the household
(Author's findings, 2018)

Quantity of waste generated in the household (kg)	Stats	Overall, how would you rate the environmental quality of the State as compared to it about 10 years' back?			Total
		Better	The same	Worse	
1-2	n	81	80	197	358
	%	22.6%	22.3%	55.0%	100.0%
3-4	n	54	84	168	306
	%	17.6%	27.5%	54.9%	100.0%
5-6	n	9	24	24	57
	%	15.8%	42.1%	42.1%	100.0%
Total	n	144	188	389	721
	%	20.0%	26.1%	54.0%	100.0%

Cramer's V: V=0.091; P=0.018.

Statistically (P<0.05), where waste was the least produced (1-2 kg daily), the proportion of those who perceived that the environmental quality was better as compared to the past 10 years' was the highest with proportion of 22.6% (81) (Figure 4.21), thus rejecting the research hypothesis here stated. Overall, just 20% of the respondents maintained that the State's environmental quality was better than 10 years ago.

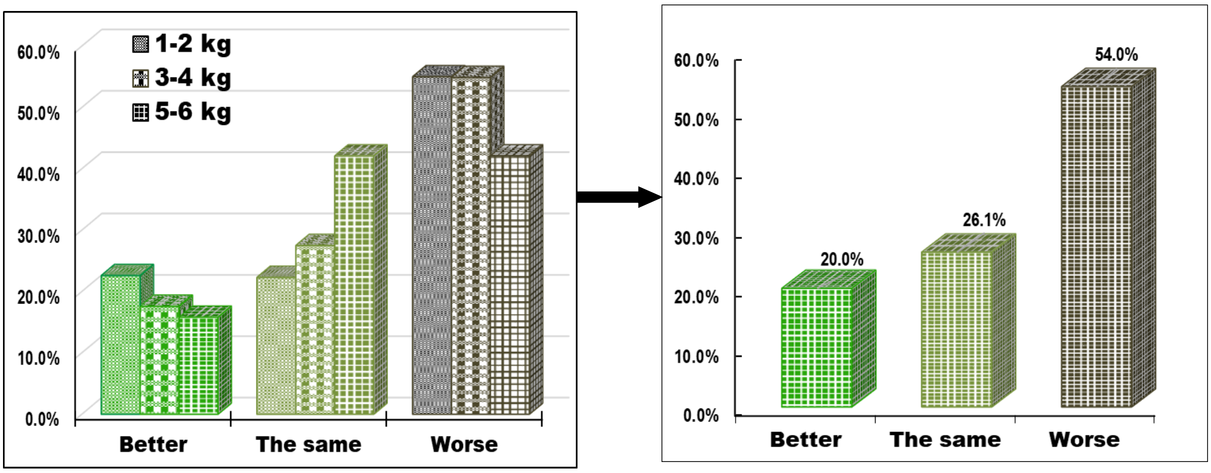


Figure 4.21 Waste quantity & environmental quality description by community members
(Author's findings, 2018)

Contribution of waste types to environmental degradation

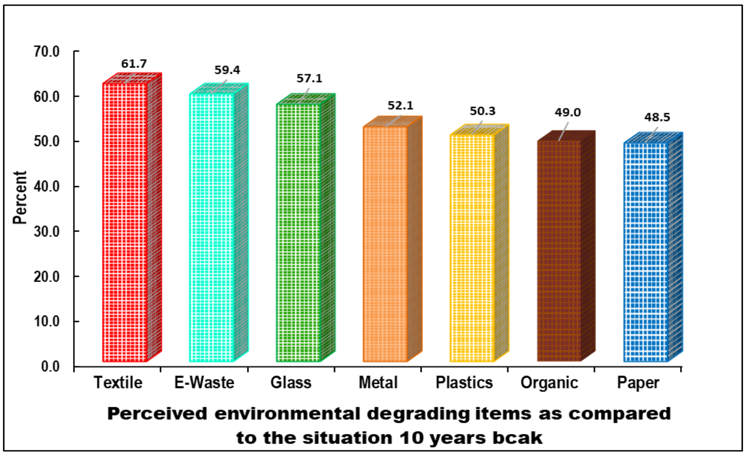


***Figure 4.22a Perceived contribution of waste types to environmental degradation*.**
N.B. Processed using Multiple Response Analysis (MRA) counting and aggregating technique.
(Author's findings, 2018)

Figure 4.22a shows that textiles contribute most (61.7%) to the degradation of the environment as waste pickers are not interested in sorting for textiles at landfills partly because they are dirty, and soaked in different liquids especially by the rains. Worthy to note is that Nigeria produces, and imports huge quantities of cheap textile from China, as well as bales of second-hand textiles from the USA and Europe. For instance, in 2017, Nigerians spent about two trillion Naira on imported clothing alone (Sangotade, 2018). It is cheaper and easier to buy from the market than the tedious recovery process for reuse. Then the electrical/electronic waste items (59.4%), which even though are most valued, are also difficult to sort out and may involve harmful scattering or burning off of the unwanted parts to get the metal residue (Figure 4.22b).

Figure 4.22b Burning to retrieve copper/brass from E-waste
(Notice the fingers are damaged from burning and sorting)
(Photos Ache, 09.02.2017).

For broken glasses whose kilogram is just 10 Naira, they do not attract waste pickers mindful of the risk of injury, pain and eventual infection. Glass does not burn to reduce volume like other waste items and therefore constitute a nuisance to the society/environment. Metal (52.1%), together with aluminum as well as plastics (50.3%) are good recycling items, but the processes involved in the first two per the waste pickers before selling are many, time consuming and need supervision. For instance, metal or aluminum cans are sorted up, compressed/pressed (Figure 4. 22c) gathered, bundled, weighed before selling. These processes reduce the attractiveness of the items to the waste pickers. Thus, many of such items are left unattended to, which in turn contribute to environmental degradation. Food/organic waste (49.0%) and then paper/carton (48.5%) were perceived as contributing less to the degradation of the environment. The sorting of paper and plastics is less tedious and less time-consuming (Figure 4.22d).

Figure 4.22c Compression of empty gathered cans by waste sorters before selling.
(Photos Ache, 09.02.2017).

Figure 4.22d Sorting of Paper/carton and plastics.
(Photos Ache, 09.02.2017).

4.2.5 Research question three: To what extent does wealth affect environmental sustainability in Imo State, Nigeria?

Wealth in the context of this study was measured using occupation, monthly income and education. These parameters are usually considered while estimating the development index of people. Only income is however considered given the strong relationship between income and occupation and income and higher level of school attained as explained below. For this reason, in testing hypothesis, income will be used. Hence, we will first establish the relationship between education, major occupation and income, and establish how it is related to waste management and environmental sustainability.

As earlier mentioned, participants were diversified in their level of education and the mode was those with first university degree 31.6% (Table 4.5). The mode major occupation was business implying that inhabitants were dominantly into trading and commercial activities with a proportion of 38.1% (Table 4.6). The dominant share of participants earned less than 50,000 Naira per month (Table 4.7).

Table 4.29 Association between income and highest level of school attainment
(Author's findings, 2018)

Highest level of education	Stats	Monthly salary (in thousands of Naira ₦)								Total
		<50	51-100	101-150	151-200	201-250	251-300	301-350	>350	
No school certificate	n	32	14	0	0	0	0	1	0	47
	%	68.1%	29.8%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	100.0%
Primary (FSLC)	n	61	1	0	0	0	0	2	0	64
	%	95.3%	1.6%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	100.0%
JSCE	n	71	21	18	10	7	0	1	1	129
	%	55.0%	16.3%	14.0%	7.8%	5.4%	0.0%	0.8%	0.8%	100.0%
SSCE	n	278	76	23	16	11	9	11	26	450
	%	61.8%	16.9%	5.1%	3.6%	2.4%	2.0%	2.4%	5.8%	100.0%
Vocational certificate	n	79	30	18	3	0	0	2	2	134
	%	59.0%	22.4%	13.4%	2.2%	0.0%	0.0%	1.5%	1.5%	100.0%
First university degree	n	290	212	103	14	6	10	7	6	648
	%	44.8%	32.7%	15.9%	2.2%	0.9%	1.5%	1.1%	0.9%	100.0%
Master's degree	n	59	84	81	29	37	13	0	23	326
	%	18.1%	25.8%	24.8%	8.9%	11.3%	4.0%	0.0%	7.1%	100.0%
Ph.D.	n	9	12	0	12	14	10	16	32	105
	%	8.6%	11.4%	0.0%	11.4%	13.3%	9.5%	15.2%	30.5%	100.0%
Others	n	61	54	5	3	7	9	1	9	149
	%	40.9%	36.2%	3.4%	2.0%	4.7%	6.0%	0.7%	6.0%	100.0%
Total	n	940	504	248	87	82	51	41	99	2,052
	%	45.8%	24.6%	12.1%	4.2%	4.0%	2.5%	2.0%	4.8%	100.0%

Cramer's V: V=0.236; P=0.000.

While the highest quota of respondents who earned below 50,000 Naira were those who never went to school (68.1%) and primary school leavers (95.3%), those with the highest monthly income (more than 350,000 Naira) were holders of a Philosophy degree (30.5%), followed by those with a Master's degree with a much lower proportion of 7.1%. This implies that income increased significantly (P<0.05) with level of school attainment.

Table 4.30 Association between income and major occupation
(Author's findings, 2018)

Major occupation	Stats	Monthly income (in thousands of Naira)								Total
		<50	51-100	101-150	151-200	201-250	251-300	301-350	>350	
Farming	n	62	8	0	0	0	0	0	0	70
	%	88.6%	11.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Business	n	318	206	124	36	39	17	10	31	781
	%	40.7%	26.4%	15.9%	4.6%	5.0%	2.2%	1.3%	4.0%	100.0%
Teaching	n	241	91	11	2	6	0	0	0	351
	%	68.7%	25.9%	3.1%	0.6%	1.7%	0.0%	0.0%	0.0%	100.0%
Lecturing	n	3	0	15	15	26	11	14	26	110
	%	2.7%	0.0%	13.6%	13.6%	23.6%	10.0%	12.7%	23.6%	100.0%
Other civil services	n	114	173	79	23	10	14	10	33	456
	%	25.0%	37.9%	17.3%	5.0%	2.2%	3.1%	2.2%	7.2%	100.0%
Others	n	202	26	19	11	1	9	7	9	284
	%	71.1%	9.2%	6.7%	3.9%	0.4%	3.2%	2.5%	3.2%	100.0%
Total	n	940	504	248	87	82	51	41	99	2052
	%	45.8%	24.6%	12.1%	4.2%	4.0%	2.5%	2.0%	4.8%	100.0%

Cramer's V: V=0.268; P=0.000.

Mostly lecturers had a monthly income of more than 350,000 Naira with proportion of 23.6% while the second category were those in other civil services with a much lower proportion of 7.2% thus implying that income was significantly (P<0.05) associated with major occupation. The association between occupation and level of school attainment is obvious as lecturers are generally holders of a Ph.D. and to some extent a Master's degree.

Table 4.31 Association between highest level of education and major occupation
(Author's findings, 2018)

			Major occupation						Total
			Farming	Business	Teaching*	Lecturing	Other civil services	Others	
Highest level of school attainment	No school certificate*	n	9	23	7	0	5	3	47
		%	19.1%	48.9%	14.9%	0.0%	10.6%	6.4%	100.0%
	Primary (FSLC)	n	15	36	7	0	0	6	64
		%	23.4%	56.2%	10.9%	0.0%	0.0%	9.4%	100.0%
	JSCE	n	30	42	21	0	3	33	129
		%	23.3%	32.6%	16.3%	0.0%	2.3%	25.6%	100.0%
	SSCE	n	10	231	10	20	66	113	450
		%	2.2%	51.3%	2.2%	4.4%	14.7%	25.1%	100.0%
	Vocational certificate	n	0	81	7	0	29	17	134
		%	0.0%	60.4%	5.2%	0.0%	21.6%	12.7%	100.0%
	First university degree	n	6	178	204	0	213	47	648
		%	0.9%	27.5%	31.5%	0.0%	32.9%	7.3%	100.0%
	Master's degree	n	0	89	90	34	93	20	326
		%	0.0%	27.3%	27.6%	10.4%	28.5%	6.1%	100.0%
	Ph.D.	n	0	15	5	56	16	13	105
		%	0.0%	14.3%	4.8%	53.3%	15.2%	12.4%	100.0%
	Others	n	0	86	0	0	31	32	149
		%	0.0%	57.7%	0.0%	0.0%	20.8%	21.5%	100.0%
Total		n	70	781	351	110	456	284	2,052
		%	3.4%	38.1%	17.1%	5.4%	22.2%	13.8%	100.0%

*In countries like Cameroon or Nigeria, instructors of the Koran who had acquired only Islamic education are referred to as teachers. Some of them function as civil servants.

Ph.D. holders were mostly lecturers and logically could earn more while master's degree holders were mostly teachers or absorbed in other civil services. Those with a first university degree, though highly involved in business had a higher proportion of those engaged by other civil services as compared to primary, vocational training and those who had no school certificate.

4.2.6 Research hypothesis three: Wealth has no significant relationship with environmental sustainability in Imo State, Nigeria.

Model validation

The influence of wealth on environmental sustainability was appraised using Logistic Regression Model. All the indicators related to development index such as education, occupation, income and ability to pay for waste disposal were considered. All the cases were considered by the model making a percentage inclusion of 100. The variability explained by this model was significant (Omnibus Tests of Model Coefficients: $\chi 2=46.603$; P=0.000).

Table 4.31.1 Case-Processing Summary *(Author's findings, 2018)*

Unweighted Cases[a]		**N**	**Percent**
Selected Cases	Included in Analysis	2,051	100.0
	Missing Cases	1	.0
	Total	2,052	100.0
Unselected Cases		0	.0
	Total	2,052	100.0

Table 4.31.2 Omnibus Tests of Model Coefficients *(Author's findings, 2018)*

		Chi-square	df	Sig.
Step 1	Step	46.603	4	.000
	Block	46.603	4	.000
	Model	46.603	4	.000

The validity of the model is also supported by the Wald statistics (P<0.05) thus indicating that the effect of the predictors was significant. Conscious that the aggregate effect of the predictors was significant as indicated by the Wald statistics, it is important to determine if the predictors contributed significantly or not. The Likelihood Model test was used to determine the influence of individual predictors on environmental sustainability. This test equally revealed that the overall effect of the predictor was significant (P<0.05), and that all the four predictive indicators contributed significantly to environmental sustainability (P<0.05), thus rejecting the hypothesis here stated.

***Table 4.31.3 Log-Likelihood Ratio test depicting the influence of individual development index indicators on environmental sustainability** (Author's findings, 2018)*

Predictors	Score	df	Sig.
Highest level of school attainment	4.908	1	.027
Major occupation	31.148	1	.000
Monthly salary	3.503	1	.049
Would agree to pay fees for the waste bins to be emptied/depots to be cleared	11.266	1	.001
Overall Statistics	45.441	4	.000

When controlled for each other as depicted by the Wald statistics, only two variables surfaced as the significant predictors of environmental sustainability, thus confirming their impact. These indicators are major occupation and willingness to pay for waste disposal (P<0.05). This could be explained by the strong association between monthly income and major occupation as well as highest level of school attainment and major occupation. This entails major occupation is as a result of level of education attained and income as a result of major occupation, thus justifying why the effect of the other two are adsorbed by major occupation in the model.

***Table 4.31.4 Wald Test depicting the influence of development index indicators controlled for each other on environmental sustainability** (Author's findings, 2018)*

Predictors	B	S.E.	Wald	df	Sig.	Exp (B)
Highest level of school attainment	.032	.022	2.114	1	.146	1.032
Major occupation	.182	.035	26.517	1	.000	1.200
Monthly salary	.040	.030	1.774	1	.183	1.040
Would agree to pay fees for the waste bins to be emptied /depots to be cleared	-.380	.124	9.422	1	.002	.684
Constant	.968	.295	10.762	1	.001	2.633

***Table 4.32.1 Association between major occupation and environmental sustainability** (Author's findings, 2018)*

Major occupation	Stats	Overall, how would you rate the quality of the environment in the State as compared to it about 10 years' back?		Total
		Improvement	No improvement	
Farming	n	17	53	70
	%	24.3%	75.7%	100.0%
Business	n	221	559	780
	%	28.3%	71.7%	100.0%
Teaching	n	97	254	351
	%	27.6%	72.4%	100.0%
Lecturing	n	12	98	110

	%	10.9%	89.1%	100.0%
Other civil services	n	75	381	456
	%	16.4%	83.6%	100.0%
Others	n	48	236	284
	%	16.9%	83.1%	100.0%
Total	n	470	1,581	2,051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.145; P=0.000.

Statistically, more business people 221 (28.3%) maintained that the quality of the State's environment has improved, followed closely by teachers (27.6%) and next by farmers (24.3%). The least category of persons was those involved in lecturing (10.9%) (Figure 4.23a). Since there is a significant relationship between education and major occupation, those with a broader educational background have a better understanding of environmental sustainability components than business persons, some teachers in nursery, primary and secondary schools as well as farmers.

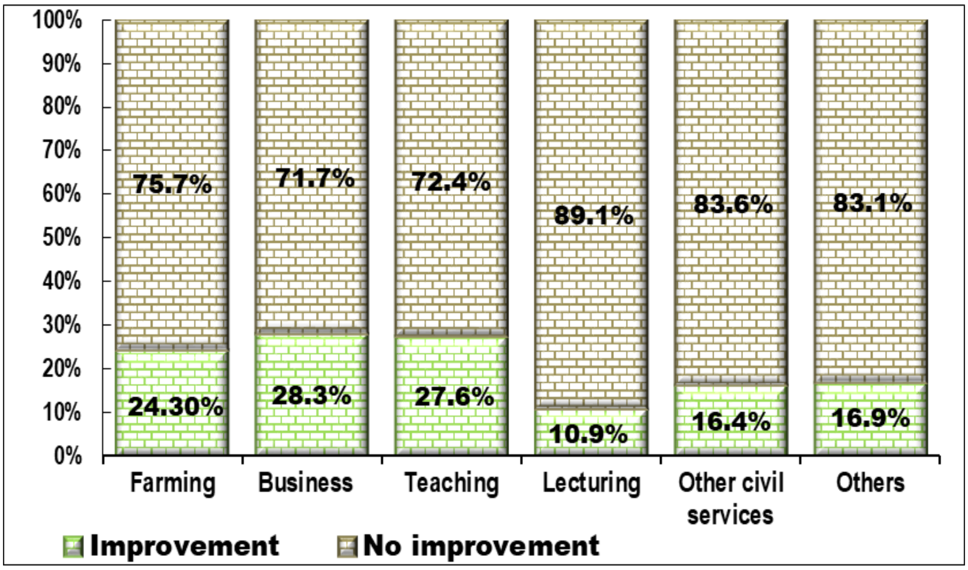


Figure 4.23a Link between environmental description and major occupation
(Author's findings, 2018)

***Table 4.32.2 Association between willingness to pay for waste disposal and environmental sustainability** (Author's findings, 2018)*

Would you agree to pay fees for the waste bins to be emptied /depots cleared?	**Stats**	**Overall, how would you rate the environmental quality of the State as compared to it about 10 years' back?**		**Total**
		Improvement	**No improvement**	
Yes	n	108	490	598
	%	18.1%	81.9%	100.0%
No	n	362	1091	1453
	%	24.9%	75.1%	100.0%
Total	n	470	1,581	2,051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.074; P=0.001.

Only 18.1% (Figure 4.23b) of those who agreed to pay for waste disposal maintained that the State's environment has improved, meanwhile a cross-sectional 77.1% of the population upheld that the State's environment has not improved (Table 4.32.2).

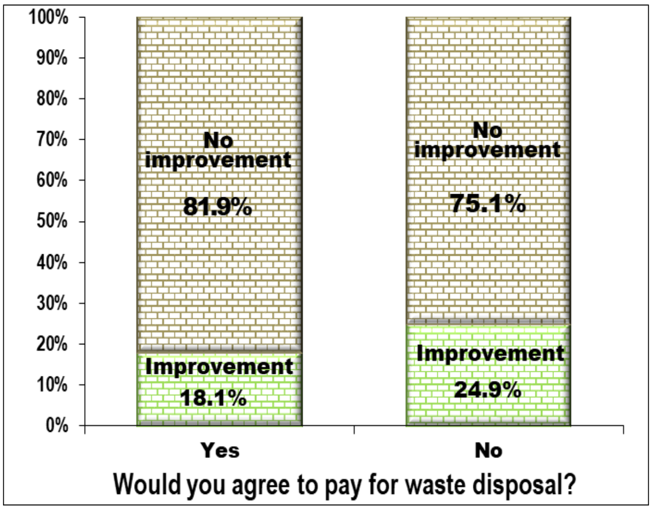


***Figure 4.23b Link between willingness to pay for waste disposal and environmental rating** (Author's findings, 2018)*

Table 4.32.3 Association between monthly income and environmental sustainability
(Author's findings, 2018)

Monthly income (in Naira)	Stats	Overall, how would you rate the environmental quality of the State as compared to it about 10 years' back?		Total
		Improvement	No improvement	
Below 50,000	n	221	718	939
	%	23.5%	76.5%	100.0%
51,000-100,000	n	127	377	504
	%	25.2%	74.8%	100.0%
101,000-150,000	n	52	196	248
	%	21.0%	79.0%	100.0%
151,000-200,000	n	25	62	87
	%	28.7%	71.3%	100.0%
201,000-250,000	n	10	72	82
	%	12.2%	87.8%	100.0%
251,000-300,000	n	6	45	51
	%	11.8%	88.2%	100.0%
301,000-350,000	n	9	32	41
	%	22.0%	78.0%	100.0%
Above 350,000	n	20	79	99
	%	20.2%	79.8%	100.0%
Total	n	470	1,581	2,051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.080; P=0.066.

Figure 4.23c shows the pictorial form of the information presented on Table 4.32.3.

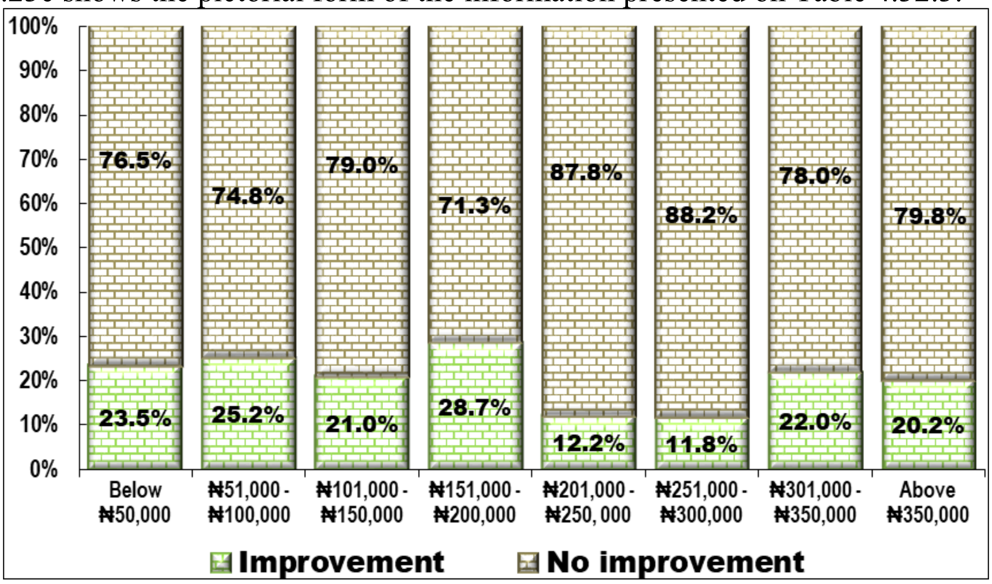


Figure 4.23c Link between monthly income and environmental rating
(Author's findings, 2018)

***Table 4.32.4 Association between highest level of school attainment and environmental sustainability** (Author's findings, 2018)*

Highest level of school attainment	Stats	Overall, how would you rate the environmental quality in the State as compared to it about 10 years' back?		Total
		Improvement	No improvement	
No school certificate	n	22	25	47
	%	46.8%	53.2%	100.0%
Primary (FSLC)	n	19	45	64
	%	29.7%	70.3%	100.0%
JSCE	n	46	83	129
	%	35.7%	64.3%	100.0%
SSCE	n	102	347	449
	%	22.7%	77.3%	100.0%
Vocational certificate	n	39	95	134
	%	29.1%	70.9%	100.0%
First university degree	n	135	513	648
	%	20.8%	79.2%	100.0%
Master's degree	n	48	278	326
	%	14.7%	85.3%	100.0%
Ph.D.	n	22	83	105
	%	21.0%	79.0%	100.0%
Others	n	37	112	149
	%	24.8%	75.2%	100.0%
Total	n	470	1,581	2,051
	%	22.9%	77.1%	100.0%

Cramer's V: V=0.150; P=0.000.

Figure 4.23d presents a pictographic description of the information displayed on Table 4.32.4.

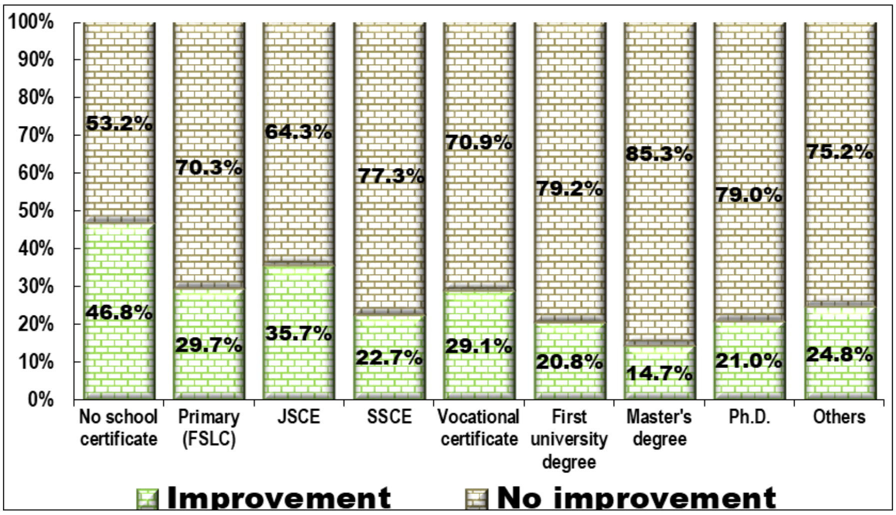


Figure 4.23d Link between educational level and environmental rating
(Author's findings, 2018)

By examining these three cross-tabulations in synchronization, we realize that farmers perceived improvement the most, the same with the least educated which were mostly farmers, while those with income above 200,000 Naira perceived improvement lesser than those with income less than 200,000 Naira. In the same line, those that will not agree to pay for waste disposal, which were mostly those with low income perceived improvement more. This paradox could be explained by the fact that those with low educational background might not have the aptitude to really comprehend changes in the environment or cannot be as critical as those who had gone further in their education and were more aware or could appreciate indicators of environmental sustainability better. Though this hypothesis is statistically accepted, it shall be nuanced in its interpretation.

Table 4.33 Relationship between quantity of waste produced (in kg) and income (in Naira)
(Author's findings, 2018)

Monthly salary	N	Mean	Median	Minimum	Maximum
Below 50,000	264	2.6	1.5	1.5	5.5
51,000-100,000	188	2.7	3.5	1.5	5.5
101,000-150,000	118	2.8	3.5	1.5	5.5
151,000-200,000	23	2.7	1.5	1.5	5.5
201,000-250,000	48	2.3	1.5	1.5	5.5
251,000-300,000	26	2.5	2.5	1.5	3.5
301,000-350,000	13	2.9	1.5	1.5	5.5
Above 350,000	42	2.8	3.5	1.5	5.5
Total	722	2.7	3.5	1.5	5.5

Kruskal Wallis Test: H=7.276; P=0.401

The amount of waste generated was not dependent on income (P>0.05). It was almost the same, ranging from 2.3 kg in average for those with income 201,000 - 250,000 Naira to 2.9 kg for those with income 301,000 – 350,000 Naira.

4.2.7 Research question four: What are the effects of employment and poverty reduction opportunities pertaining to waste management on environmental sustainability in Imo State, Nigeria?

Amount of waste items sorted by waste pickers per day (kg)

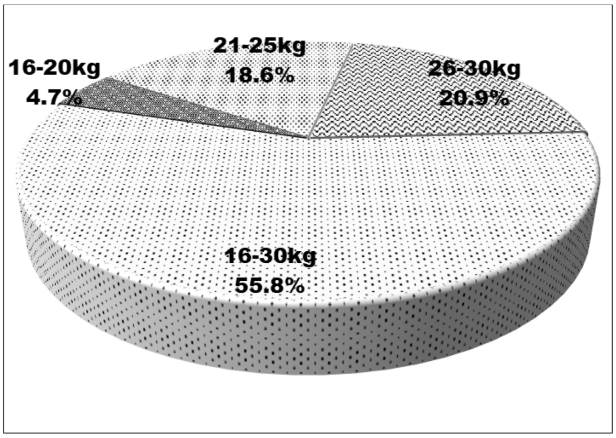


Figure 4.24a Average amount of sorted waste per day (Kg)
(Author's findings, 2018)

While most waste pickers variably sorted between 16 to 30 kg (55.8%) of waste per day, 20.9% of them sorted 26 to 30 kg, 18.6% sorted 21 to 25 kg while 4.7% sorted 16 to 20 kg. As already established (Figure 4.19), all waste pickers gathered paper, plastics, aluminum, metal and E-waste while a strong majority sorted for textile and other waste types. These items are sold or used by the waste pickers. The Table below depicts the prices of items.

Table 4.34.1 Prices of sorted items *(Author's findings, 2017)*

Waste items	Price/kg
Glass pieces (broken)	10 Naira
Paper/carton	10 Naira
Textile	10 Naira
Plastics/rubber	20 Naira
Metal/iron	30 Naira
Aluminium	200 naira
Copper/brass (E-waste)	800-1400 Naira*

*E-waste per the waste pickers is copper/ brass wire. According to them, these are the most expensive waste items, they are very difficult to come by and the price fluctuates with the Dollar/Naira exchange rate. When the Dollar rises, the price per kilogram rises. For instance, in January 2017, a kilogram was 800 Naira but by 2nd week of February, it rose to 1,400 Naira.

These items are recycled to produce ornaments like earrings, rings, bracelets and necklaces. Unbroken glass bottles are sold between 5-50 Naira at the site. (1€ = 323 ₦ in February, 2017).

Employment and ability of waste sorting and trading to sustain livelihood

The employment and ability of waste sorting to sustain livelihood was obvious as all the waste pickers did not have second jobs besides waste sorting, and, at the same time acknowledged that the money from sorting waste as sole job is enough. They generally earned between 1500-2000 Naira per day. Waste pickers generally liked their job with a proportion of 93.9% while only 6.1% claimed they did not like it. The waste traders on their part maintained that they earned between 12,000 and 20,000 Naira per week; and that this sum was enough to cater for their families since all of them were married with children (Table 4.34.2).

Belong to an organization, group or association of waste pickers

The waste pickers generally belonged to a waste pickers' association with proportion of 84.8%. The Association was SUA – Imo Scrap Union Association and this association was not (yet) registered at the Local or State government. The association had three major objectives: to protect the interest of its members; render physical and financial help to members; and to be our brothers' keeper.

Challenges and remedies

The waste pickers maintained that they experienced bites/attacks from insects and animals, health crises, injuries and accidents as well as theft of their gathered items from onsite residents, particularly the Muslim youths. As remedies to these problems, they suggested that the government should provide safety wears like strong shoes, strong/protective clothes, gloves and something to cover their nostrils. The Muslim waste pickers (five of them) who did not belong to the SUA maintained as set back that, they were being accused as waste thieves since they live and work at the site. To improve waste sorting, the waste pickers appeal to the government to provide crushing or recycling machines at or near the site, while the union members pleaded that the government provides means of securing their sorted materials at the site against theft.

4.2.8 Research hypothesis four: Employment and poverty reduction opportunities pertaining to waste management have no significant relationship with environmental sustainability in Imo State, Nigeria.

Waste sorting to the waste dealers was a full time employment. Some of the waste pickers emphasized that waste sorting sustained their families (43%) while some upheld that it is the sole alternative to earn a living (16%). A reasonable proportion maintained that it is cheaper and easy, as they needed no capital to start up (23%) (Figure 4.24b). Some were happy to be freelance workers as they explained: (*"I am the Oga*[47]*at the top of my job and I can do what I want and come any time").* Waste sorting has many potentials to contribute in sustaining environmental conservation in Imo State, Nigeria; it also contributes in adding value to waste and reducing pollution. Should the waste pickers work full time and are satisfied with their income, and then they are most likely to continue sorting waste items. Thus reducing environmental degradation and the depletion of resources, while contributing to their own socio-economic development, that of the State and that of the country. Based on this analysis, the hypothesis here stated is rejected.

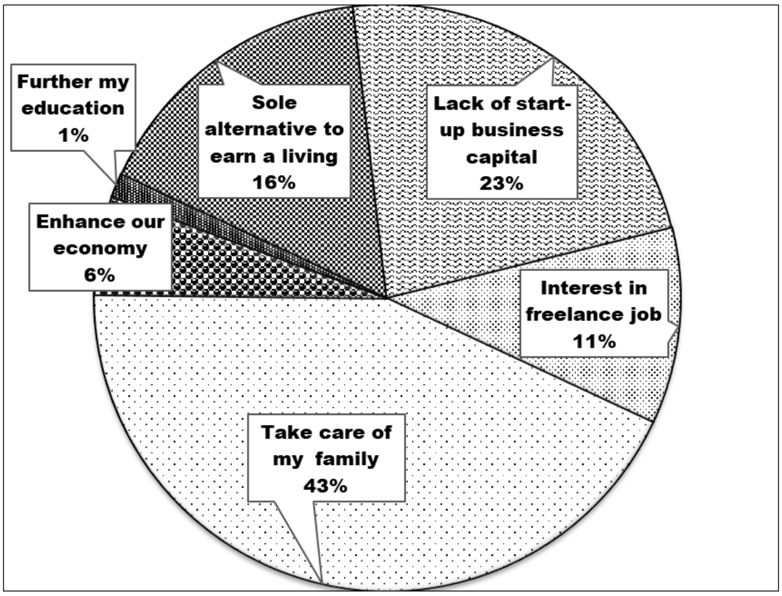


Figure 4.24b Reasons given by waste pickers for choosing waste sorting.
(Author's findings, 2018)

[47] The word *'Oga'* is used in Nigeria and its environs to mean chef, employer, senior, boss, master/manager, sir, husband or someone in position of authority.

Waste traders

Table 4.34.2 Characterization of waste traders (buying and selling)
(Author's findings, 2018)

State of origin	Duration in trade	Marital status	Nº of Child-ren	Another job	Enough for u & family	Earning per week (in Naira)	Items bought	Price per kg
Anambra	2013	Married	3	No	Yes	15 - 20,000	Glass bottles, bras/copper, plastic/rubber, paper/carton, metals/ aluminium	Same as bought
Anambra	2013	Married	2	No	Yes	12 - 18,000	√	√
Imo	2014	Married	4	No	Yes	12 - 20,000	√	√
Imo	2014	Married	5	No	Yes	15 - 20,000	√	√
Imo	2014	Married	3	No	Yes	12 - 20,000	√	√

The waste traders were married, had no other job and had children. They traded in glass bottles, bras/copper, plastic/rubber, paper/carton, metals/aluminum and textile between Owerri, Onitsha and Lagos. The waste traders maintained that the job was lucrative as they could cater for their families and needs at their pace. They further stressed that they also recovered many items from the trade, which were still in good state, and, this to them was very important because such items they claimed were stronger and more durable than new ones. This according to them was because such items have stood the test of time (Personal communication, 10 February 2017).

Some of the sorted materials and their market outlets include:

- Plastics: they are supplied to companies producing plastic seats, canopies, tables, cups, plates, cutlery, trays, etc. in Onitsha
- Paper and carton: they are supplied to paper and book producing companies both in Owerri and Onitsha
- Brass/copper with metal: to companies producing jewelry
- Aluminum: companies producing aluminum items like zinc and pots
- Undamaged glass and plastic bottles are supplied to the companies that produce the content of these products. However, individuals buy these undamaged sorted glass and plastic bottles and clandestinely produce the contents.

It is worthy to note that the picking, recovery, sorting or reclaiming of materials from waste has been proven beneficial to the economy, the municipality and the environment. The waste pickers in South Africa, because of their contribution to waste management, cleanliness and enhancement of the environment, impelled the Minister of the Department of Environmental Affairs to formally recognize the country's more than 62,000 registered waste pickers in 2016 (Chamane, 2016). Also, the waste pickers at one of the biggest E-waste landfills in the world – Agbobloshie in Accra, Ghana, with an internationally registered waste picker group – Sarbah and Ablekuma (Global Alliance of Waste Pickers, 2011), who retrieve and sell recyclables also contribute to their livelihood and the sustenance of the environment. The lucrativeness and the employability of waste picking can be seen from the works of WIEGO and GAWP (Global Alliance of Waste Pickers, n.d.). The latter maintains that since waste pickers collect, sort and process recyclable materials, such services create an estimated 15 million jobs worldwide as well as contribute energy and natural resource conservation.

4.2.9 Research question five: To what extent does waste disposal affect environmental sustainability in Imo State, Nigeria?

Frequency at which the nearest public bins are emptied/depots are cleared

Household level

Table 4.35 Frequency at which the nearest public bins are emptied/depots are cleared as perceived at household level *(Author's findings, 2018)*

How often are the nearest public bins emptied/waste depots cleared?	Frequency	Percent	Cumulative percent
Once a week	511	24.9	24.9
Twice a week	211	10.8	35.7
Daily	3	0.1	35.8
Once a month	28	1.4	37.2
Never	3	0.1	37.3
Not fixed	83	4.0	41.4
Don't know	1,182	57.6	99.0
Others (non-specified)	21	1.0	100.0
Total	2,052	100.0	

There was no clear-cut dominant frequency at which community members perceived that the nearest public bins were emptied or the waste depots cleared. The mode was once a week with a proportion of 24.9%. This implies waste collection/evacuation was/is not a standardized regular exercise at the three sites. This situation is unlike in Würzburg city where waste collection/evacuation is regular following a waste pick-up calendar and carried out by *'Die Stadtreiniger'*.

School level

Primary and secondary institutions of learning generally did not take their waste to the nearest public bins/ waste depots; and for the few that did so, all of them stated twice a week.

Shops' level

Table 4.36 Frequency at which the nearest public bins are emptied/ waste depots are cleared as perceived by shop attendants/owners *(Author's findings, 2018)*

How often are the nearest public bins emptied/waste depots cleared?	Frequency	Percent	Cumulative percent
Once a week	66	24.3	24.3
Twice a week	13	4.8	29.0
Rarely	00	00	29.0
Once a month	00	00	29.0
Never	0	00	29.0
Not fixed	0	00	29.0
Don't know	136	50.0	79.0
Other (non-specified)	57	21.0	100.0
Total	272	100.0	

A dominant share of shop attendants did not know how often the public bins were emptied or the disposal sites cleared; while cumulatively, only 29.0% could give a tangible response. One part 24.3% stated once a week and the other 4.8% twice a week.

Apparent state of public bins

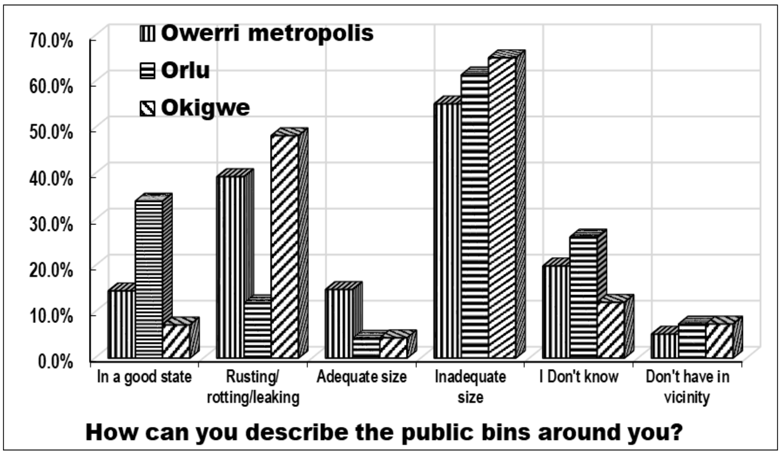
Household level

Table 4.37 Perceived state of public bins by households, comparing among study sites *(Author's findings, 2018)*

Apparent state of public bins by households	Stats	Study sites			Total
		Okigwe	Orlu	Owerri metro.	
In good state/condition	n	38	184	144	366
	%	7.2%	34.1%	14.6%	
Rusting/rotting/leaking	n	255	65	388	708
	%	48.3%	12.0%	39.4%	
Adequate size	n	23	23	147	193
	%	4.4%	4.3%	14.9%	
Inadequate size	n	344	332	543	1,219
	%	65.2%	61.5%	55.2%	
Don't know	n	64	142	197	403
	%	12.1%	26.3%	20.0%	
Don't have a bin in the neighbourhood	n	39	40	51	130
	%	7.4%	7.4%	5.2%	
Total		528	540	984	2,052

Cramer's V: V=0.274; P=0.000

The variation in the perceptions of the nature of public bins between the study sites was significant (P<0.05). The population at the study sites mostly mentioned that public bins had inadequate sizes with proportions of 65.2% in Okigwe, 61.5% in Orlu and 55.2% in Owerri metropolis. Orlu visibly had more public bins in good state with a proportion of 34.1% as compared to 14.6% in Owerri metropolis and 7.2% in Okigwe. Figure 4.25a illustrates these differences.



N=2,052

Figure 4.25a Households' description of public waste bins per site
(Author's findings, 2018)

Shops

Shop attendants/owners as well remarked that public bins were inadequate in size with a proportion of 71.3%, rusting, rotting and/or leaking (45.6%) while only 29.4% maintained that they were in good state and 8.5% stated they had adequate size. Figure 4.25b illustrates this.

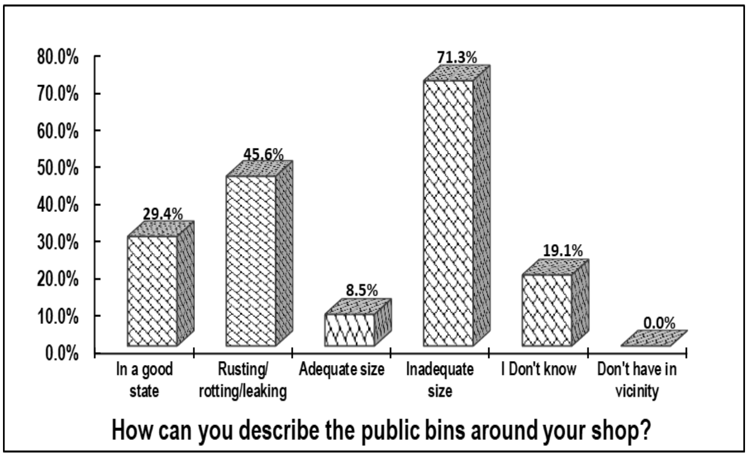


Figure 4.25b: Description of public bins by shop attendants
(Author's findings, 2018)

Even though households and shops both underscored that the public bins around their precincts were of inadequate sizes (Figure 4.25c), the latter had a higher proportion (71.3%) against 60.6% for the former. Hence, the population mostly described public waste bins to be inadequate in size (66.0%) while 39.4% endorsed that the waste bins were either rusting, leaking and/rotting. Only some 24.0% stated that the waste bins were in a good state while 8.2% expressed that the bins had adequate sizes (Figure 4.25c). Some (3.3%) did not have waste bins in their vicinity and so could not describe.

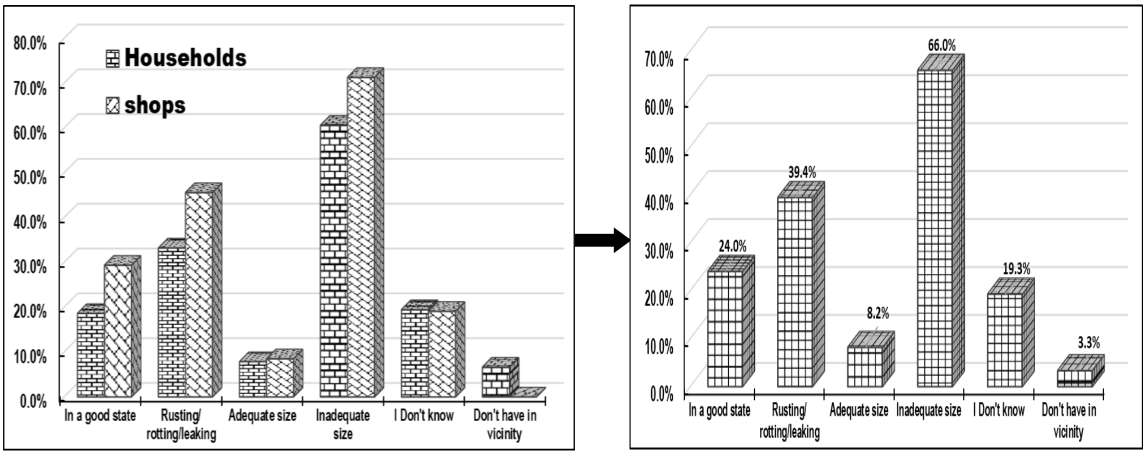


Figure 4.25c Population's description of public waste bins
(Author's findings, 2018)

Willingness to pay for waste disposal

Households generally were not ready (70.9%) to pay for the clearance of waste disposal sites or public waste bins to be emptied (Table 4.37). Those in Owerri metropolis were significantly ($P<0.05$) more willing to pay for waste bins to be emptied/disposal sites cleared with proportion of 35.0%. This proportion is high compared to 25.0% in Orlu and 22.5% for Okigwe.

Table 4.38 Households' willingness to pay for waste bins to be emptied/depots cleared: comparing among study sites *(Author's findings, 2018)*

Willingness to pay for waste disposal	Stats	Would you agree to pay fees for the waste bins to be emptied/depots cleared?		Total
		Yes	No	
Okigwe	n	119	409	528
	%	22.5%	77.5%	100.0%
Orlu	n	135	405	540
	%	25.0%	75.0%	100.0%
Owerri metropolis	n	344	640	984
	%	35.0%	65.0%	100.0%
Total	n	598	1,454	2,052
	%	29.1%	70.9%	100.0%

Cramer's V: V=0.124; P=0.000.

Schools

Almost half of the schools (46.2%) maintained that they regularly payed for their waste evacuation to the State Corporation named ENTRACO in amount ranging from 12,000 to 30,000 Naira per term. Out of the schools that paid waste evacuation levy, a proportion of 77.8% alleged that the amount was high.

Table 4.39 Schools' perception of amount paid for waste evacuation *(Author's findings, 2018)*

Is the amount paid for waste evacuation high?	Frequency	Percent	Valid Percent
Yes	14	35.9	77.8
No	4	10.3	22.2
Total	18	46.2	100.0
System	21	53.8	
Total	39	100.0	

Shops

Table 4.40 Shops' willingness to pay for waste bins to be emptied/depots cleared: comparing amongst study sites *(Author's findings, 2018)*

Study sites	Stats	Would you agree to pay fees for the waste bins to be emptied/ depots cleared?		Total
		No	Yes	
Owerri metropolis	n	54	68	122
	%	44.3%	55.7%	100.0%
Orlu	n	56	26	82
	%	68.3%	31.7%	100.0%
Okigwe	n	59	9	68
	%	86.8%	13.2%	100.0%
Total	n	169	103	272
	%	62.1%	37.9%	100.0%

Cramer's V: V=0.361; P=0.000.

Less than half (37.9%) of shop owners/attendants were willing to pay for waste evacuation. Just as households, the willingness of the shop attendants/owners to pay for waste evacuation was significantly higher in Owerri metropolis (55.7%), than in Orlu (31.7%) and in Okigwe (13.2%). Traders in Owerri metropolis had perhaps learnt from the *'2016 Independence day waste saga'* along Douglas Road whose odour chocked a young asthmatic patient in commuter tricycle to his death earning it a derogatory 'Garbage capital' label (Njoku C. I., 2016). The different population strata were not willing to pay for the public bins to be emptied or disposal sites to be cleared off (Figure 4.26). Not even all the schools accepted to pay as only 46.2% effectively paid for waste evacuation from their premises.

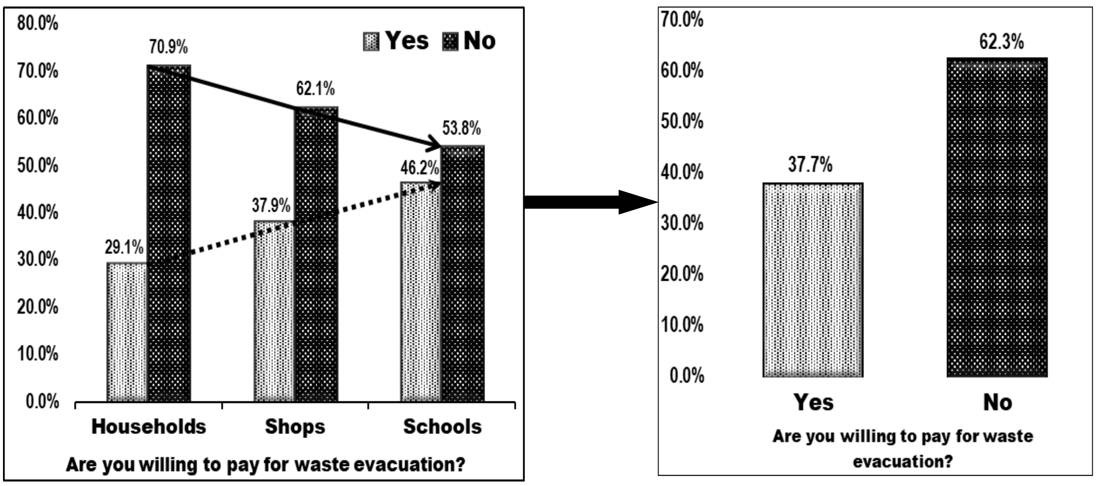


Figure 4.26 Population's willingness to pay for waste evacuation.
(Author's findings, 2018)

Neighbourhood perception of the waste disposal system challenge

Some 76.9% (Table 4.41) of the households accepted that the waste disposal system in the neighbourhood was a challenging issue.

Table 4.41 Waste disposal manner identified as a challenge: comparing among study sites *(Author's findings, 2018)*

Study sites	Stats	Do you think the waste disposal manner is a problem in your neighbourhood?		Total
		Yes	No	
Okigwe	n	449	79	528
	%	85.0%	15.0%	100.0%
Orlu	n	442	98	540
	%	81.9%	18.1%	100.0%
Owerri metropolis	n	688	296	984
	%	69.9%	30.1%	100.0%
Total	n	1,579	473	2,052
	%	76.9%	23.1%	100.0%

Cramer's V: 0.163; P=0.000

Though majority of households maintained that the waste disposal method was a challenging issue, it was observed to be significantly ($P<0.05$) less pronounced in Owerri metropolis with a proportion of 69.9% as compared to 85.0% in Okigwe and 81.9% in Orlu.

Disposal manner perceived as problem in the market

Table 4.42 Waste disposal manner perceived as challenging by shop owners: comparing among study sites *(Author's findings, 2018)*

Study sites	Stats	Do you think the waste disposal manner is a problem at the market square?		Total
		No	Yes	
Owerri metropolis	n	18	104	122
	%	14.8%	85.2%	100.0%
Orlu	n	10	72	82
	%	12.2%	87.8%	100.0%
Okigwe	n	7	61	68
	%	10.3%	89.7%	100.0%
Total	n	35	237	272
	%	12.9%	87.1%	100.0%

Cramer's V: 0.055; P=0.663

Even 85.2%, 87.8% and 89.7% for Owerri metropolis, Orlu and Okigwe respectively of shop owners/attendants had almost the same level ($P>0.05$) of dissatisfaction at the three study sites. Meanwhile, all the schools maintained that the (adopted) waste disposal manner at their various institutions is not a challenge. This entails 82.0% of the population was grossly dissatisfied with the waste disposal system within their various spheres of influence.

Evaluating the system of waste collection in the neighbourhood

Table 4.43: Households' evaluation of waste collection in their respective vicinities: comparing among study sites *(Author's findings, 2018)*

Study sites	Stats	How is the waste collection system in your neighbourhood?				Total
		Good	Fair	Not good	Don't know	
Okigwe	n	26	55	385	62	528
	%	4.9%	10.4%	72.9%	11.7%	100.0%
Orlu	n	36	96	346	62	540
	%	6.7%	17.8%	64.1%	11.5%	100.0%
Owerri metropolis	n	226	159	501	98	984
	%	23.0%	16.2%	50.9%	10.0%	100.0%
Total	n	288	310	1,232	222	2,052
	%	14.0%	15.2%	60.0%	10.8%	100.0%

Cramer's V: 0.191; P=0.000

Though at all the sites it was generally maintained that the system of waste collection in the neighbourhood was not good, the problem was significantly less pronounced in Owerri metropolis with a proportion of 50.9%, Orlu 64.1% than Okigwe 72.9%. This is because Imolites have adopted different ways of disposing waste and since they do not want these items in their spheres of influence any longer i.e., the '*not-in-my-back-yard'* (*NIMBY)* syndrome that has deteriorated to the '*not-in-my-house'* (*NIMH)* syndromes. Imolites practice fly-tipping and flying toilet in disposing of waste.

Evaluation of the system of waste collection in the market

Table 4.44: Shop owners' evaluation of waste collection system in the market
(Author's findings, 2018)

Study sites	Stats	How is the system of waste collection in the market?			Total
		Fair	Not good	Don't know	
Owerri metropolis	n	28	78	16	122
	%	23.0%	63.9%	13.1%	100.0%
Orlu	n	20	54	8	82
	%	24.4%	65.9%	9.8%	100.0%
Okigwe	n	15	45	8	68
	%	22.1%	66.2%	11.8%	100.0%
Total	n	63	177	32	272
	%	23.1%	65.1%	11.8%	100.0%

Cramer's V: 0.033; P=0.962

Shop attendants/owners had almost the same level (P>0.05) of dissatisfaction at the three study sites as far as the system of waste collection at the markets was concerned with a dissatisfaction rate of 63.9%, 65.9% and 66.2% for Owerri metropolis, Orlu and Okigwe respectively. A majority of households (60.0%) against only 14.0% maintained that the system of waste collection in their various neighbourhoods was not good (Figure 4.27a). This was same for the majority of the shop attendants/owners (65.1%) while just 23.2% perceived it as fair (Figure 4.27a). The population generally retained that the waste collection system was not good (Figure 4.27b).

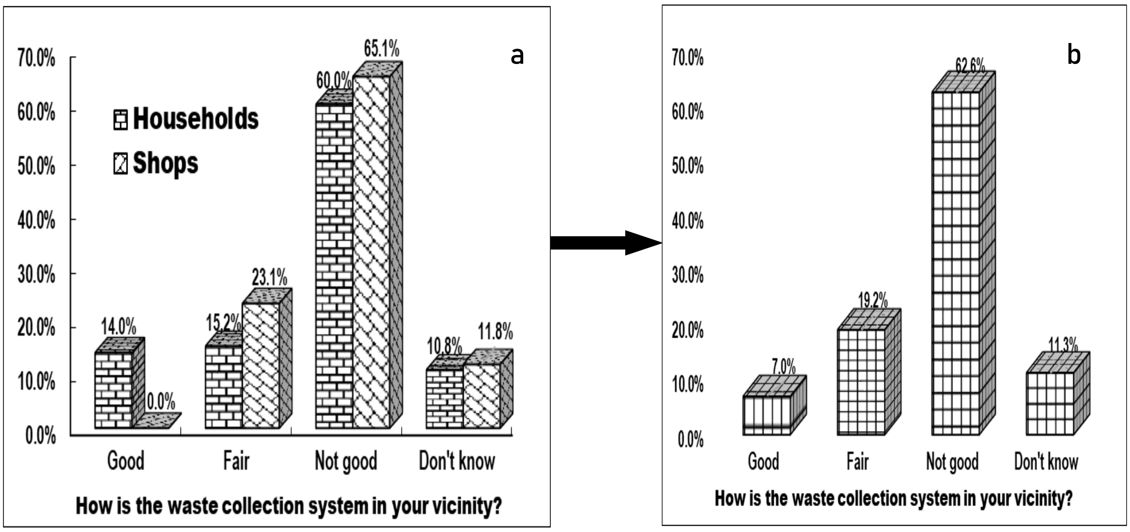
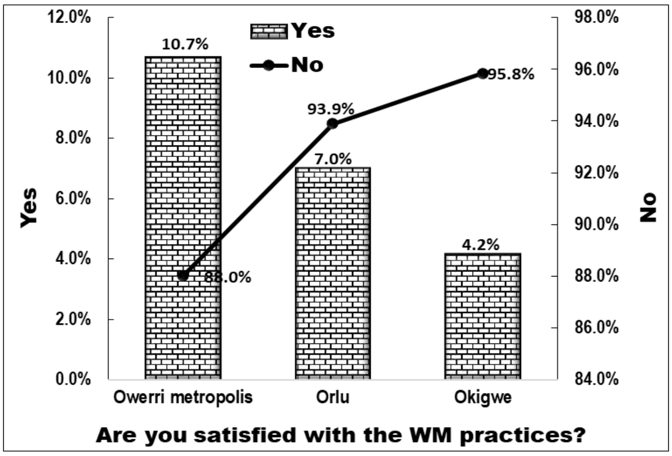


Figure 4.27 Population's description of the waste collection system
(Author's findings, 2018)

Appraisal of the waste management practices

Households were generally dissatisfied with the state of waste management (WM) with a proportion of 92.2%. This rate of dissatisfaction tends to escalate from the heart of the State (Owerri metropolis) to the smaller towns of Orlu and Okigwe. (Figure 4.28). All the shop owners/attendants were dissatisfied with the state of waste management at the markets and commercial areas.



N=2,050

Figure 4.28 Households' appraisal of the waste management practices
(Author's findings, 2018)

Containers in which waste is collected at generation points

Table 4.45 Containers in which waste is collected: comparing among households, schools and shops *(Author's findings, 2018)*

Types of container	Households		Schools		Shops	
	n	%	n	%	n	%
Plastics (bags)	1,249	60.9	39	100.0	145	53.3
Old bucket	135	6.6	16	41.0	20	7.4
Tin/Can	55	2.7	3	7.7	8	2.9
Old bag	177	8.6	0	0.0	64	23.5
Carton	24	1.2	19	48.7	51	18.8
Others	5	0.2	10	25.6	6	2.2
Total	2,052		39		272	

Plastics were mostly used in the temporary collection of waste with proportions of 60.9% for households, 100% for schools and 53.3% for shops complying with findings of Mangundu et al. (2013), Nyanzou & Jerie (2014), Tsiko & Togarepi (2012) who noted that the use of plastic bags for temporary waste collection as common phenomenon in towns of Sub-Saharan Africa.

This finding also justifies the large amount of littering with plastics along streets and roads of the city, propagated by 'fly-tipping' and 'flying toilets', the free use of plastic shopping bags and the high production of paper waste by the residents. The types of old bags used include used bags of rice, beans, flour, wheat, semolina, '*walkie-talkie bags or sacks & motto and Ghana-must-go bags'*[48] and old travelling bags. Figure 4.29a indicates high proportion use of cartons in schools (48.7%) as against 1.2% and 18.8% respectively for households and shops perhaps because pedagogic and other school materials are supplied mostly in cartons and; and so rather than discard them, they are reused for waste collection until they are thorn. The more use of old buckets in schools as temporal waste collection containers is perhaps due to the fact that many schools do not have a ready and steady water supply system. Hence, the school management acquires many buckets to fetch water. When these buckets are no longer usable for water fetching (their original purpose), they are not thrown away, rather they are used to collect waste (secondary use). Figure 4.29b presents plastics as the most used type of waste collection container by Imolites perhaps because it is very light, buoyant and easily portable.

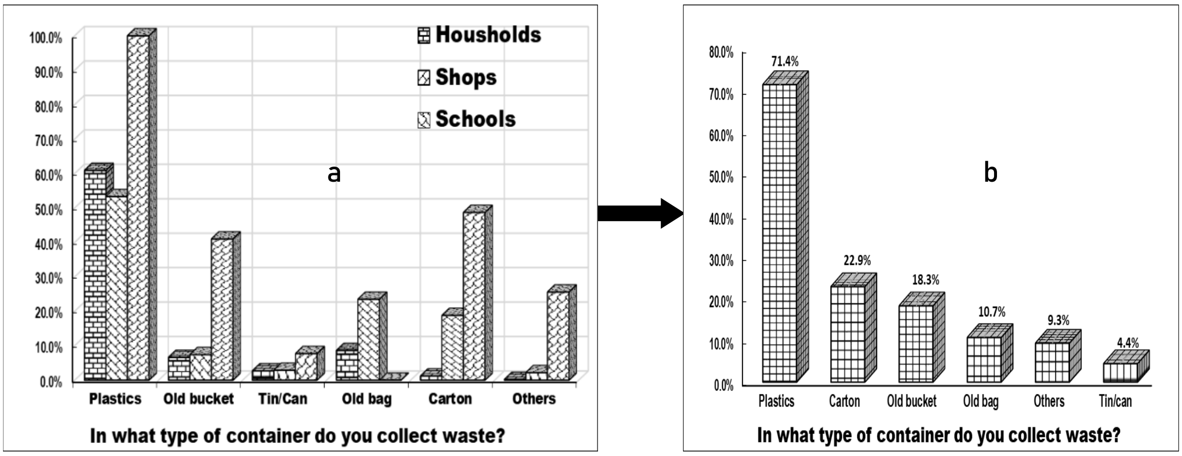


Figure 4.29 Population's waste collection containers

(Author's findings, 2018)

A discussion with the hotel managers and the Chairman of Nigerian Hotels Association (NHA) - Imo State Chapter, revealed that hotels and guesthouses use plastic bags (25 litres) bought from Imo ENTRACO for waste collection. This further increases the use of plastics in waste collection. Unfortunately, the quantity or frequency of purchase and use of these bags by the

[48] These are bags used for shopping, packaging, travelling and storage at home, offices and other establishments. The bags are barely durable as they easily tear off. Hence, they end up bad after a very short while, even at the point of purchase. Since they cannot just be 'thrown away' after first use or just after buying, they are reused as waste collection containers across the population and end up the waste collection points and at the landfill.

hotels was not hitherto noted as explained by the interviewees. Worthy to note is the aspect that the use of these containers – old buckets, tins/cans, old bags, cartons and the plastic shopping bags are all forms of material reuse or waste use. Their 'new' uses were not the primary intention of/at production (time); they only assumed the second function after the primary functions have been fulfilled (per Bontoux & Leone, 1997).

Frequency at which waste containers are emptied

Household level

Table 4.46.1 Frequency at which households emptied waste containers
(Author's findings, 2018)

How often do you empty your waste container?	Frequency	Percent	Cumulative Percent
Daily	426	20.8	20.8
Two times a week	327	15.9	36.7
Weekly	1,019	49.7	86.4
When filled	10	0.5	86.8
Others	270	13.2	100.0
Total	2,052	100.0	

Households emptied their waste containers mostly weekly (49.7%).

Table 4.46.2 Frequency at which households emptied waste containers: per study sites.
(Author's findings, 2018)

Study sites	Stats	How often do you empty your waste container?					Total
		Daily	Two times a week	When filled	Weekly	Others	
Okigwe	n	83	63	5	341	36	528
	%	15.7%	11.9%	0.9%	64.6%	6.8%	100.0%
Orlu	n	99	59	0	331	51	540
	%	18.3%	10.9%	0.0%	61.3%	9.4%	100.0%
Owerri metropolis	n	244	205	5	347	183	984
	%	24.8%	20.8%	0.5%	35.3%	18.6%	100.0%
Total	n	426	327	10	1,019	270	2,052
	%	20.8%	15.9%	0.5%	49.7%	13.2%	100.0%

Cramer's V: V=0.205; P=0.000.

At the study sites, less than the majority of households emptied their waste containers more than once a week. The cumulative proportion of households that emptied their waste containers two times a week was 27.6% in Okigwe, 29.2% in Orlu and 45.6% in Owerri metropolis, being the highest and this difference was significant. Meanwhile in all the schools, waste containers were emptied daily.

Shops

Table 4.47.1 Frequency at which shops emptied waste containers *(Author's findings, 2018)*

How often do you empty your waste container?	Frequency	Percent	Cumulative Percent
Daily	151	55.5	55.5
Twice a week	28	10.3	65.8
Thrice a week	20	7.4	73.2
Weekly	57	21.0	94.2
When filled	11	4.0	98.2
Others	5	1.8	100.0
Total	272	100.0	

Shops mostly emptied their waste containers daily with a proportion of 55.5% and cumulatively, 73.2% emptied their waste containers three times a week.

Table 4.47.2 Frequency at which waste containers are emptied by shops per study sites *(Author's findings, 2018)*

Study sites	Stats	How often do you empty your waste container?						Total
		Daily	Twice a week	Thrice a week	Weekly	When filled	Other	
Owerri metropolis	n	61	17	11	21	7	5	122
	%	50.0%	13.9%	9.0%	17.2%	5.7%	4.1%	100.0%
Orlu	n	62	4	6	10	0	0	82
	%	75.6%	4.9%	7.3%	12.2%	0.0%	0.0%	100.0%
Okigwe	n	28	7	3	26	4	0	68
	%	41.2%	10.3%	4.4%	38.2%	5.9%	0.0%	100.0%
Total	n	151	28	20	57	11	5	272
	%	55.5%	10.3%	7.4%	21.0%	4.0%	1.8%	100.0%

Cramer's V: V=0.267; P=0.000.

In Owerri metropolis, some 72.9% of the shops cumulatively emptied their waste containers at least thrice a week; this proportion was 87.8% in Orlu and 55.9% in Okigwe being the lowest. Waste containers in hotels/guesthouses are knotted and kept at a (waste) corner within the hotel premises but are sorted up by IWMA or ENTRACO trucks after a phone call weekly.

Waste disposal options after temporal collection and storage by Imolites

This item was designed to find out how Imolites dispose of waste after collection in the households, shops, offices, hotels, markets, schools, etc. This could follow the Würzburg city example where waste generation points have a well-constructed/defined temporary storage area within each premise for the waste bins. These areas are modelled in a way to shield the waste bins from direct sun's rays, rain and snow. They are also kept away from the living area to avoid any possible odour or insects (especially in summer). Following a waste calendar, these waste bins are sorted up and emptied by the waste services' department of *'die Stadtreiniger'*. On such days, the waste bins are brought out by the residents and placed by the road for easy pick-up and emptying. In addition, the population brings out waste bins before pick-up time. Thus, waste pick-up is an organized exercise in Würzburg city.

Household level

Table 4. 48 Waste disposal options by households per study sites *(Author's findings, 2018)*

Method/place of waste disposal	Stats	Study sites			Total	χ2-test
		Okigwe	Orlu	Owerri Met.		
Into public bin/at a communal disposal site	n	204	203	569	976	χ2=249.13
	%	10.3%	15.1%	43.7%		P<0.001
By a water body	n	46	37	36	119	χ2=0.46
	%	2.3%	2.8%	2.8%		P=0.795
In a pit in own compound	n	140	91	79	310	χ2=0.59
	%	7.1%	6.8%	6.1%		P=0.744
Thrown into a bush/ on the farmlands	n	282	269	173	724	χ2=12.50
	%	14.3%	20.0%	13.3%		P=0.002
Into the refuse collection vehicle	n	62	77	156	295	χ2=42.56
	%	3.1%	5.7%	12.0%		P=0.000
By the road or street	n	286	150	118	554	χ2=10.33
	%	14.5%	11.2%	9.1%		P=0.006
Collected by cart pushers	n	33	46	81	160	χ2=18.54
	%	1.7%	3.4%	6.2%		P=0.000
On an open space	n	152	99	49	300	χ2=13.88
	%	7.7%	7.4%	3.8%		P=0.001
Burnt	n	773	370	41	1,184	χ2=326.41
	%	39.1%	27.6%	3.1%		P=0.000

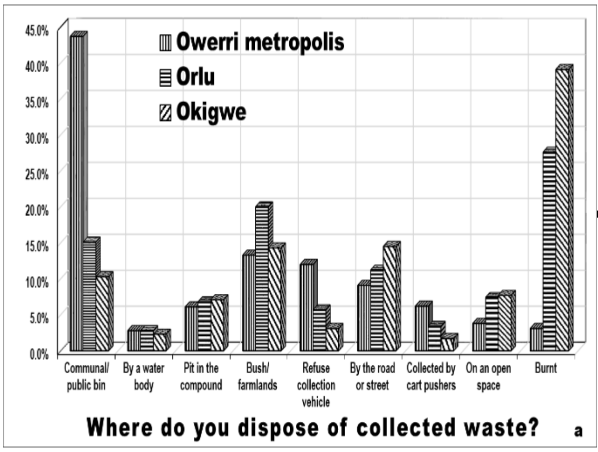
Table 4.48 indicates that most households in Okigwe (39.1%) and in (Orlu 27.6%) burnt waste, followed by those in Orlu who mostly threw waste into the bush and/or on the farmlands (20.0%). Households in Okigwe also tipped-off waste by the roads/streets (14.5%) as well as into the bushes and/or on farmlands (14.3%). Figure 4.30 shows waste dump along the road and street. In Owerri metropolis, waste was mostly deposited at the communal disposal sites and/or into the public bins with proportion of 43.7%, followed by those who tipped-off waste

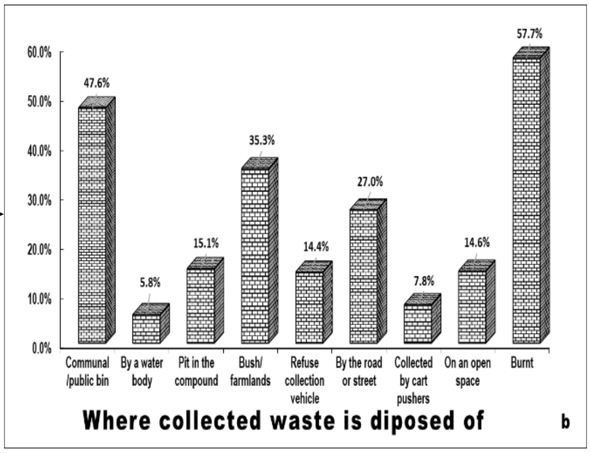
into nearby bushes and/or on farmlands (13.3%) as well as those who made use of the refuse collection trucks (12.3%).

Figure 4.30a Fly-tipping along Enugu-Umuahia road, Okigwe.
(Photo Ache, 07.02.2017)

Figure 4.30b Waste dump along Douglas Street, Owerri.
(Photo Ache, 13.02.2017)

Table 4.48 also denotes a low percentage use of refuse collection vehicles: 12.0%, 5.7% and 3.1% respectively for Owerri metropolis, Orlu and Okigwe sites. This setback is also shared by Magundu et al. (2013). They expressed that instead of the needed 120 waste trucks in Harare city, only 33 are being used. Meanwhile, this is the main method of waste evacuation/disposal in Würzburg city as the waste collection vehicles ply every street and household to pick-up waste. Owerri metropolis has only fourteen garbage trucks (Table 3.4) offering pick-up services to over one million inhabitants on a surface area of 104km^2 (NPC, 2006). This explains the low percentage of the services of the refuse collection vehicles vis-à-vis households (Figure 4.31a). It is apparent that households in Owerri metropolis made use of the communal disposal sites and/or public bins more than their counterparts at the other two study sites (Figure 4.31b). This outcome also implies if the waste bins are available, Imolites will make use of them.





N =2,052

Figure 4.31 Households' waste disposal options

(Author's findings, 2018)

Imolites also most often tipped-off waste on patches of unprotected vegetation and farmlands, burnt waste openly, practices that are illegal in Würzburg city. Figure 4.31b displays that generated waste is mostly burnt (57.7%). Besides making use of communal disposal sites and/public waste bins (which is the right thing to do), Imolites mostly practiced fly-tipping traits.

School level

Schools generally burnt waste within the school premises (79.5%) (Figure 4.32a) after school hours. These institutions also emptied their waste containers in a pit within the school compound (46.2%), some 17.9% got their waste picked up by the refuse collection vehicle, 15.4% at the communal disposal sites and/or public bin and 2.6% got their waste collected by cart pushers. The Federal Girls' Government College, - FGGC Owerri, Girls Secondary School - GSS Ikenegbu and Maria Assumpta Cathedral Nursery and Primary School all in Owerri metropolis have a temporary waste collection/storage corner within the compound where the garbage is stored until the ENTRACO vehicle comes (Figure 4.32b). In Claret Academy, while the Primary section has a pit to dump waste, the Secondary section has built metal rectangular tanks/containers to burn waste (Figure 4.32c).

Figure 4.32a Schools' waste disposal options
(Author's findings, 2018)

Figure 4.32b Waste corner at FGGC, Owerri. ***Figure 4.32c Waste burning in school.***
(Photos Ache, 27.01.2017)

A positive remark about these institutions is their complete avoidance of fly-tipping traits: dumping by a valley or water body, throwing of waste into bushes and/or on farmlands, dumping by the road or street as well as dumping on an open space. Open burning of waste by these institutions is the most used method of waste treatment as seen on Figure 4.32a, an act that is prohibited in Germany and other in European countries.

Shop level

*Table 4.49 **Waste disposal options of shops per study site*** *(Author's findings, 2018)*

Method of waste disposal	Stats	Study sites			Total
		Owerri m.	Orlu	Okigwe	
At the communal disposal site/ into public bins	n	98	49	42	189
	%	21.5%	16.6%	16.4%	
By a valley or water body	n	0	21	24	45
	%	0.0%	7.1%	9.4%	
In a pit at the market area	n	6	13	8	27
	%	1.3%	4.4%	3.1%	
Thrown into the bush/ on the farmlands	n	28	38	18	84
	%	6.1%	12.8%	7.0%	
Into the refuse collection vehicle	n	28	19	15	62
	%	6.1%	6.4%	5.9%	
By the road or street	n	109	30	37	176
	%	23.9%	10.1%	14.5%	
Collected by cart pushers	n	78	39	13	130
	%	17.1%	13.2%	5.1%	
On an open space	n	57	32	51	140
	%	12.5%	10.8%	19.9%	
Burnt	n	52	55	48	155
	%	11.4%	18.6%	18.8%	

Shop attendants in Owerri metropolis (23.8%) dispose of their waste by the road and/or street and only 21.5% at the communal disposal sites and/or into public bins, compared to Orlu (16.6%) and Okigwe (16.4%). Traders in Okigwe tipped-off waste on open spaces (19.9%) and burnt some (18.8%) like their counterparts in Orlu (18.8%) more than those in Owerri metropolis (11.4%). A depiction of waste disposal options of shops is seen on Figure 4.33a.

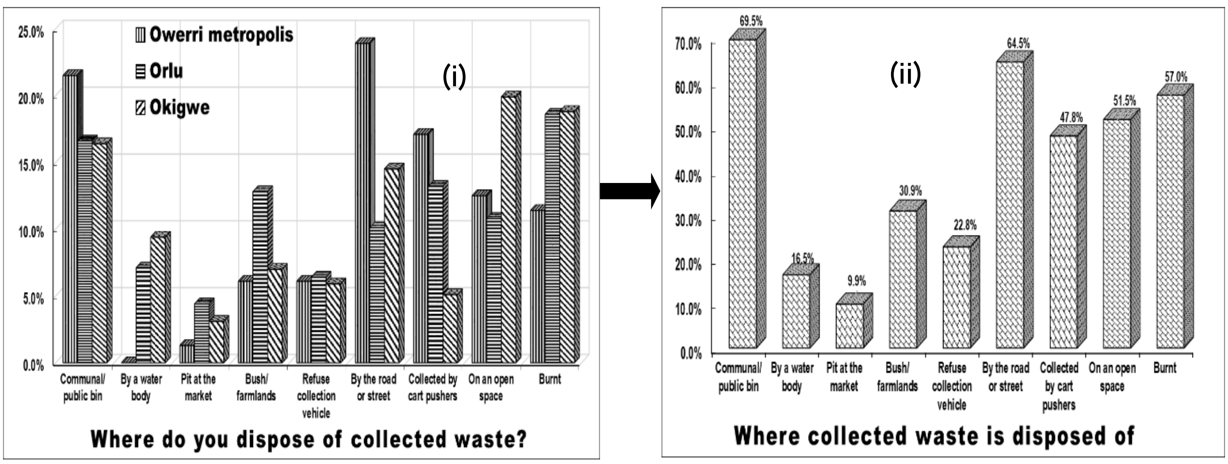


Figure 4.33a Shops' waste disposal options.
(Author's findings, 2018)

Shop owners/attendants (Figure 4.33a (ii) for a strong majority emptied their waste containers at the communal disposal sites and/or into public bins with a proportion of 69.5% and tipped-off waste by the road or street (64.5%). Imolites also burnt their waste (57.0%), dumped waste on an open space (51.5%) as well as got their waste collected by cart pushers 47.8%. Some however tipped-off waste into the bush/on the farm 30.9%, emptied waste into the refuse collection vehicle (22.8%), threw waste by a valley or water body (16.5%) and in a pit in the market area (9.9%).

The frequent use of the streets/roads as waste dumping ground by Imolites in Owerri metropolis (Figure 4.33a (i) among other reasons can be attributed to the site of the markets/commercial areas. The markets in Owerri metropolis are situated along major and busy roads in the city, especially the Owerri main market. Known as *Eke-Ukwu* or *Eke-Unuwa (pronounced Ekenuwa)*, the Owerri market, one of the most popular markets in the south-east geo-political zone is located along the busiest and most commercial avenue (Douglas road/street) in the State. In addition, its location at the heart of the State and closeness to the shortest roads linking the State's neighbouring Abia, Anambra, Ebonyi, Enugu and Rivers States make it an outstanding hub and beehive of activities with one of the outstanding results being waste materials dumped along the A6 (Douglas) Federal road. Also, popular and very busy streets engulfed by the market which include Rotibi Street, School Road, Christ Church Street, Njemanze Street, Njeribeakor Street, Tetlow Street and Onuwa Street from where the market derived its pseudonym *'Eke-Onuwa'* are also known for their nefarious activities among which waste material heaps are outstanding.

Rotibi Street for instance is made popular by the location of virtually all the branch offices of the nation's newspapers and warehouses of goods in the State; major dealers of provisions also operate within this street. School Road, the most popular stretch in the market is renowned for the sales of imported second-hand clothing (and some small household items like plates, pots, cutlery, cosmetic items, etc.) popularly referred to as *'OK'*, *'Okrika' or 'Tokumbo' or 'Toks'*. These wears and items in some cases are so bad that they cannot be used/sold again, so, the traders simply dump them on the streets, especially when the wears are soaked by the rains. Njamanze and Njeribeakor Streets are noted for hair-dressing and cosmetic activities which leave behind heaps of synthetic fibre commonly referred to as 'weave-on', 'mesh, 'wool, 'attach' or 'extensions'.

The Douglas road itself is illustrious for the display of commodities especially the early morning (from 5.00am) commerce of perishables and grains as well as other food items from neighbouring villages, which leave the Street with huge heaps of organic garbage on a daily basis. Hence, activities in and around *Eke-Ukwu* start as early as 5.00am and last for at least thirteen (13) hours. A market therefore with no official or legal system of temporal waste collection and evacuation leaves the commuters with no other option than to get the waste out of their shops/side or sight and dump it at/on the next available space. This custom or reaction dwindles to a deleterious swing of the Sub-Saharan waste management argot *NIMBY syndrome* to *NIMH or 'not-in-my-shop-syndrome' – NIMH syndrome.* This is because the waste oodles can be behind or anywhere near the house or shop but not inside the shop or house where people live and carry out their chores.

The ever-visible oodles of garbage along Douglas Street which reached its pinnacle on October 1st 2016[49] (Figure 4.33b), an aspect that gave the State the new appellation 'Gold to dunghill' (Onyekakeyah, 2013) and 'Garbage capital'(C. I. Njoku, 2016), a situation which pushed the traders to say it is the State government's move to force them to relocate (Punch, 2016b). These negative traits, together with other repugnant activities along this Street intensified the Imo State government's vigour to relocate the market, an action that met stout resistance resulting to property destruction, injuries and loss of lives in August 2017 (Nkwopara et al., 2017; Olowolagba, 2017; Punch, 2017). All these resulted to more waste (especially construction and demolition waste) at the heart of the city/State.

Figure 4.33b Tons of waste on Douglas road on October 1, 2016.
(Photo retrieved from Punch, 2016a)

[49] Huge heaps of waste were abandoned on the middle of Douglas Road between 26 September 2016, which was last Saturday of the month (Clean-up day) until October 3, 2016: the nation's Independence Day celebration – October 1.

One can conclude that Imolites more frequently practice the disastrous act of open waste burning (Figure 4.33c (ii). Even though Nigeria has an Environmental Protection Law contained in Chapter II, Section 20 of its 1999 Constitution 'that Nigeria shall protect and improve the environment and safeguard the water, air, land, forest and wildlife of the country'(*Nigeria's Constitution*, 1999, p. 16), backed by a Criminal Code to punish defaulters, the population still dumps waste by the valley and water bodies, by the roads and on the streets, on open spaces and even throw some into bushes and farms (vegetation) as seen on Figure 4.33c. Though Adeoye O. A. (2018) and Nwufo (2010) maintained that the Environmental Law was a good attempt on environmental legislation, its enforcement through arrest and securing conviction to serve as a deterrent to others have not been achieved despite the awareness of existence of this law.

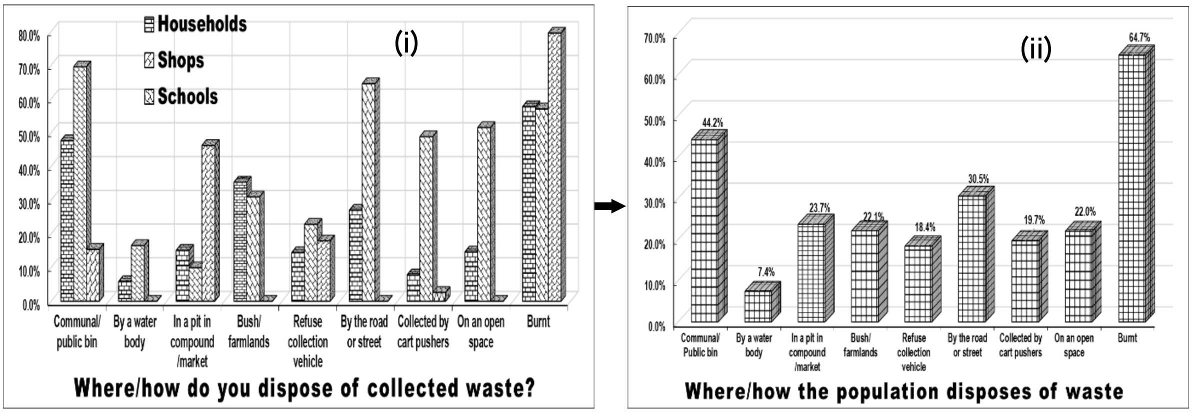


Figure 4.33c Population's waste disposal options
(Author's findings, 2018)

While Triassi et al. (2015) outlined land deterioration, ground and surface water pollution as well as poor air quality as environmental impacts of illegal waste disposal, Shrader-Frechette (1993) in her book enumerated the technical shortcomings of permanent geological disposal of high-level radioactive wastes. The lack of savvy with long-term isolation and the arduousness of knowing geological features and the developments at the great depths and over the long time periods required, the claim of the impossibility of assuring the isolation of the wastes underground and the dead of hundreds of people in rad-waste accidents (Shrader-Frechette, 1993, pp. 3-4). Koe et al. (2001) maintained that the smoke from biomass open burning is reported to be a cause of the recurring transboundary haze problem in Southeast Asia as well as (Kim et al., 2015; Permadi & Kim Oanh, 2013) endangers the population and environment exposed to such smoke. Black R. et al. (2012), Fiedler (2007), Kanabkaew & Kim Oanh (2011), Thuy et al. (2011) and T. T. Zhang et al. (2011) asserted that open waste burning is the most significant source of generating Persistent Organic Pollutants – POPs in developing countries. Gullett et al. (2010), Hedman et al. (2005), Solorzano-Ochoa et al. (2012) and M. Zhang et al. (2017) also substantiated that open waste burning or uncontrolled combustion such as 'backyard burning of waste' in many countries is the dominant source of polychlorinated dibenzodioxins, dibenzofurans and biphenyls (PCDD/PCDF/PCB). However, Collet & Fiani (2006), Gullett et al. (2010), Hedman et al. (2005), Ikeguchi & Tanaka (1999), Lemieux et al. (2003, 2004) and T. T. Zhang et al. (2009) observed that even in developed and industrialised countries there is significant combustion of domestic waste in open piles, barrels, fireplaces, household heating stoves and/or primitive incinerators. Hence, waste burning in Imo State, though rampant, is not limited to this geographical area.

Pupils and students in their institutions played an important role in the waste management process: they gathered waste and conveyed it to respective areas or dump them in the holes. This was noted by all the respondents (head teachers in these institutions); and, these pupils/students are either late comers, students on punishment or generally during (manual) labour, which is observed weekly in all schools. Besides this, and, in nursery and primary schools, the gardener, security/gate man/men also conveyed the waste to their dumping grounds. In Owerri metropolis, 15% of the schools indicated they made use of public bins and these were placed five-ten minutes' walk from the school premises; this duration was the same noted in Orlu (4%) and in Okigwe (9%). While the waste evacuation vehicle picks up the waste twice weekly from schools in Owerri metropolis, it does so once weekly at the Orlu and Okigwe sites.

Time at which waste bins are emptied

This item was introduced to ascertain at what time(s) Imolites usually take away their collected waste from their properties to empty/dump them at the available sites. This is because for any meaningful planning and sustainable waste management process to be implemented in this study area, the stakeholders should be versed with the times the inhabitants like/wish to empty their waste containers after collection and temporal storage at generation points.

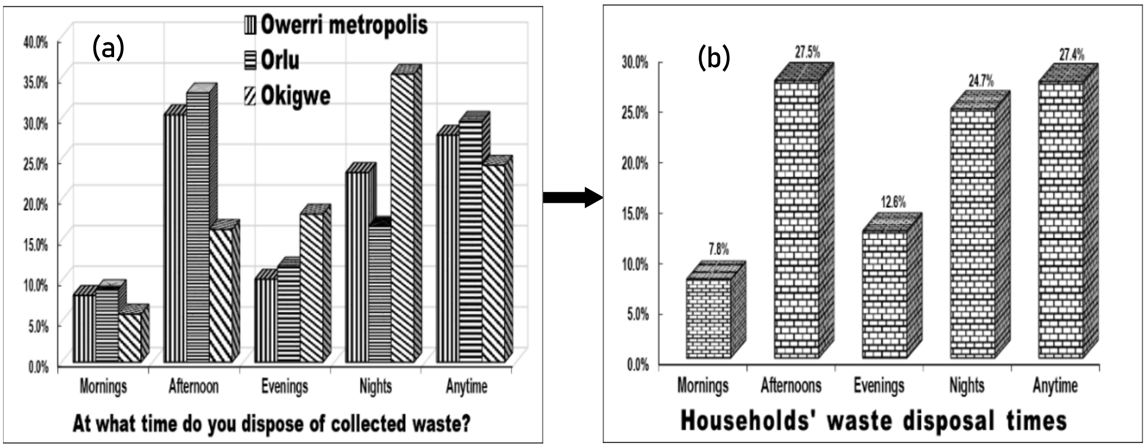
Household level

Table 4.50 When households emptied waste bins: comparing among study sites
(Author's findings, 2018)

Study sites	Stats	When collected waste is taken to disposal site					Total
		Mornings	Afternoons	Evenings	Nights	Anytime	
Okigwe	n	31	86	96	187	128	528
	%	5.9%	16.3%	18.2%	35.4%	24.2%	100.0%
Orlu	n	48	179	63	90	160	540
	%	8.9%	33.1%	11.7%	16.7%	29.6%	100.0%
Owerri metropolis	n	81	299	100	229	275	984
	%	8.2%	30.4%	10.2%	23.3%	27.9%	100.0%
Total	n	160	564	259	506	563	2,052
	%	7.8%	27.5%	12.6%	24.7%	27.4%	100.0%

Cramer's V: V=0.154; P=0.000.

Periods at which waste containers were taken away and emptied differed significantly among the three study sites (P<0.05). While Imolites in Orlu (33.1%) and in Owerri metropolis (30.4%) mostly conveyed their waste bins for emptying in the afternoons, in Okigwe this was done mainly at nights (35.4%). Figure 4.34a illustrates these variations.



N=2,052
Figure 4.34 When households conveyed waste to disposal sites.
(Author's findings, 2018)

There was no clear demarcated period when households emptied their waste containers. However, they mostly disposed of collected waste in the afternoons as seen on Figure 4.34b.

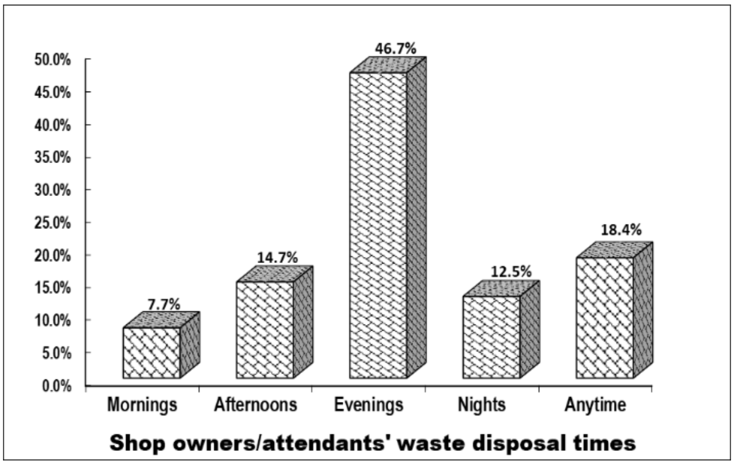
Shop level

Table 4.51 When shops emptied waste bins: comparing among study sites
(Author's findings, 2018)

Study sites	Stats	Time at which collected waste is taken away from shop					Total
		Mornings	**Afternoons**	**Evenings**	**Nights**	**Anytime**	
Owerri metropolis	n	6	11	70	14	21	122
	%	4.9%	9.0%	57.4%	11.5%	17.2%	100.0%
Orlu	n	9	13	32	11	17	82
	%	11.0%	15.9%	39.0%	13.4%	20.7%	100.0%
Okigwe	n	6	16	25	9	12	68
	%	8.8%	23.5%	36.8%	13.2%	17.6%	100.0%
Total	n	21	40	127	34	50	272
	%	7.7%	14.7%	46.7%	12.5%	18.4%	100.0%

Cramer's V: V=0.233; P=0.063.

There was no Significant time difference of waste disposal for the shop owners/attendants among the study sites; whereby collected waste was mostly disposed of in the evenings with proportions of 57.4%, 39.0% and 36.8% for Owerri metropolis, Orlu and Okigwe respectively. At all the study sites, shops hardly threw their waste in the mornings. Figure 4.35 presents a collective time period during which shop owners/attendants mostly emptied their waste bins.



N=272

Figure 4.35 Times at which shop owners/attendants emptied their waste containers
(Author's findings, 2018)

Shop owners/attendants mostly dispose of collected waste in the evenings (46.7%). This is because when the market closes (officially at 6pm), they leave the premises with the waste container (mostly plastic as already established) and on their way home tipped them off either by the road/street, on an open space, in a bush/farm or in a hole.

Existence of approved disposal site(s) or public bin(s) near the house

The residents were asked if approved waste disposal sites (sites evacuated by the IWMA/ENTRACO trucks) or public bins were close to their houses (depending on the duration they took to get such places on foot). Some 70.89% of the population maintained that there were no public bins/ approved disposal sites near their houses.

Table 4.52 Existence of approved disposal sites or public bins near the house: comparing among study sites *(Author's findings, 2018)*

Study sites	Stats	Is there an approved disposal site or public bin near the house?		Total
		Yes	No	
Okigwe	n	119	409	528
	%	22.5%	77.5%	100.0%
Orlu	n	135	405	540
	%	25.0%	75.0%	100.0%
Owerri metropolis	n	344	640	984
	%	35.0%	65.0%	100.0%
Total	n	598	1,454	2,052
	%	29.1%	70.9%	100.0%

Cramer's V: V=0.124; P=0.000.

The non-existence of public bins/approved disposal sites near the house was significantly different amongst the sites. While Okigwe (77.5%) and Orlu (75.0%) noted the non-existence of such bins near the house, the proportion was significantly (P<0.5) lower in Owerri metropolis (65.0%).

Table 4.53 Time taken to get to the closest approved disposal site or public bin on foot: comparing amongst study sites *(Author's findings, 2018)*

Study sites	Stats	Time spent to carry waste to closest approved disposal site or public bin						Total
		5-10 minutes	11-15 minutes	16-20 minutes	21-25 minutes	26-30 minutes	Above 30 minutes	
Okigwe	n	26	29	27	37	196	213	528
	%	4.9%	5.5%	5.1%	7.0%	37.1%	40.3%	100.0%
Orlu	n	36	30	32	37	124	281	540
	%	6.7%	5.6%	5.9%	6.9%	23.0%	52.0%	100.0%
Owerri metropolis	n	225	70	34	16	286	353	984
	%	22.9%	7.1%	3.5%	1.6%	29.1%	35.9%	100.0%
Total	n	287	129	93	90	606	847	2,052
	%	14.0%	6.3%	4.5%	4.4%	29.5%	41.3%	100.0%

Cramer's V: V=0.214; P=0.000.

In Okigwe, 77.4% of the population spent more than 25 minutes to get to the closest approved disposal sites or public bin(s), 75.0% in Orlu and 65% in Owerri metropolis; though critical as well, but significantly ($P<0.05$) less than at the two sites. Community members mostly took more than 30 minutes to get to the closest public bins on foot with a proportion of 41.3%. (Figure 4.36). Precisely, 70.8% of community members took more than 25 minutes to get to the closest approved disposal site or public waste bin.

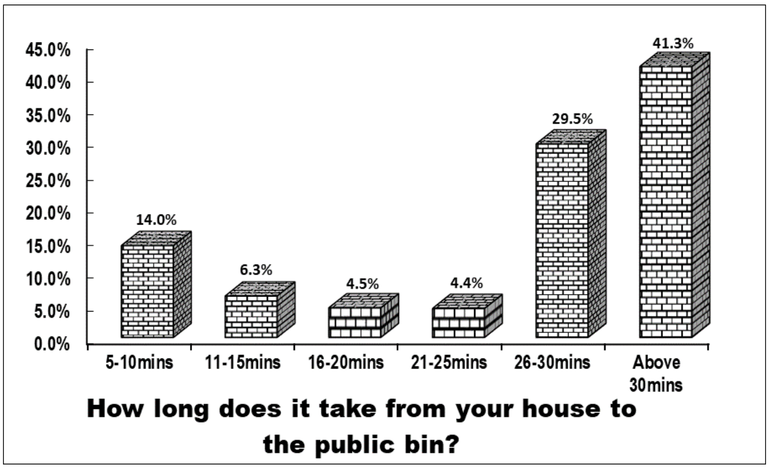


***Figure 4.36 Population's time to get to the closest approved site/public bin**.*
(Author's findings, 2018)

Means of conveying waste to the disposal sites or public bin

Household level

***Table 4.54 Means used by community members to convey waste to the disposal sites or public bin: comparing amongst study sites** (Author's findings, 2018)*

Study sites	Stats	Means of carrying waste to the disposal sites by households						Total n
		My car	Wheel-barrow	*Keke*[50]	Hand cart	With hand (on foot)	Others	
Okigwe	n	20	328	34	37	413	12	528
	%	3.8%	62.1%	6.4%	7.0%	78.2%	2.3%	
Orlu	n	26	347	38	40	483	17	540
	%	4.8%	64.3%	7.0%	7.4%	89.4%	3.1%	
Owerri metropolis	n	105	720	61	68	696	21	948
	%	10.7%	73.2%	6.2%	6.9%	70.7%	2.1%	
Total		151	1,395	133	145	1,592	50	2,052

[50]A commercial tricycle that has an engine

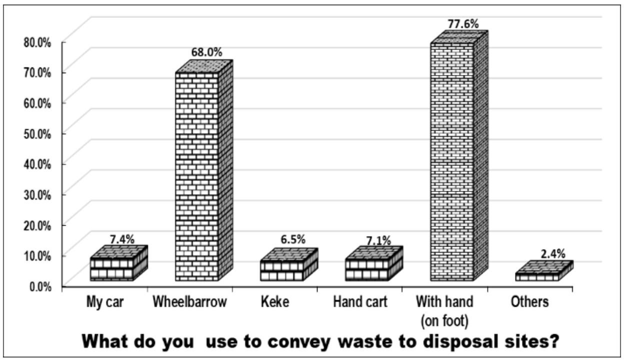


Figure 4. 37 Population's means of conveying collected waste to disposal sites
(Author's findings, 2018)

Community members at the study sites mostly carried their waste containers with hand (considered in this case as a means of conveyance) and walk to the disposal sites/public bin. Figure 4.37 indicates that 77.6% used the above means while 68.0% used the wheelbarrow. As a separate entity, the wheel-barrow is therefore the commonest means of transporting waste to disposal sites; this was also maintained by Adogu et al. (2015) in Imo State, Nigeria. The wheelbarrow (or for short 'barrow') is a very common product owned and used by many in the country: farmers, gardeners, traders; and its use has given birth to a profession – 'Barrow pusher'. Its availability and price (between 5,000 Naira and 40,000 Naira[51]) in Imo State are made easier with its recent fabrication in the near-by Enugu State (Anya, 2017); a product that before now was only imported.

Table 4.54.1 Association between population's means of carrying waste to public bin and time taken to get there *(Author's findings, 2018)*

Means of conveying collected waste	Stats	Time spent to dispose of collected waste at approved site/public bin			Total
		1-15 minutes	16-25 minutes	Above 26 minutes	
My car	n	33	8	110	151
	%	21.9%	5.3%	72.8%	
Barrow	n	306	130	959	1,395
	%	21.9%	9.3%	68.7%	
Keke	n	23	17	93	133
	%	17.3%	12.8%	69.9%	
Hand cart	n	28	19	98	145
	%	19.3%	13.1%	67.6%	
With hand (on foot)	n	314	144	1,134	1,592
	%	19.7%	9.0%	71.2%	
Other	n	5	8	37	50
	%	10.0%	16.0%	74.0%	
Total		416	183	1,453	

χ2-test: χ2=3.45; df=4; P=0.486.

[51] Though exchange rate fluctuates, 1€=424.194 ₦ (Rate in October 2017).

The difference in time spent by community members at the study sites to dispose of collected waste was not significant (P>0.05). Figure 4.38a indicates that no matter the means used, community members spent above 26 minutes to reach the closest approved disposal site and/or public bin.

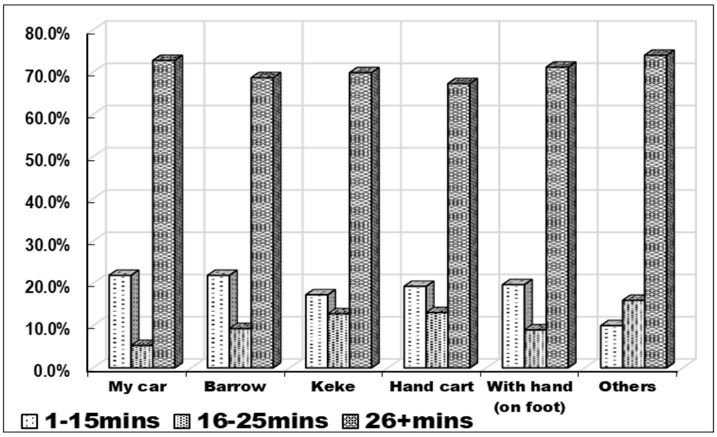


Figure 4.38a Link between means of conveying waste to the public bins and the duration to get there
(Author's findings, 2018)

Table 4.54.2 Association between means of carrying waste to disposal site(s) & disposal methods *(Author's findings, 2018)*

Method/place of waste disposal	**Stats**	**What is used in conveying waste to the disposal site(s)**						**Total**
		My car	**Wheel barrow**	**Keke**	**Hand cart**	**With hand (on foot)**	**Other**	
Communal depot /public bin	n	92	664	53	53	719	26	976
	%	60.9%	47.6%	39.8%	36.6%	45.2%	52.0%	
By a valley or water body	n	5	70	20	12	87	6	119
	%	3.3%	5.0%	15.0%	8.3%	5.5%	12.0%	
Pit in own compound	n	18	210	19	14	256	8	310
	%	11.9%	15.1%	14.3%	9.7%	16.1%	16.0%	
Into the bush /on the farm	n	46	494	51	48	583	18	724
	%	30.5%	35.4%	38.3%	33.1%	36.6%	36.0%	
Refuse coll. vehicle	n	19	218	12	19	230	8	295
	%	12.6%	15.6%	9.0%	13.1%	14.4%	16.0%	
By the road or street	n	40	349	38	28	446	14	554
	%	26.5%	25.0%	28.6%	19.3%	28.0%	28.0%	
Collected by cart pushers	n	7	114	2	48	112	2	160
	%	4.6%	8.2%	1.5%	33.1%	7.0%	4.0%	
On an open space	n	7	189	15	21	267	11	300
	%	4.6%	13.5%	11.3%	14.5%	16.8%	22.0%	
Burnt	n	56	766	73	78	856	26	1,184
	%	37.1%	54.9%	54.9%	53.8%	53.8%	52.0%	
Total		151	1,395	133	145	1,592	50	

Table 4.54.2 indicates that those who mostly dropped waste at the communal disposal site/public bin were those who used their cars (60.9%). As already established, these communal/public bins are far from the houses (i.e., more than 26 minutes away). Cars are used probably to reduce the time. Those on foot had the highest proportion of those who threw waste on open spaces, by the road or street, into the bush/on the farmlands (all fly-tipping traits), in a hole in their compound or burnt the waste. Several reasons can be attributed to these actions: - the public bins are far away from the residence and the waste is heavy (since more is organic) and the bins are generally emptied once weekly, there is the tendency for the waste to stink, just 68% could afford to use a wheelbarrow for waste disposal, not many can afford to pay for waste pick-up by a *keke* or handcart and waste burning (especially in one's compound) is not (yet) prohibited.

Imolites however, made great use of the public waste bins, irrespective of the means of disposing of collected waste (47.7%) even when they carried the waste containers (with hands) and walked (45.2%) or even pushed the wheelbarrow (47.6%). This means the community members are ready to use these public containers if they are available. Figure 4.38b indicates that irrespective of the means used in conveying waste to disposal sites, community members more often burnt generated waste.

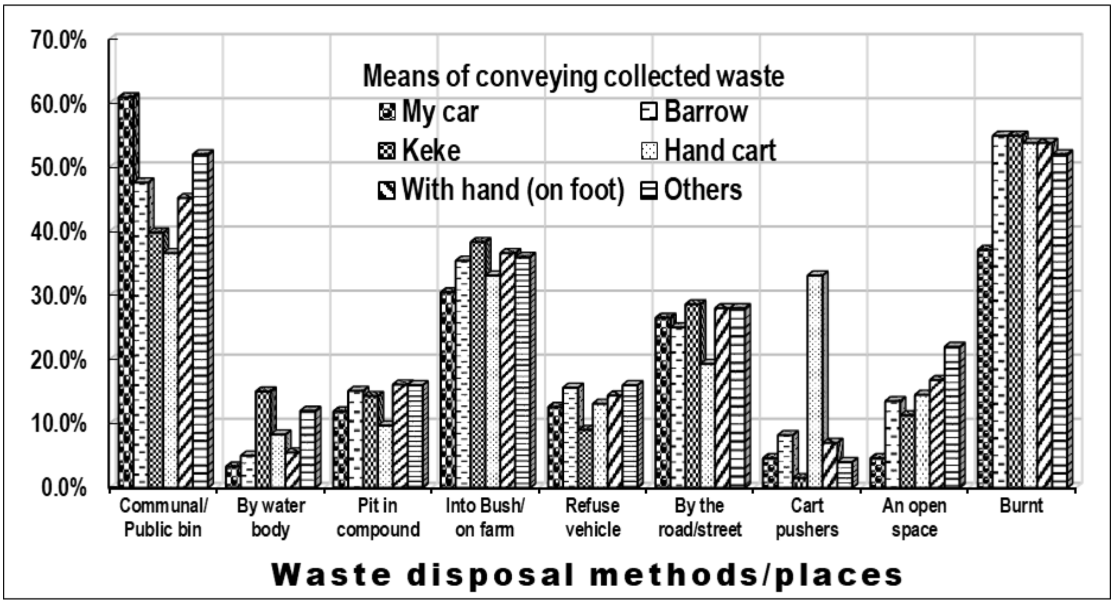


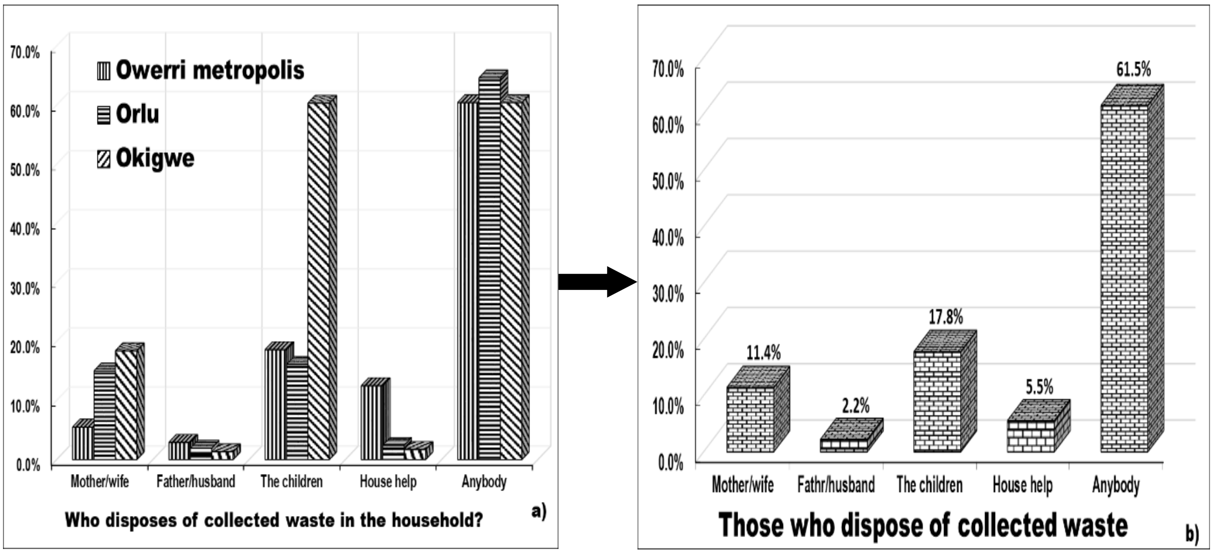
Figure 4.38b Link between means of conveying waste to disposal site and disposal options
(Author's findings, 2018)

Household members who convey collected waste to disposal sites

Table 4.55 Household members who disposed of collected waste: comparing amongst study sites *(Author's findings, 2018)*

Study sites	stats	Mother/ wife	Father/ husband	The children	House help	Anybody in the house	Total
Owerri metropolis	n	55	29	183	123	594	984
	%	5.5%	2.9%	18.6%	12.5%	60.4%	
Orlu	n	81	10	87	13	349	540
	%	15.0%	1.9%	16.1%	2.4%	64.6%	
Okigwe	n	97	7	96	9	319	528
	%	18.4%	1.3%	60.4%	1.7%	60.4%	
Sub total		233	46	366	145	1,262	2,052

Besides anybody conveying waste to the disposal site, the children and the mother/ wife were mostly involved in this activity. The proportion of house helps is higher in Owerri metropolis (12.5%) than in Orlu (2.4%) and in Okigwe (1.7%), perhaps because Owerri metropolis has the siege of professional house helps/nanny dealers and suppliers, and they supply to the entire nation (GreatAupair, n.d.). Figure 4.39b also shows the minimal participation of the father/husband in conveying collected waste to the disposal sites.



N=2,052

Figure 4.39 Persons who convey waste to the disposal sites.
(Author's findings, 2018)

Table 4.55.1 Association between the person who disposes of waste and the disposal options *(Author's findings, 2018)*

Method/place of waste disposal	Stats	Person who conveys waste to disposal site					Total
		Mother/ wife	Husband/ father	The children	House help	Anybody	
At the communal depot/public bin	n	105	28	166	65	612	976
	%	45.1%	60.9%	45.4%	44.8%	48.5%	
By a valley or water body	n	9	2	23	8	77	119
	%	3.9%	4.3%	6.3%	5.5%	6.1%	
In a pit in own compound	n	44	8	54	14	190	310
	%	18.9%	17.4%	14.8%	9.7%	15.1%	
Thrown into bush /on the farm	n	96	19	123	39	447	724
	%	41.2%	41.3%	33.6%	26.9%	35.4%	
In the refuse collection vehicle	n	34	3	62	33	163	295
	%	14.6%	6.5%	16.9%	22.8%	12.9%	
By the road or street	n	79	11	102	18	344	554
	%	33.9%	23.9%	27.9%	12.4%	27.3%	
Collected by cart pushers	n	14	1	34	12	99	160
	%	6.0%	2.2%	9.3%	8.3%	7.8%	
On an open space	n	53	1	51	13	182	300
	%	22.7%	2.2%	13.9%	9.0%	14.4%	
Burnt	n	198	21	203	28	734	1,184
	%	85.0%	45.6%	55.5%	19.3%	58.2%	
Total		233	46	366	145	1,262	2,052

Table 4.55.1 indicates that community members mostly dropped collected waste at the communal/approved disposal site or into the public bin. Waste was rarely thrown by the valley or water body probably because not all community members live near such geographical features; and, they won't carry waste around looking for these features when other waste disposal options are available. Those that mostly got waste collected by cart pushers were the children and house helps. The latter mostly dropped waste into the in the refuge collection vehicle, as he/she is probably mostly at home when the waste truck comes. Even if all members of the household are present, waste related activities are considered chores of the house cleaners. Hence, they seldom burnt waste (just 19.3% as against more than 45% for the rest household members) (Table 4.55.1).

Those who mostly tipped-off waste by the road or street, on an open space or other places (such as uncompleted buildings or abandoned buildings), threw waste in a hole in their compound as well as the disastrous act of burning waste were the mother/wife. The latter also mostly threw waste into the bush/on the farmlands accompanied by the husband/father. Table 4.55.1 also indicates that the father/husband did not often burn waste, throw waste by a water body, tip-off waste by the road/street or on an open space as well as did not often hand over waste to cart pushers. Generally, the father/husband is not very much involved in waste related activities (example as seen again on Figure 4.39b above); and when he does, he is expected (and strives) to do the right thing (highest user of the communal/public bin as seen on Table 4.55.1 above). This result is a substantiation of the description of the socio-cultural/traditional place, value and authority of a man/male (husband/father) in a typical Igbo context.

Historically and culturally, the household or home or compound in the Igbo context where this research was carried out is dissimilar and therefore not limited to the anthropologist's fundamental family which includes the head/man of the house *'pater familias'*, the wife/mother, their child/children and may be their wards (Uchendu, 1995). The Igbo man refers to his home as *'ezi na ulo'* meaning 'outside relations and those in the house or the extended family' in Igbo Civilisation (Ekeopara, 2012; Uchendu, 1995). Hence, the Igbo household implies physical structures that constitute a compound[52], the household members (which would include grandchildren – *'umu di ala'*, in-laws – *'ndi ogo'*, grandparents – *'ndi ikwu nne na nna ochie'*) and the household's relationship with its environment. Uchendu (1995) maintained that the above is a clear description of an Igbo household/home as painted by the famous Nigerian writer – Chinua Achebe in his novels like in *Things Fall Apart (Achebe, 1958, pp. 13-14)*.

Although the quest for privacy and security embedded in modernism and some education and enlightenment, and flanked by pride, urbanisation and the economic situation have diminished the erecting of distinct edifices for the wife/mother and the husband/father, the role of the latter in Igbo land with the right to inherit and as *pater familias* cannot be enfeebled. Until April 2014, the Igbo Customary Law gave the right to inherit only to the male (Banjo, n.d.; Goitom, 2014). It is considered a taboo for an Igbo man to engage in household chores (Akanle et al., 2016, pp. 11 & 14) (let alone household waste container); if seen, the wife would be fined no matter her status or that of the man. In the Nigerian context, (Olawoye et al., 2004) society may not see the woman as having any value, except in terms of her ability to perform her traditional household chores; some of which, she can assign to children or house help/maid if available. In many traditional contexts, reported Akanle et al. (2016, p. 3), women really do all the house works. This aspect per these authors, calls for more articles that are scholarly. The question is,

[52] The structures that make up an Igbo compound include the *mpuke* - wife's house, usually built behind the man's *obi* and an abundant space – yard where the children can play and farm produce sunned.

given all what she has to do, why will not the mother/wife practice negative waste disposal methods?

A meagre percentage of the father/husband is involved in conveying waste to disposal sites/public bins while the children and the mother/wife do so more often (Figure 4.39b). Figure 4.39a indicates that while the proportion of father/husband who engage in waste disposal is higher in Owerri metropolis, the proportion is reduced in the new and emerging small towns of Orlu and Okigwe, where the influence of culture and tradition (traditional household tasks of the wife/woman) still have a strong foothold. The men (husband/father) in Owerri metropolis are more enlightened and exposed the reason for their participation in the waste disposal despite their position as '*pater familias*'.

Table 4.55.1 also indicates that the proportion of household members mostly involved in negative and unsustainable waste disposal actions is the mother/wife. Given her responsibilities in the household as seen above, she has a lot to do and so has to make use of the means that is most convenient to her (irrespective of the type and consequence(s) to dispose of waste.

Table 4.55.2 Association between waste disposal methods/pace and highest level of education *(Author's findings, 2018)*

Method/place of waste disposal	Stats	Highest level of school attainment									Total
		No school certificate	Primary	JSCE	SSCE	Vocational certificate	First university degree	Master's degree	Ph.D.	Others	
Communal/ public bin	n	20	23	66	187	53	355	161	59	52	976
	%	42.6%	35.9%	51.2%	41.6%	39.6%	54.8%	49.4%	56.2%	34.9%	
By a valley or water body	n	0	14	13	27	17	22	12	7	7	119
	%	0.0%	21.9%	10.1%	6.0%	12.7%	3.4%	3.7%	6.7%	4.7%	
Pit in own compound	n	21	9	19	79	26	94	45	10	7	310
	%	44.7%	14.1%	14.7%	17.6%	19.4%	14.5%	13.8%	9.5%	4.7%	
Thrown into a bush/farm	n	21	35	52	155	72	239	83	22	45	724
	%	44.7%	54.7%	40.3%	34.4%	53.7%	36.9%	25.5%	21.0%	30.2%	
Refuse Coll. truck	n	3	9	20	55	18	107	48	17	18	295
	%	6.4%	14.1%	15.5%	12.2%	13.4%	16.5%	14.7%	16.2%	12.1%	
By the road or street	n	17	21	43	154	34	125	75	31	54	554
	%	36.2%	32.8%	33.3%	34.2%	25.4%	19.3%	23.0%	29.5%	36.2%	
Collected by cart pushers	n	1	3	12	19	16	46	38	5	20	160
	%	2.1%	4.7%	9.3%	4.2%	11.9%	7.1%	11.7%	4.8%	13.4%	
On an open space	n	7	8	36	75	24	70	37	8	35	300
	%	14.9%	12.5%	27.9%	16.7%	17.9%	10.8%	11.3%	7.6%	23.5%	
Burnt	n	34	57	102	318	109	325	126	28	85	1184
	%	72.3%	89.1%	79.1%	70.7%	81.3%	50.2%	38.7%	26.7%	57.0%	

Table 4.55.2 indicates that those who burnt waste the least were Ph.D. holders (26.6%), Master's degree holders (38.7%) and holders of a first university degree (50.2%). These three classes of people, who also are the most educated, were also amongst the highest users of the communal/public bin. This also entails these three categories are more versed with the negative consequences of waste burning and the other negative waste disposal methods. They however equally threw waste into the bush and/or onto farmlands, even fly tipping of waste by the road/street was amongst the first three options for Ph.D. holders.

Table 4.55.3 Association between waste disposal methods/place and waste quantity generated *(Author's findings, 2018)*

Method/place of waste disposal	Stats	Quantity of waste generated in the household			Total
		1-2 kg	3-4 kg	5-6 kg	
In the communal/public bin	n	166	144	29	339
	%	21.7%	25.4%	27.6%	
By a valley or water body	n	20	19	4	43
	%	2.6%	3.4%	3.8%	
In a pit in own compound	n	41	28	9	78
	%	5.4%	4.9%	8.6%	
Thrown into a bush/farm	n	113	102	28	243
	%	14.8%	18.0%	26.7%	
Into the refuse collection vehicle	n	52	62	6	120
	%	6.8%	11.0%	5.7%	
By the road or street	n	92	52	4	148
	%	12.0%	9.2%	3.8%	
Collected by cart pushers	n	23	17	3	43
	%	3.0%	3.0%	2.9%	
On an open space	n	66	26	8	100
	%	8.6%	4.6%	7.6%	
Burnt	n	192	116	14	322
	%	25.1%	20.5%	13.3%	

Besides making use of the communal disposal sites/public bins, waste burning and throwing of waste into bushes as well as on farmlands were amongst the three main ways of disposing of waste no matter the quantity generated.

***Table 4.55.4 Association between waste disposal methods and awareness of waste management** (Author's findings, 2018)*

Method/place of waste disposal	Stats	Have you ever heard/read about waste management? Yes	No	Total
Communal depot/public bin	n	923	53	976
	%	21.0%	22.8%	
By a valley or water body	n	115	4	119
	%	2.6%	1.7%	
In a pit in own compound	n	291	19	310
	%	6.6%	8.2%	
Thrown in bush/farm	n	688	36	724
	%	15.7%	15.5%	
In the refuse collection vehicle	n	279	16	295
	%	6.4%	6.9%	
By the road or street	n	525	29	554
	%	12.0%	12.5%	
Collected by cart pushers	n	153	7	160
	%	3.5%	3.0%	
On an open space	n	289	11	300
	%	6.6%	4.7%	
Burnt	n	1,127	57	1,184
	%	25.7%	24.6%	

Even those who were aware of waste management also burnt waste, threw waste materials into the bushes/on the farmlands as well as by the roads/streets.

***Table 4.55.5 Association between waste disposal methods/place and education on proper waste disposal** (Author's findings, 2018)*

Method/place of waste disposal	Stats	Have you ever been educated on proper waste disposal by the LG or State? Yes	No	Total
Communal depot/ public bin	n	577	399	976
	%	21.5%	20.6%	
By a valley or water body	n	68	51	119
	%	2.5%	2.6%	
In a pit in own compound	n	181	129	310
	%	6.7%	6.7%	
Thrown into the bush /on farmland	n	419	305	724
	%	15.6%	15.8%	
Into the refuse collection vehicle	n	173	122	295
	%	6.4%	6.3%	
By the road or street	n	318	236	554
	%	11.8%	12.2%	
Collected by cart pushers	n	93	67	160
	%	3.5%	3.5%	
On an open space	n	164	136	300
	%	6.1%	7.0%	
Burnt	n	694	490	1,184
	%	25.8%	25.3%	

$\chi 2$=1129.85; df=8; P=0.000.

Even those who maintained that they were educated on proper waste disposal methods still burnt waste, threw waste items into nearby bushes and on farmlands as well as dumped waste materials by the roads/streets.

Table 4.55.6 Association between waste disposal methods and frequency at which waste container is emptied *(Author's findings, 2018)*

Method/place of waste disposal	Stats	How often do you empty your waste bin?					Total
		Daily	Twice a week	When filled	Week ly	Others	
Communal depot/ public bin	n	186	161	8	463	158	976
	%	21.6%	25.3%	28.6%	17.9%	31.2%	
By a valley or water body	n	22	14	0	63	20	119
	%	2.5%	2.2%	0.0%	2.4%	3.9%	
In a pit in own compound	n	65	40	0	180	25	310
	%	7.5%	6.3%	0.0%	7.0%	4.9%	
Thrown into the bush /on farmland	n	139	81	3	413	88	724
	%	16.1%	12.7%	10.7%	16.0%	17.4%	
Into the refuse collection vehicle	n	73	46	0	152	24	295
	%	8.5%	7.2%	0.0%	5.9%	4.7%	
By the road or street	n	86	79	5	322	62	554
	%	10.0%	12.4%	17.9%	12.4%	12.2%	
Collected by cart pushers	n	30	43	3	65	19	160
	%	3.5%	6.8%	10.7%	2.5%	3.7%	
On an open space	n	58	52	5	163	22	300
	%	6.7%	8.2%	17.9%	6.3%	4.3%	
Burnt	n	204	120	4	767	89	1,184
	%	23.6%	18.9%	14.3%	29.6%	17.6%	

No matter the frequency at which community members emptied their waste containers, burning of waste and throwing of waste into the bush/ on farmlands were amongst the three main ways through which they disposed of waste.

Table 4.55.7 Association between disposal methods/place and time spent to dispose of waste *(Author's findings, 2018)*

Method/place of waste disposal	Stats	Time spent			Total
		1-15 mins.	16-25 mins.	26+ mins.	
Communal depot/public bin	n	248	74	654	976
	%	31.8%	15.2%	19.5%	
By a valley or water body	n	28	20	71	119
	%	3.6%	4.1%	2.1%	
In a pit in own compound	n	49	30	231	310
	%	6.3%	6.1%	6.9%	
Thrown into bush/ on farmland	n	119	82	523	724
	%	15.3%	16.8%	15.6%	
Into the refuse collection vehicle	n	71	26	198	295
	%	9.1%	5.3%	5.9%	
By the road or street	n	82	68	404	554
	%	10.5%	13.9%	12.0%	
Collected by cart pushers	n	18	14	128	160
	%	2.3%	2.9%	3.8%	
On an open space	n	27	32	241	300
	%	3.5%	6.6%	7.2%	
Burnt	n	138	142	904	1,184
	%	17.7%	29.1%	27.0%	

No matter the time spent to convey waste to disposal site/public bin, community members still threw waste into the bush/on farmlands or burnt waste as they appeared amongst the three main ways through which waste was disposed of.

Table 4.55.8 Association between waste disposal methods/places and availability of a communal bin(s) near the house *(Author's findings, 2018)*

Method/place of waste disposal	Stats	Is there a communal bin near your house?		Total
		Yes	No	
Communal depot/public bin	n	321	655	976
	%	53.7%	45.0%	
By a valley or water body	n	48	71	119
	%	8.0%	4.9%	
In a pit in own compound	n	79	231	310
	%	13.2%	15.9%	
Thrown into bush/on farmland	n	201	523	724
	%	33.6%	36.0%	
Into the refuse collection vehicle	n	97	198	295
	%	16.2%	13.6%	
By the road or street	n	149	405	554
	%	24.9%	27.9%	
Collected by cart pushers	n	32	128	160
	%	5.4%	8.8%	
On an open space	n	59	241	300
	%	9.9%	16.6%	
Burnt	n	279	905	1,184
	%	46.7%	62.2%	

Even where communal disposal sites or public bins were said to be near of the house, burning of waste and throwing of waste into the bush/on farmlands were amongst the three main ways through which waste materials were disposed of.

School level

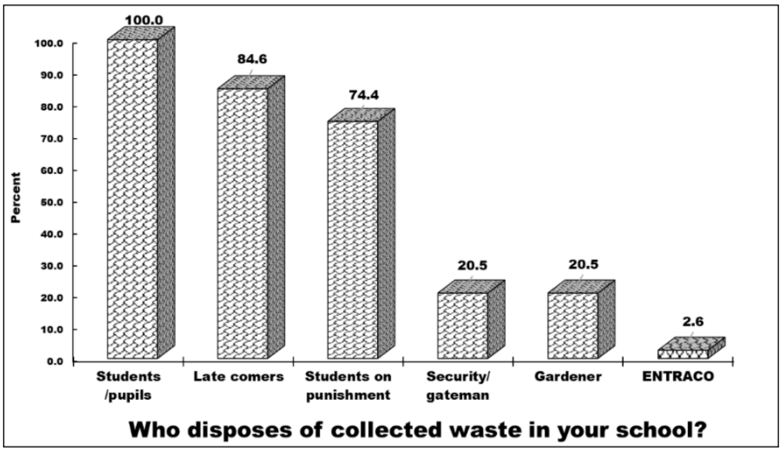


Figure 4.40 Persons who convey waste to the bin or disposal site in schools
(Author's findings, 2018)

Students/pupils transported waste (containers) to the disposal site or bin in their institutions. Late comers were also mostly engaged in carrying waste to the disposal site (84.6%), to very high extent by students on punishment (74.4%), to a very low extent by security/gateman as well as gardener (20.5%). The State enterprise – ENTRACO, an official waste evacuation corporation evacuates just 2.6%.

Source separation of waste

Households and shop owners/attendants were generally willing to support source separation of waste with a proportion of 88.8% and 85.3% respectively.

Aware of waste sorting as a waste management strategy and a source of employment

Community members were generally aware that waste sorting is a waste management strategy and source of livelihood with a proportion of 73.0%. While 7.0% attested not to know, 20.0% maintained they were not sure if it is waste management strategy and source of employment.

Waste management options

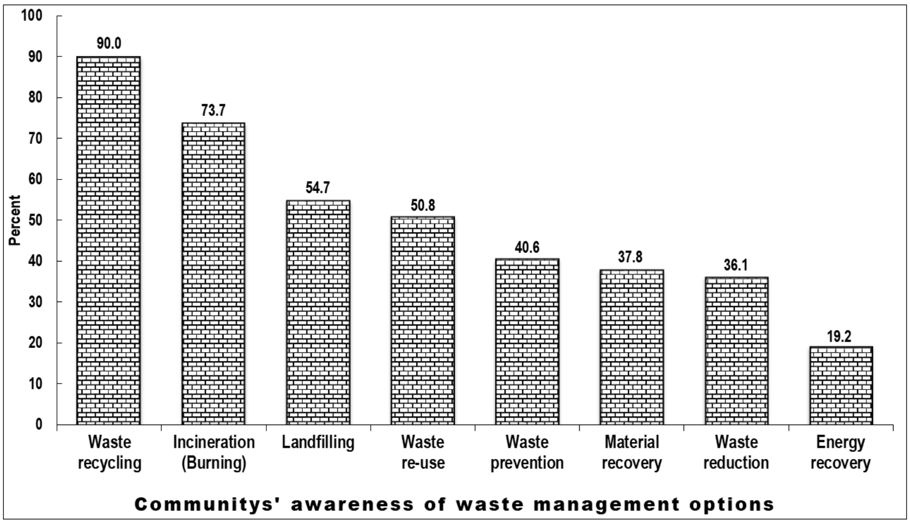


Figure 4.41a Imolites' awareness of waste management options
(Author's findings, 2018)

Community members were mostly aware of waste recycling with a proportion 90.0%, followed by waste burning (73.7%), landfilling (54.7%), etc. Hence, they considered waste recycling the most suitable option for the State with a proportion of 82.4% (Figure 4.41b).

Options community members considered suitable for the State

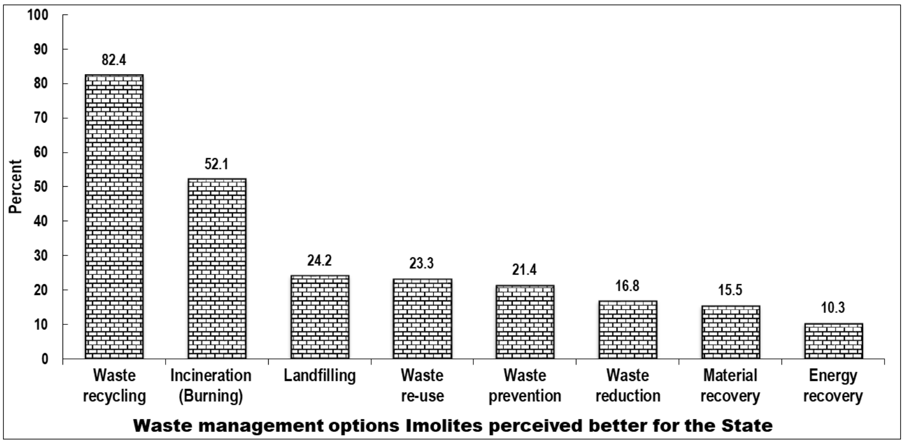


Figure 4.41b Waste management options community members considered better for the State. *(Author's findings, 2018)*

The waste management ladder for this study area would be thus (Figure 4.42a). The steps on this ladder are quite theoretical since results from the field indicated community members actually practiced something different (Figure 4.42b). The steps on both ladders are quite dissimilar to those established by international organizations and Ad Lansink – the father of the Waste Hierarchy; beginning with prevention and ending with disposal (Figures 4.42c-f).

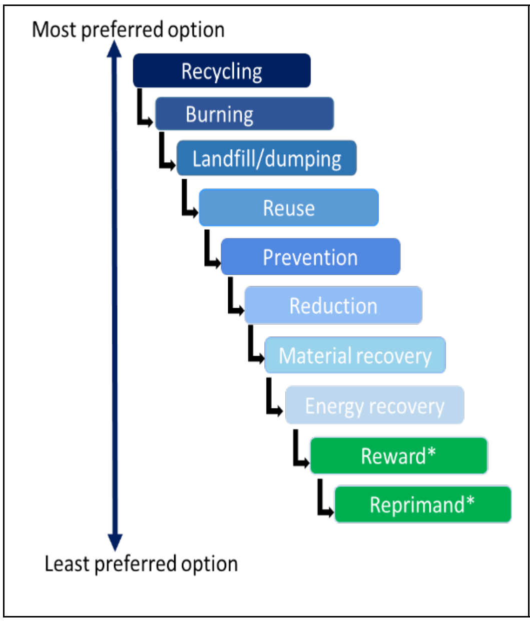


Figure 4.42a Waste management ladder for Imo State: theoretical.

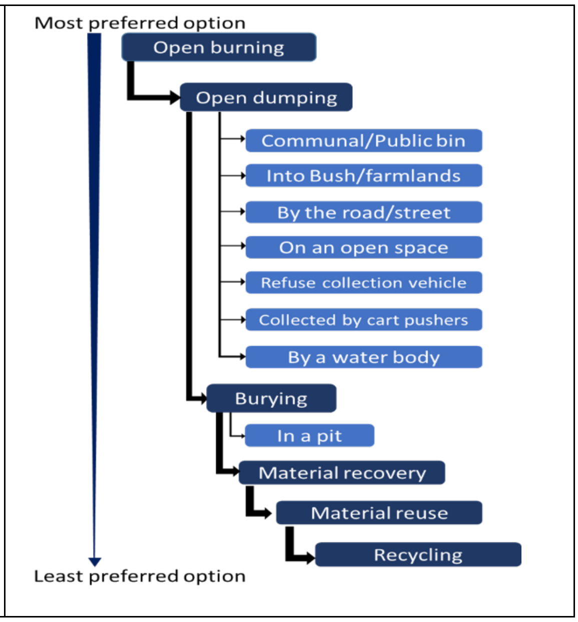


Figure 4.42b waste management Ladder for Imo State: practical.

(Author's concept, 2018)

Fogwe (2005, 2007) and Yengoh et al. (2016) suggested that 'reward' (compensate and give prizes to those who adhere to proper waste disposal rules) and 'reprimand' (punish and inflict legal penalty on those who fail to comply to such rules) should be added to the waste management hierarchy as a self-regulatory scheme that could work for unplanned cities of the Third World like Nigeria. Even though community members recommended that the government should use such schemes in the management of waste, both of them were not part of the options on the instrument used for this research.

For instance, EC (2008), DEFRA (2013) and OECD (2013) (Figure 4.42c) all have a similar hierarchy with steps beginning with prevention and ending with disposal including the EPA (1990) and the Basel Convention (1989). This is unlike in Imo State, Nigeria where disposal (landfill/dumping) as well as burning were given priority as seen on Figure 4.42a.

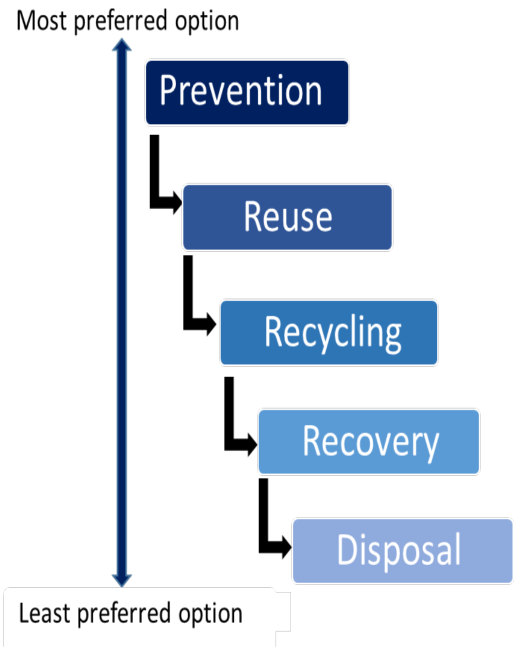


Figure 4.42c WMH (European Council, 2008; OECD, 2013).

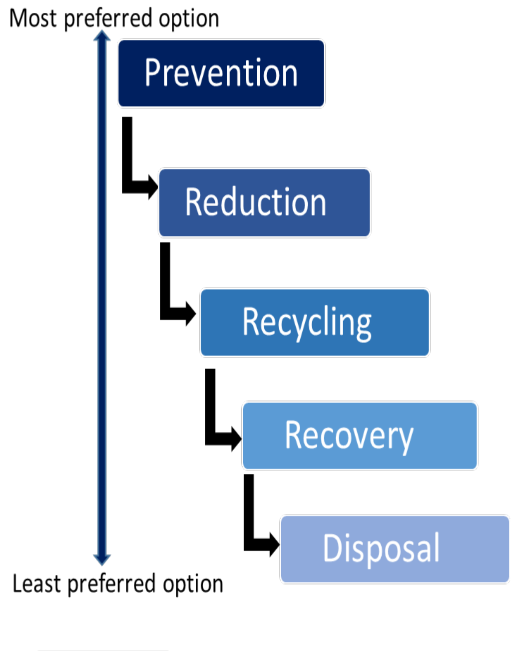


Figure 4.42d WMH (Basel Convention, 1989).

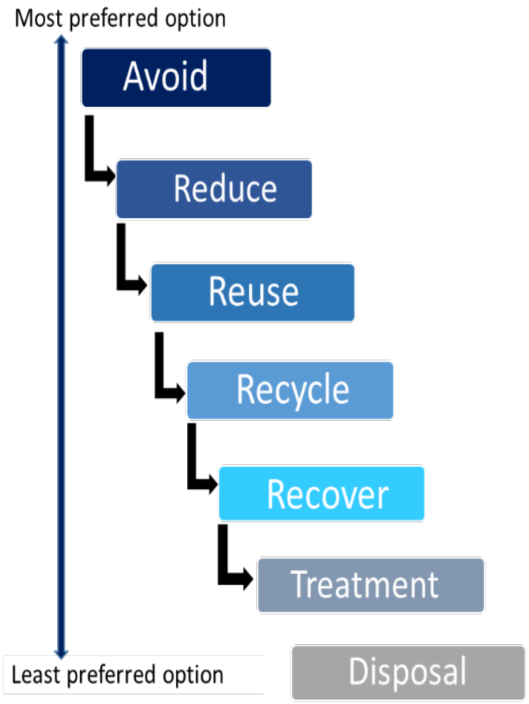


Figure 4.42e WMH (EPA, 1990).

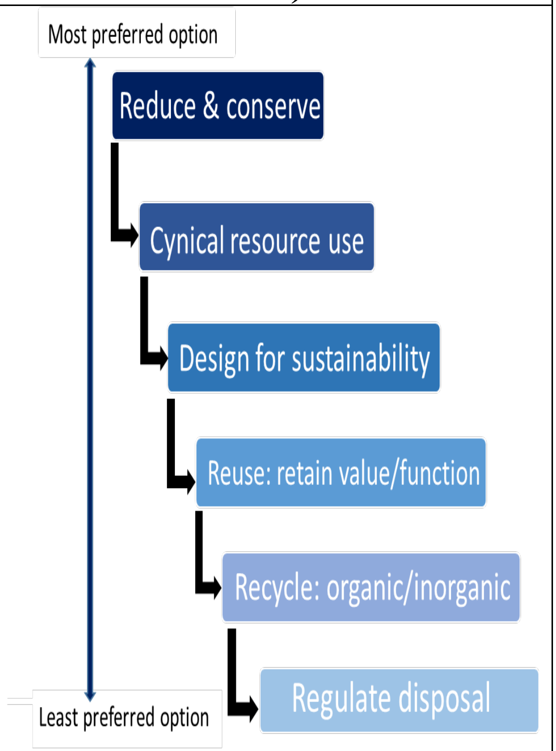


Figure 4.42f Zero Waste Hierarchy (2013).

Waste management and environmental awareness by schools

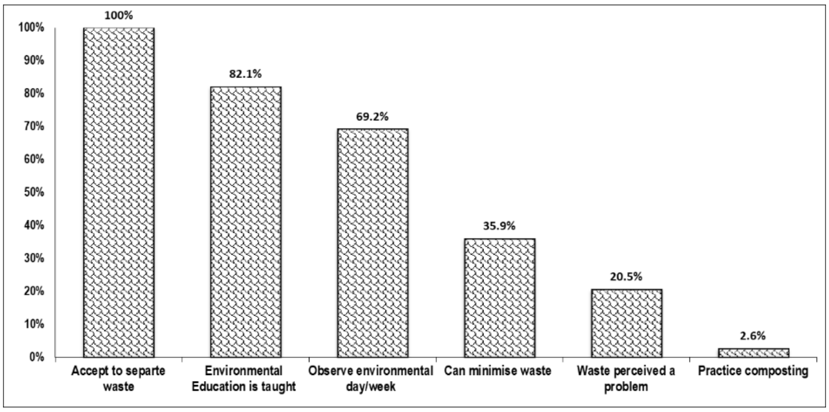


Figure 4.43 Waste management and environmental awareness by schools
(Author's findings, 2018)

The schools generally did not practice composting (97.4%) but accepted to separate waste (100%) while less than the majority agreed they could minimize waste (20.5%).

Waste/used water disposal

Households

Table 4.56 Households' used/waste water disposal methods/places *(Author's findings, 2018)*

Where/how, do you dispose of used/waste water?	Stats	Study sites			Total
		Okigwe	Orlu	Owerri metro.	
At my back yard/ over the fence	n	146	137	404	687
	%	27.8%	25.4%	41.1%	
Into the gutter/ water channel	n	451	389	739	1,579
	%	85.9%	72.0%	75.1%	
It is used again	n	49	156	546	751
	%	9.3%	28.9%	55.5%	
On the road/street	n	161	119	332	612
	%	30.7%	22.0%	33.7%	
Into the toilet	n	325	193	629	1,147
	%	61.9%	35.7%	63.9%	
By a water body	n	40	70	145	255
	%	7.6%	13.0%	14.7%	
Others	n	3	30	165	198
	%	0.6%	5.6%	16.8%	
Total		525	540	984	2,049

Households mostly poured their waste/used water in the gutter/water channel (76.9%), into the toilet to dispose of it or for flushing (55.9%) - an aspect of waste water use as well as used it again (36.6%), especially to sprinkle on the yard before sweeping mostly in the dry season. This trend was the same at the study sites as population generally poured waste/used water was into the gutter or water channel. Figure 4.44a presents an image of wastewater disposal options used by households.

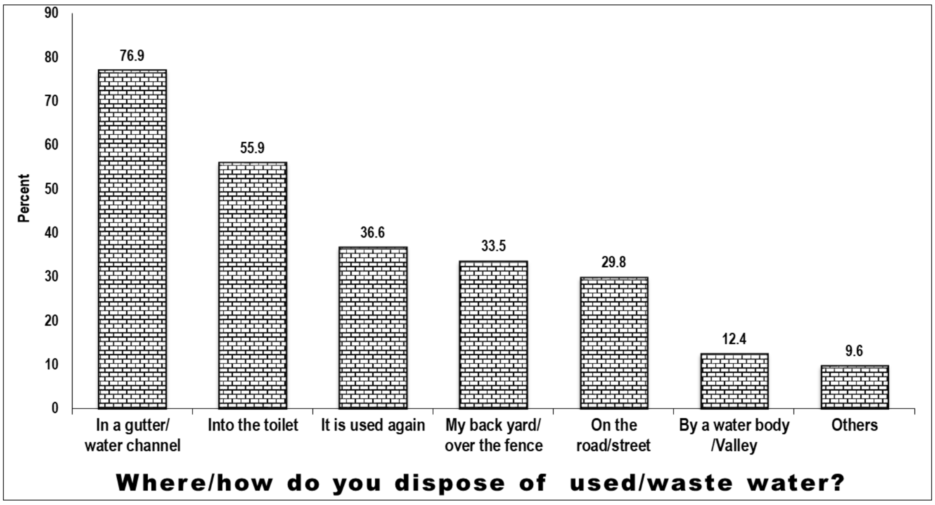


Figure 4.44a Households' used/waste water disposal methods/places.
(Author's findings, 2018)

Shops

Table 4.57 Shops' used/waste water disposal methods/places *(Author's findings, 2018)*

Shop attendants/owners' waste/used water places/methods	Stats	Study sites: Owerri metropolis	Orlu	Okigwe	Total
In front of my shop	n	28	21	23	72
	%	23.0%	25.6%	33.8%	
Into the gutter/water channel	n	76	47	60	183
	%	62.3%	57.3%	88.2%	
It is used again	n	7	3	1	11
	%	5.7%	3.7%	1.5%	
On the road /street	n	31	16	16	63
	%	25.4%	19.5%	23.5%	
By a water body/valley	n	1	3	0	4
	%	0.8%	3.7%	0.0%	
On top of the waste heap	n	28	24	32	84
	%	23.0%	29.3%	47.1%	
Anywhere	n	37	7	3	47
	%	30.3%	8.5%	4.4%	
Total		122	82	68	272

At all the study sites, shops for the majority poured their waste/used water into the gutter or water channel and this was the most pronounced means of disposing of waste/used water in Okigwe (88.2%), Owerri metropolis (62.3%) than Orlu (57.3%). Figure 4.44b shows that Imolites in commercial areas mostly poured waste/used water into gutter/water channel (67.3%), on top of the waste heap (30.9%), in front of their shops (26.5%) and even on the road/street (23.2%).

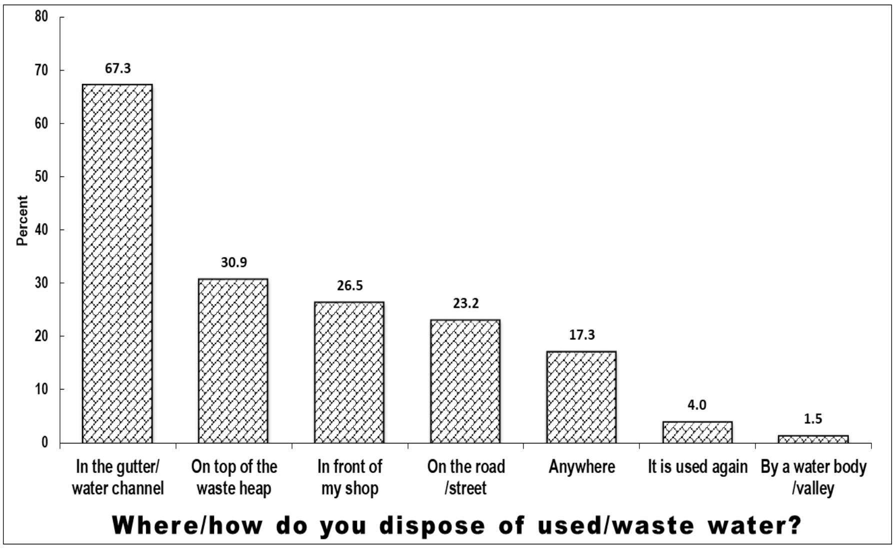


Figure 4.44b Shops' used/waste water disposal options *(Author's findings, 2018)*

Figure 4.44c Examples of water channels in which Imolites dispose of used water.
The photos were taken in the dry season; but the water channels are filled with stinking wastewater and waste. (Photos by Ache).

Perceived importance of waste management

Imolites perceived that waste management is important with a proportion of 93.5%. Meanwhile, hotels/guesthouses generally pour used water into the septic/sewage tank at the hotels.

Landfill site residents and environmental sustainability

Table 4.58 Characterization of the Old Road Landfill site residents
(Author's findings, 2018)

State	Arrival on site	Marital status	Kids?	Occupa-tion	Why the site**	Toi-lets?	Hitches?	Solu-tions
Adamawa	2014	Married	4	Scrap trader		No	Yes	
Bauchi	2013	Married	5	Vegetable trader		No	Yes	
Bornu	2013	Single, unmarried	0	Barrow pusher		No	Yes	
Bornu	2013	Single, Widower	2	Vegetable trader		No	Yes	
Kano	2013	Married	5	Beans seller		No	Yes	

**They are all Northerners who escaped the insurgency in this part of the country and came to the east. Around the Old Road landfill, land is cheap and since they maintained that they lack finance, they set up tents and huts to live in. They also live(d) without lavatories and made use of the landfill site. The difficulties per these residents were too much odour, smoke, mosquitoes, wild ants and other insects and wild animals like snakes, bush rats; sicknesses such as malaria and typhoid; bites from animals and insects; itches, cough and Apollo.

To alleviate these hitches, they requested for mosquito nets and that the government should build walls round the site or relocate them.

4.2.10 Research hypothesis five: Waste disposal in Imo State, Nigeria has no significant relationship with environmental sustainability.

Model validation

The influence of waste disposal on environmental sustainability was appraised using Logistic Regression Model. The model, making a percentage inclusion of 100 considered all the cases. The variability explained by this model was significant (Omnibus Tests of Model Coefficients: $\chi2=87.608$; $P=0.000$). The validity of the model is also supported by the Wald statistics ($P<0.05$) thus indicating that the effect of the predictors is significant. If the aggregated effect of the predictors is significant as indicated by the Wald statistics, which of the predictors contributed significantly or non-significantly? The Likelihood Model test helped in depicting the influence of individual predictors of waste disposal on environmental sustainability. This test equally revealed that the overall effect of the predictors was significant ($P<0.05$), and that 10 predictors out of 13 significantly predicted environmental sustainability ($P<0.05$), thus rejecting the hypothesis here stated.

Table 4.59.1 Case Processing Summary *(Author's findings, 2018)*

Unweighted Cases		**N**	**Percent**
Selected Cases	Included in Analysis	2,046	99.7
	Missing Cases	6	.3
	Total	2,052	100.0
Unselected Cases		0	.0
	Total	2,052	100.0

Table 4.59.2 Omnibus Tests of Model Coefficients *(Author's findings, 2018)*

		Chi-square	**df**	**Sig.**
Step 1	Step	87.608	13	.000
	Block	87.608	13	.000
	Model	87.608	13	.000

Table 4.60.1 Log-likelihood ratio test depicting the influence of individual waste disposal indicators on environmental sustainability. *(Author's findings, 2018)*

Predictors	Score	df	Sig.
Frequency at which waste container is emptied	4.850	1	.028
How waste is disposed of	17.967	1	.000
When collected waste is disposed of	1.152	1	.283
There is a communal depot or public bin near the house	11.756	1	.001
Time spent to convey waste to disposal site/public bin	23.386	1	.000
What is used in conveying waste to disposal site/ public bin	3.728	1	.053
Person who conveys waste to the disposal site/public bin	6.848	1	.009
Frequency at which the nearest public bins are emptied/depots cleared	14.289	1	.000
Perceived state of the public bin(s) near the house	4.761	1	.029
Would agree to pay fees for the waste bins to be emptied/depots cleared	11.756	1	.001
Think the waste disposal manner is a problem in your neighbourhood	20.421	1	.000
Evaluation of waste collection system in your vicinity/ neighbourhood	23.341	1	.000
Is satisfied with the waste management processes in the State	8.056	1	.005
Waste management option one is aware of	12.551	1	.000

When controlled for each other as depicted by the Wald statistics, the number of significant predictors dropped to 7. They are:

- Frequency at which waste container is emptied;
- How waste is disposed of;
- There is a communal depot or public bin near the house;
- Time spent convey waste to disposal site;
- Person who conveys waste to the disposal site/public bin;
- Frequency at which the nearest public bins are emptied/depots cleared and
- Is satisfied with the waste management processes in the State.

Table 4.60.2 Log-likelihood ratio test depicting the influence of individual waste disposal indicators controlled for each other on environmental sustainability.
(Author's findings, 2018)

Predictors	B	S.E.	Wald	df	Sig.	Exp(B)
Frequency at which waste container is emptied	-.075	.040	3.539	1	.048	.928
How waste is disposed of	-.090	.024	14.437	1	.000	.914
When collected waste is disposed of	-.067	.041	2.584	1	.108	.936
There is a communal depot/public bin near the house	.595	.292	4.165	1	.041	1.814
Time spent convey waste to disposal site	-.269	.109	6.131	1	.013	.764
What is used in conveying waste to the disposal site/ public bin	-.047	.039	1.483	1	.223	.954
Person who conveys waste to the disposal site/public bin	.104	.038	7.311	1	.007	1.109
Frequency at which the nearest public bins are emptied/disposal sites cleared	-.041	.014	8.505	1	.004	.960
Perceived state of the public bin(s) near the house	-.034	.034	.991	1	.319	.967
Would agree to pay fees for the waste bins to be emptied/disposal sites cleared	.142	.299	.227	1	.634	1.153
Think the waste disposal manner is a problem in your neighbourhood	-.015	.137	.011	1	.915	.985
Evaluation of the system of waste collection in your vicinity or neighbourhood	.021	.289	.005	1	.943	1.021
Is satisfied with the waste management processes in the State	-.117	.037	9.813	1	.002	.889

Table 4.61.1 Association between frequency at which waste container is emptied and overall rating of the State's environmental quality as compared to it about 10 years' back.
(Author's findings, 2018)

How often do you empty your waste container?	Stats	Overall, how would you rate the environmental quality of the State as compared to it about 10 years' back?			Total
		Better	The same	Worse	
Daily	n	81	128	217	426
	%	19.0%	30.0%	50.9%	100.0%
Twice a week	n	56	97	174	327
	%	17.1%	29.7%	53.2%	100.0%
Weekly	n	298	272	448	1018
	%	29.3%	26.7%	44.0%	100.0%
When filled	n	3	2	5	10
	%	30.0%	20.0%	50.0%	100.0%
Others	n	32	75	163	270
	%	11.9%	27.8%	60.4%	100.0%
Total	n	470	574	1007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.117; P=0.001.

The quality of the environment was least perceived as improved over the past 10 years in areas where people were not conscious of the importance of regularly emptying waste containers; that is, they neither emptied their waste containers daily, twice a week, weekly nor when filled. They did so at a rhythm that is not clearly defined. This category of people in the study were identified by 'others' and their percentage of perceived improvement was the least 11.9%, far below that of those who scheduled to empty their waste containers over the week till when it is filled with percentages ranging from 17.1% to 30.0%.

Table 4.61.2 Association between distance to communal bin and overall rating of the State's environmental quality as compared to it about 10 years' back.
(Author's findings, 2018)

Is there a communal disposal site or public bin near your house?	**Stats**	**Overall, how would you rate the state's environment as compared to it about 10 years' back?**			**Total**
		Better	**The same**	**Worse**	
Yes	n	108	173	317	598
	%	18.1%	28.9%	53.0%	100.0%
No	n	362	401	690	1,453
	%	24.9%	27.6%	47.5%	100.0%
Total	n	470	574	1007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.075; P=0.003.

Where there was no communal disposal site(s) or public bin(s) near the house, it was more remarked that the quality of the environment had improved with a proportion of 24.9% as against 18.1% where it was not the case. This sounds paradoxical. When cross-analyzing the findings, it makes sense because people generally complained that public bins and/or communal disposal sites were not regularly emptied and/or cleared; and these generated offensive odour, attracted many flies and other insects, were visited by many animals etc., thereby instead degrading the environment. These caused a nuisance to the immediate community members. The statistical trend of this Table (4.61.2) aligns with that of the following Table (4.61.3) as environmental improvement was perceived more where people managed to dispose of their waste themselves than where waste was dropped at the communal disposal sites or public bins, collected by the refuse collection vehicle or even by cart pushers. In the same line, the closer the communal disposal site or public bin to the houses, the lesser people observed improvement in the quality of the environment (Table 4.61.3). This also entails that such waste communal disposal sites/ public bins were not apparently taken good care of.

Table 4.61.3 Association between disposal methods/place and overall rating of the State's environmental quality as compared to it about 10 years' back *(Author's findings, 2018)*

Waste disposal methods/places	Stats	Overall, how would you rate the environment of the State as compared to it about 10 years' back?			Total
		Better	The same	Worse	
Communal disposal site/public bin	n	169	304	503	976
	%	17.3%	31.1%	51.5%	100.0%
By a water body/valley	n	22	23	42	87
	%	25.3%	26.4%	48.3%	100.0%
In a pit in own compound	n	62	50	96	208
	%	29.8%	24.0%	46.2%	100.0%
Thrown into a bush/on a farmland	n	91	59	116	266
	%	34.2%	22.2%	43.6%	100.0%
Into the refuse collection vehicle	n	27	42	120	189
	%	14.3%	22.2%	63.5%	100.0%
By the road or street	n	59	39	43	141
	%	41.8%	27.7%	30.5%	100.0%
Collected by cart pushers	n	16	29	52	97
	%	16.5%	29.9%	53.6%	100.0%
On an open space	n	17	21	25	63
	%	27.0%	33.3%	39.7%	100.0%
Burnt	n	24	7	10	24
	%	29.2%	29.2%	41.7%	100.0%
Total	n	470	574	1,007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.154; P=0.000.

Table 4.61.4 Association between time spent to take waste to communal site and overall rating of the State's environmental quality as compared to it about 10 years' back. *(Author's findings, 2018)*

Time spent to carry waste to the communal site/public bin	Stats	Overall, how would you rate State's environment as compared to it about 10 years' back?			Total
		Better	The same	Worse	
5-10 minutes	n	35	86	166	287
	%	12.2%	30.0%	57.8%	100.0%
11-15 minutes	n	19	43	67	129
	%	14.7%	33.3%	51.9%	100.0%
16-20 minutes	n	19	24	50	93
	%	20.4%	25.8%	53.8%	100.0%
21-25 minutes	n	35	20	35	90
	%	38.9%	22.2%	38.9%	100.0%
26-30 minutes	n	148	159	298	605
	%	24.5%	26.3%	49.3%	100.0%
Above 30 minutes	n	214	242	391	847
	%	25.3%	28.6%	46.2%	100.0%
Total	n	470	574	1,007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.103; P=0.000.

Community members who spent less time (between 5 and 20 minutes) to reach the communal disposal site and/or public bin maintained that the State's environmental quality was worse. This also entails that even though these were approved disposal sites, the accumulated waste was not regularly evacuated. Hence, the closer such sites to the households, the more uncomfortable community members would become because of their negative effects such as the repellent odour.

Table 4.61.5 Association between person who disposes of waste and overall rating of the State's environmental quality as compared to it about 10 years' back.
(Author's findings, 2018)

Who conveys waste to the disposal site/public bin?	**Stats**	**Overall, how would you rate the quality of the environment as compared to it about 10 years' back?**			**Total**
		Better	**The same**	**Worse**	
Mother/wife	n	88	50	95	233
	%	37.8%	21.5%	40.8%	100.0%
Husband/father	n	8	19	19	46
	%	17.4%	41.3%	41.3%	100.0%
The children	n	60	102	204	366
	%	16.4%	27.9%	55.7%	100.0%
House help	n	21	43	81	145
	%	14.5%	29.7%	55.9%	100.0%
Anybody	n	293	360	608	1261
	%	23.2%	28.5%	48.2%	100.0%
Total	n	470	574	1,007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.110; P=0.000.

It was observable that where waste was disposed of by the mother/wife, improvement in environmental quality was more perceptible with a proportion of 37.8%; and where house helps or children disposed of waste, improvement in the quality of the environment was less perceptible, with proportions of 14.5% and 16.4% respectively.

Table 4.61.6 Association between frequency at which the nearest public bins are emptied/depots cleared and overall rating of the State's environmental quality as compared to it about 10 years' back. *(Author's findings, 2018)*

Frequency at which the nearest public bins were emptied/depots cleared	Stats	Overall, how would you rate the quality of the environment as compared to it about 10 years' back?			Total
		Better	The same	Worse	
Satisfactorily	**n**	**141**	**250**	**368**	**759**
	%	18.6%	32.9%	48.5%	100.0%
Not satisfactorily	n	0	0	6	6
	%	0.0%	0.0%	100.0%	100.0%
Not fixed	n	31	12	40	83
	%	37.3%	14.5%	48.2%	100.0%
Don't know	n	296	310	576	1,182
	%	25.1%	26.2%	48.7%	100.0%
Others (non-specified)	n	2	2	17	21
	%	9.5%	9.5%	81.0%	100.0%
Total	n	470	574	1007	2,051
	%	22.9%	28.0%	49.1%	100.0%

Cramer's V: V=0.115; P=0.000.

It was observed that where people were not satisfied with the frequency at which the public bins were emptied and/or disposal sites cleared, it was perceived that the quality of the environment became worse as compared to the situation 10 years' back. This was acknowledged by all of them (100%).

Table 4.62 Contingency Table/summary of findings *(Author's findings, 2018)*

Research questions	Statistical test used	Comments
Research question one: How do environmental awareness and education affect environmental sustainability in Imo State, Nigeria?	Descriptive: Frequencies and proportion: Hypothesis testing: Binary Logistic Regression Model.	The community was generally aware of waste management (94.1%) and the salient sources of awareness were radio and TV. They were also to a moderate extent educated on waste management (58.0%). Generally, schools integrated environmental education in their program (82.1%). Both household members and shop owners mostly perceived that the quality of the environment has worsened as compared to the situation about 10 years' back. Two suggestions to improve waste management cut across the sites, which were government to provide enough waste bins of adequate sizes or suitable dumping sites and government to ensure regular evacuation of waste, and mostly daily. The influence of environmental awareness and education on environmental sustainability was appraised using Logistic Regression Model. All the cases were considered by the model making a percent inclusion of 100. The variability explained by this model was significant (Omnibus Tests of Model Coefficients: $\chi2$=42.742; P=0.014), implying that environmental awareness

		and education significantly predict(ed) environmental sustainability. Hypothesis rejected.
Research question two: In what way does waste quantity and its distribution affect environmental sustainability in Imo State, Nigeria?	Descriptive: Frequencies and proportion. Hypothesis testing: Cramer's V test.	Food/organic waste was the most generated waste type by households (97.1%), followed by paper (56.0%), plastics (38.3%), E-waste (12.5%), glass (12.0%), textile (11.2%), metal (8.0%) while 10.4% generated other waste types not specified. Waste valorisation was measured through the activities of waste pickers; all of them picked paper/carton, plastic/rubber, aluminium and metal/iron. A very strong majority sorted textile (78.8%) and 39.4% sorted glass while 78.8% sorted other types of waste not specified. It was statistically clear ($P<0.05$) that where waste was the least produced (1-2 kg daily), the proportion of those who perceived that the environmental quality was better as compared to the past 10 years was the highest (22.3%), thus asserting the link between waste generation and the quality of the environment. Hypothesis rejected.
Research question three: To what extent does wealth affect environmental sustainability in Imo State, Nigeria?	Descriptive: Frequencies and proportion: Hypothesis testing: Binary Logistic Regression Model.	The influence of wealth on environmental sustainability was appraised using Logistic Regression Model. All the indicators related to development index such as education, occupation, income and ability to pay for waste disposal were considered. The variability explained by this model was significant (Omnibus Tests of Model Coefficients: $\chi2=46.603$; $P=0.000$). In synchronization, it was evident that farmers mostly noticed environmental improvement, the same with the least educated, which were mostly farmers, while those with income above 200,000 Naira remarked improvement lesser than those with income less than 200,000 Naira. In the same line, those who will not agree to pay for waste disposal, which were mostly those with low income perceived improvement more. This paradox could be explained by the fact that those with low educational level might not have the ability to really appreciate changes in the environment or cannot be as critical as those who had gone further in their education and were more aware or could appreciate indicators of environmental sustainability better. Though this hypothesis is statistically accepted, it was nuanced in its interpretation.
Research question four: What are the effects of employment and poverty reduction opportunities on environmental sustainability in Imo State, Nigeria?	Descriptive: Frequencies and proportion. Qualitative: Thematic analysis.	The employability and ability of waste sorting to sustain livelihood was obvious as all the waste pickers did not have another job besides waste sorting and simultaneously acknowledged that the money from sorting waste as sole job was enough; and 93.9% liked the job. Some of them emphasized that the job sustained them as perceived in their phrases (*"take care of our family"; "enhance our economy"*) and some to further their education with the money generated from waste sorting (*"further my education"*).
Research question five: To what extent	Descriptive: Frequencies and proportion:	The influence of waste disposal on environmental sustainability was appraised using Logistic Regression Model. The variability explained by this model was significant (Omnibus Tests of Model Coefficients: $\chi2=87.608$; $P=0.000$). The validity of the model is also

does waste disposal affect environmental sustainability in Imo State, Nigeria?	Hypothesis testing: Binary Logistic Regression Model.	supported by the Wald statistics (P<0.05) thus indicating that the effect of the predictors is significant. Environmental sustainability was highly dependent on frequency at which waste container is emptied; How waste is disposed of; the availability of a communal depot or public bin near the house; time spent to dispose of collected waste; person who conveys waste to the depot/bin; frequency at which the nearest public bins/depots are emptied/cleared and perceived adequacy of waste management processes in the State.

Given the above observations, analyses and results discussed in this chapter, Imo State, Nigeria has and may (with time) continue to have an unsustainable environment as seen on Figure 4.45a. The principles of an integrated solid waste management - ISWM system as laid down by (Klundert & Anschutz, 2001) are conspicuously absent in the management of waste in Imo State, Nigeria since the heaps of garbage on the streets and roads are considered by Uchegbu (1998) and Parnham & Rispin (2001) to be the result of inefficiency and ineffectiveness of waste management. The waste system elements as well as the stakeholders and the dynamics involved in the management of waste in Imo State, Nigeria are contrary to those that characterise an integrated sustainable waste management model as laid down by Van de Klundert & Anschütz (2001) – Figure 4.45b.

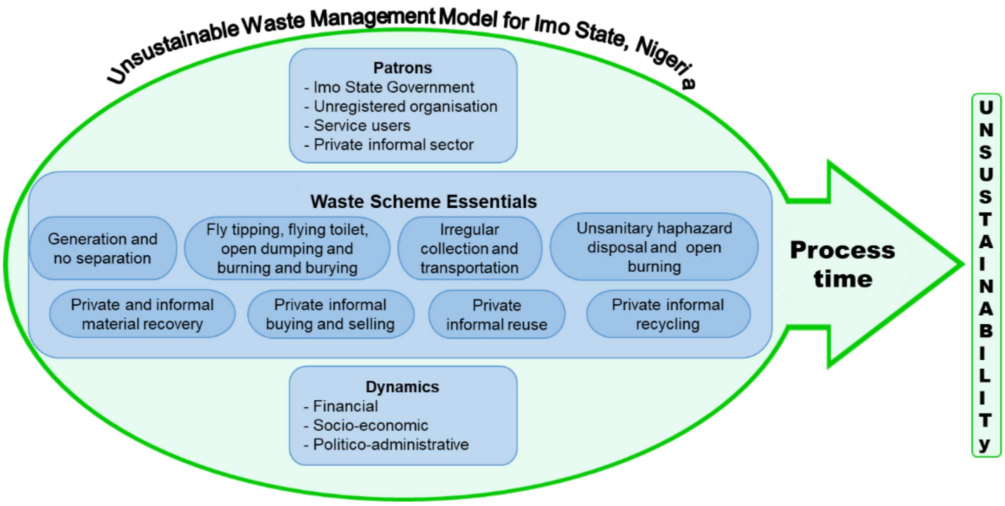


Figure 4.45a Unsustainable waste management scheme for Imo State, Nigeria.
(Modified after Van de Klundert & Anschutz, 2001).

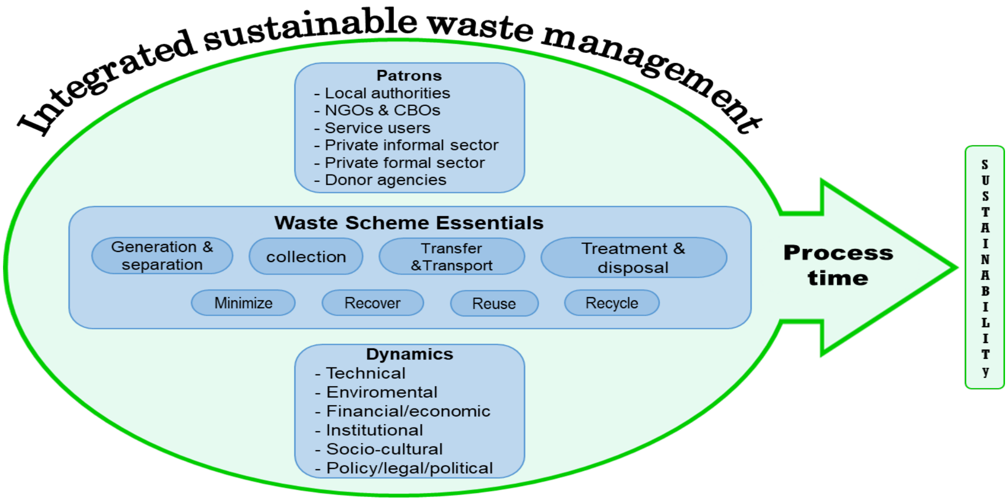


Figure 4.45b An integrated sustainable waste management - ISWM model
(After Van de Klundert & Anschutz, 2001).

While for instance the dynamics in an ISWM model found in Figure 4.45b consider and involve environmental, institutional, cultural, policy and legal aspects, these are found glaringly wanting in the management of waste in Imo State, Nigeria.

5 DISCUSSIONS, CONCLUSIONS AND OUTLOOK

Introduction

This chapter presents an analytical discussion of the research findings. This is based on the evidences and substantiations from reviewed literature, concepts and models in chapter two. The objectives are clearly spelt out and explanations to back up the arguments for each item are properly explained. Based on the analysis, I came forth with some conclusions grounded on reasoned arguments and evidences. This chapter is therefore discussed under the following headings: discussion of findings, conclusion, recommendations and suggestions for further research, contributions to literature and limitations of the study.

5.1 Discussion of Findings

This section deliberated on the results obtained following the different research hypotheses that were articulated to explore the phenomenon under study.

5.1.1 Alternative Research Hypothesis One

Environmental awareness and education do not affect environmental sustainability in Imo State, Nigeria.

Findings based on this hypothesis portrayed that environmental awareness and education significantly affect the sustainability of the Imo State's environment. The term waste management was not new to the majority of the community. Most of them had heard about waste management via different sources. In addition, there was a positive equivalence between educational level and education on proper waste management. A great majority of the community had been educated about proper waste disposal as their families participated in the monthly environmental sanitation. A reasonably proportion of them had heard about and/or seen health problems related to waste while a good number think there is enough information or sensitization about the environmental impact of waste. The results of this study showed that in areas where respondents observed the above-mentioned attributes, the environmental quality of the State was remarked to have improved.

These findings are in line with the views of the New Zealand Qualification Authority (NZQA, 2017) and the New Zealand's Department of Conservation, Ministries of Environment and Education (Wagner & Smith , 2017) who maintained that education has a vital role as it consolidates the ability of the individuals and communities to constructively influence the environment and society. Explaining why education is important for sustainability, the reports maintained that through apprised choices, actions and innovations, inhabitants could contribute to reshaping how they live and work leading in the development of an economy that is based on a sustainable and a flourishing environment. The reports contended that growing generations who understand environmental issues keenly contribute to a healthy and sustainable future for all.

The earlier works of (Arcury; Vining & Ebero, 1990) further support the findings of this study. They maintained that the more individuals are educated, the more they are concerned about the environment. While Vining and Ebreo attested higher education is associated with higher environmental concern as it is directly related to the access to information on environmental quality and the ability to process the information into knowledge, Arcury buttressed the fact that there is a consistent positive relationship between environmental awareness (knowledge) and environmental sustainability attitudes. Also in line with the findings is the result of the Program for International Student Assessment – PISA 2006 (OECD, 2006). The outcome proved that education is associated with increased environmental awareness as students who scored higher in environmental science across the 57 participating countries reported higher awareness of complex environmental issues. The results of the 2005-2008 as well as 2010-2012 World Values Survey (Inglehart, et al., 2014) further indicated that the more years of schooling, the more a person's concern for environmental protection increases.

The findings of this study additionally align with the works of (Lükő & Kollarics, 2013) who upheld out that there is a significant connection between environmental education and adult environmental education. In the same light, the Hamburg Declaration on Adult Learning adopted at the fifth International Conference on Adult Education in 1997 as documented by the UNESCO Institute for Education in Hamburg (UIE, 1997) and followed by the international conference on adult education in Brazil in 2009 examined the positive connection between these two variables. The conferences stressed that education for a sustainable environment should be a life-long process as adult education can play an important role in the sensitization and mobilization of communities and decision makers towards a sustained environmental action.

The findings of this study are further corroborated by the non-binding plan of action of the UN - Agenda 21 (UNCED, 1992) in 1992 with regard to sustainable development. This document called for the re-orientation of environmental education towards sustainability. This call simply attests to the significant relationship that exists between the two variables and how the latter can be achieved through the former. This relationship can be seen in many works: (Haury, 1998; Huckle, 1990; Iizuka, 2000; Sterling & Cooper, 1992; Tilbury, 1995).

5.1.2 Alternative Research hypothesis two

Waste quantity and its distribution have no significant relationship with environmental sustainability in Imo State, Nigeria.

The null hypothesis here was once more overruled and the alternative retained that waste quantity and its distribution have a significant relationship with environmental sustainability in Imo State, Nigeria. The findings indicated that where waste was least generated per day, a great majority of the respondents posited the quality of the State's environment was better. Also, waste items that were hardly picked (such as textile and broken glasses) and those that were mostly burnt (such as the remains of E-waste after extraction of the valuable copper and brass), contributed more to environmental degradation than those that were mostly picked for resell, reuse or recycling.

The findings in this domain are in line with a study carried out by (Rao & Khan, 2008). They maintained that water bodies are toxic through waste distribution such as the discharge of industrial effluents and that this is a worldwide environmental problem. These authors argued that there is a considerable amount of heavy metals and organic pollutants in industrial wastewater that would endanger public health and the environment if discharged without adequate treatment. Wilcox et al. (2015) also stressed that waste quantity and distribution in aquatic medium have led to the entanglement of marine animals in debris, especially as dilapidated nets and other abandoned fishing apparatus have been commonly documented as the key cause of mortality. The works of Balazs (1985), Derraik (2002) and *FAO* (2009) also support this result.

The versatility of waste materials, especially plastics as buttressed by Hansen (1990) and Laist (1987) has led to the increase in their everyday use, as they are cheap and durable. Laist (1987) and Pruter (1987) argued that these traits make them a serious environmental hazard. Their buoyancy, durability and wide dispersion over long distances as stated by Goldberg (1995, 1997), Hansen (1990) and Ryan (1987) may make them to persist for many centuries.

The findings of this study are also in accordance with the views of Jarup et al. (2002) who stressed on cancer risks of populations living near landfill sites in the UK. They maintained that bladder cancer is the most frequently noted distortion associated with landfills. Jarup et al. (2002) remarked that a vast range of waste degradation products might be released into the environment from landfill site while El-Fadel et al. (1997) noted that leaching and runoff of decomposed waste products may occur. Elliot et al. (2000, 1996) further maintained that environmental toxicants due to waste distribution may accumulate in the liver and binary tract as well as little excess of liver cancer have been articulated by previous studies around UK incinerators. More so, Bertram et al. (2002) corroborated that E-waste despite recycling is a major contributor of Cuprum[53] emitted into the environment annually. The works of Ernst et al. (2003) and Ladou & Lovegrove (2008) also explored the negative environmental effect of E-waste.

5.1.3 Alternative Research hypothesis three

Wealth has no significant relationship with environmental sustainability in Imo State, Nigeria. Findings based on this hypothesis depicted that wealth has a significant relation with environmental sustainability in Imo State, Nigeria. Wealth in this study included education, occupation and income (which are all indicators related to development index) as well as the ability to pay for waste disposal. A greater proportion of the respondents in occupations like farming, business and others perceived that the quality of the State's environment has improved. This is paradoxical because with their limited educational background, they lack an understanding of environmental sustainability components and so could not adequately determine the environmental quality of the State. Meanwhile, a smaller proportion of the respondents who were lecturers and those involved in other civil services stated the highest that the quality of the State's environment has not improved as compared to the last 10 years. Their broad and deeper educational background provides them with a better understanding of the environmental sustainability components than their counterparts in other occupations like farming or business with little or no education.

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[53] Cuprum is a soft, malleable and ductile metal with very high thermal and electrical conductivity

In addition, only a lesser proportion of the respondents who agreed to pay for waste disposal maintained that the quality of the State's environmental has improved. Mindful of the link that exists between education, major occupation, monthly salary and the ability to pay for waste disposal, this proportion are those with income above 200,000 Naira, broader educational background and lucrative jobs.

The findings of this study are also in line with the concept of the Environmental Kuznets Curve – EKC. Named after Simon Kuznets in 1955, the EKC hypothesis has been interpreted to imply that economic growth will eventually redress the adverse environmental impacts of the early stages of economic growth and that continued growth will lead to further improvements in the environmental quality. A Third World State like this study area, being a primary economy cannot therefore appreciate the adverse environmental impacts hitherto present. The EKC relationship per (Niwa, 2007) postulates that development and industrialization of agrarian and pre-industrial economies increase, environmental damage increases due to greater use of natural resources, more emission of pollutants, the operation of less efficient and relatively dirty technologies. This also implies that agrarian communities must reach a certain level of income, before they can afford to allocate the resources needed to protect (sustain) the environment (Figure 5.1). Meanwhile wealthier nations per Barkin (2005) have a tendency to allocate an increasing proportion of their national income to improving the environment. Hence, poor communities do not care much about the environment as they have more challenging issues to handle.

Nigeria has remarkable thought-provoking issues as it is ranked the third most terrorized nation in the world (Institute for Economics and Peace, 2017, p. 10; 2018, p. 8). This nation is also home to the world's highest number of people (87 million) living in extreme poverty as released by the Brookings Institute (Kharas et al., 2018b) thereby labelled the poverty capital of the world (Kazeem, 2018a). This situation will get worse to more than 110 million by 2030, if the current trajectory is not changed (Kharas et al., 2018a). The same country according to the Health Effects Institute (HEI, 2018) has the highest pollution-related deaths in the African continent and the fourth in the globe. Nigeria is also home to the largest number of out-of-school children in the globe (BBC News [Online], 2017) as well as home to the highest number of new-births in Africa and third in the globe (kazeem, 2018b). A recent release of the world (modified) Misery Index by an economist from John Hopkins University; Baltimore (Hanke, 2019) placed Nigeria as the 6th most miserable country in the world. He considered unemployment, inflation and bank lending rates as indicators of the index. In addition to its swelling population without attendant resources, Nigeria is faced with high proliferation, consumption and abuse of illicit drugs as well as the recent release by NAFDAC, NDLEA, NOA and CIO, who unanimously agreed that about 70% of the all the drugs in Nigerian markets are fake and substandard (Nwaiwu, 2019). These issues are perhaps far too challenging for the nation to think about waste items, which are out of their spheres of influence and are dumped elsewhere (the environment).

Nazrul (2015) however, posited that the Environmental Kuznets curve - EKC is helpful for understanding the observed negative correlation between income inequality and environmental outcomes, where, as the community members strive to increase their per capita income, the environment continues to decay. The EKC explains a hypothesized relationship between environmental quality and economic development. This stipulates that various environmental degradation indicators tend to get worse as modern economic progress ensues until standard revenue attains a sure point over the pathway of development. Summarily, the EKC suggests that the solution to pollution is economic growth. Since Imolites are still developing, there is environmental degradation.

The earlier works of Miller & Spoolman (2014) are also in line with the results of this study. These authors maintained that affluent societies have the financial means to invest in technological research that can reduce pollution and other forms of consumer waste as well as improve environmental status through the funding of scientific research. This opinion is backed up by Senik (2014) who maintained that wealth has been, and continues to be an indicator of well-being. In addition, wealthier economies generally have high standards of education, which encourages people to demand governments and corporations to be more environmentally friendly. Hence, Nigeria, being the poverty capital of the world, and Imo State, with a poverty level of 74% (NBS, 2010a), 70.4% of Imolites earn 100,000 Naira or less in a month regardless of their family sizes. This entails the population is generally of low income and so do not have the concern and the capacity to appreciate the sustainability of their environment.

Barkin's (2005) work further buttresses the findings of this study. He maintained there is an extensive recognition that contemporary levels of per capita resource consumption in the richer countries cannot possibly be generalized to the rest of the world. He stressed that there are vital principled questions about global sustainability especially while working with communities with little chance of fulfilling the most fundamental of their needs. Considering the definition of sustainability and sustainable development, such communities cannot keep up with the sustainability process.

5.1.4 Alternative Research hypothesis four

Employment and poverty reduction opportunities pertaining to waste management have no significant relationship with environmental sustainability in Imo State, Nigeria.
The null hypothesis was refuted here again and the alternative hypothesis retained. Employment and poverty reduction opportunities pertaining to waste management have a significant relationship with the sustainability of the Imo State's environment. All the respondents (waste pickers, waste buyers, and waste transporters) in this regard attested that the trading in waste items was their sole employment and helped them to reduce poverty, as the remuneration from this trade was enough and sustained their livelihood. A great majority of them maintained that the job enhanced the economy and needed no capital to begin with as well as it was the sole alternative to earn a living. A reasonable proportion confirmed that they were not only employed; they were also the boss themselves with the use of the phrase 'I am the *Oga* of my job'. In addition, waste sorting, selling, buying and transporting contribute to waste recovery, reduction, reuse and recycling as well as waste valorization. These aspects tend to reduce environmental pollution, degradation and the depletion of resources.

Employment pertaining to waste management and its significant relationship with the sustainability of the environment is inevitable. For instance, the need to harness other energy sources in Nigeria, especially through waste has been highlighted by (Nwofe, 2013). He stressed that proper waste management helps secure recovery or disposal of waste without putting humans or the environment at risk. Nnaji (2015) also outlined the benefits of waste collection and scavenging activities across Nigeria. The various stages in these activities contribute immensely to revenue generation, job creation and environmental preservation. Typical examples are the activities of enterprises like Team Orange, Karl Fischer & Söhne GmbH & Co. KG, Kirsch und Sohn GmbH, Würzburger Recycling GmbH (WRG), WÜRO Papierverwertung GmbH & Co. KG and the Würzburg 'Stadtreiniger', an enterprise with 290 workers taking care of 2.3 million waste containers yearly. These enterprises and their employees are a proof of employability pertaining to waste management.

Furthermore, there exists over 100 waste sorter organizations in the globe with about 265,089 registered members (WIEGO, 2018). The Report stated that about 24 million people worldwide are engaged in recycling activities ranging from collecting, recovering, sorting, grading, cleaning, or compacting waste, as well as processing them into new products. In the same light, Pfaff-Simoneit (2012) maintained that the waste management sector provides enormous employment opportunities even to lower-skilled and illiterate persons; this creates occupational and income opportunities for the disadvantaged groups of the society thereby contributing to attaining MDG 1 – poverty reduction. He argued that the sector makes crucial contribution to urban hygiene, environmental protection as well as greenhouse gas mitigation and efficient use of resources. In South Africa for instance, Rutowitz (2010) stipulated that waste collection created 98,000 direct new jobs between 2011 and 2012, 255,000 between 2013 and 2017 while 462,000 more are expected to be created between 2018 and 2025. The International Labour Office (ILO, 2013) and the sector specialist at WIEGO (Diaz, 2016) have more documentation about the employment opportunities of waste collection.

Furthermore, the opening of a waste plastic recycling plant for the production of pavement bricks in 2016 in Yaoundé, Cameroon by the ex-footballer – Albert Roger Milla through 'Coeur d'Afrique' (Arogundade, 2018) has employed about 20 permanent workers, created 300 jobs in the waste collection chain and has the potential of creating more 2,500 jobs for the even the unskilled job seekers. The waste plastics, which would have been an environmental nuisance, have been turned into eco-friendly paving bricks. A similar recycling plant to be opened in Douala, Cameroon will create more jobs, which will also keep the environment plastic-free.

Still in Cameroon, faced with flooding plastic bottles when it rains, Essome Ismael (Teke, 2018), a young Cameroonian collected the plastic bottles and started building fishing boats in 2014. This 'ecoboat' project turned into an association/NGO called 'Madiba and Nature' in 2016. The NGO has offered opportunities to the youths who have worked in collaboration with many communities, especially about 250 in Kribi, South Region of the country. The goal of this NGO is not only to reduce plastic pollution in urban areas, aquatic medium and beaches but also to preserve and sustain the environment as well as contribute in promoting sustainable artisanal fishing, ecotourism and offer a better and cheaper livelihood to the fishermen.

The results of this study are also in accordance with the works of Örgev et al. (2016) who maintained that garbage collection has become a source of livelihood for people who are in the fight for survival due to the economic value of waste. These authors upheld that waste collectors have realized a very vital activity in relation to employment and national economy. In Sabon Yelwa Kaduna, Nigeria collected waste plastic bottles have been used for the construction of houses (Abubakar, 2011), offering job opportunities to job seekers, and even teenagers as well as keeping the environment plastic bottle free.

5.1.5 Alternative Research hypothesis five

Waste disposal in Imo State, Nigeria has no significant relationship with environmental sustainability.

The alternative hypothesis was retained here and the null hypothesis invalidated. Waste disposal in Imo State, Nigeria has a significant relationship with environmental sustainability. In areas where community members were more cognizant of the significance of consistently emptying their waste bins, the quality of the environment was appraised to be better since they could no more perceive the odour from such collected waste. A reasonable proportion of Imolites who asserted to have public waste bins or disposal sites near their houses maintained that the quality of the State's environment had worsened as such containers/disposal sites were always stinking as well as had animals and smoke around them. Imolites around disposal sites complained of traits like diarrhoea, catarrh, insect bites, malaria, smoke and a stinking air. In addition, a proportion of Imolites who used the waste disposal methods provided by the authorities (public waste bins and communal disposal sites) maintained that the environmental quality of the State was worse since their services were not well planned. Furthermore, when the wife/mother disposes of waste, the environmental quality was observed to be better as compared to the other household members.

The findings of this study are in line with the earlier works of Jönsson et al. (2003) who maintained that the biodegradation of organic waste deposited in places like a landfill generates landfill gas, which contains high concentrations of the greenhouse gases methane (CH_4, 35-60%) and carbon dioxide (CO_2 30-35%). This aspect is buttressed by Allen et al. (1997) and Davoli et al. (2009) who stated that landfill gas contains substances such as volatile organic compounds (VOCs), which may have health and environmental effects as well as odour problems.

The work of Marín et al. (2007) and Wilkins et al. 2(007) also elucidated the result of this study. They maintained that during the citrus juice production process, about 50-60% of the crop ends up as waste and (Forgács, 2012) the estimated residues (citrus wastes – CWs) range between 15 and 25 million tons per year. These wastes per Kaparaju & Rintala (2006) and Plessas et al. (2007) cause environmental problems in terms of odour, disposal problems and methane emission due to uncontrolled anaerobic degradation. Cointreau-Levine (1994), maintained that improperly managed waste might lead to decomposition and putrefaction, which pollute the environment; decomposition of organic solid waste may also generate repugnant odours as well as methane gas, a global warming agent. Cointreau-Levine (1994) further asserted that this problem is common especially in Third World countries where very few dumpsites and landfills meeting environmental standards exist.

In Nigeria, precisely in Ebonyi State, Okwesili et al. (2016) lamented that most communicable diseases in Abakaliki metropolis are contracted from dirty environment, which stem from indiscriminate waste disposal. These authors described waste disposal as an intractable environmental monster whose heaps spoil the aesthetics of the environment and their decay generates horrible odour, contaminates the soil and water as well as the environment at large. These traits were observed in Imo State, Nigeria. Okwesili et al. (2016) further maintained that Abakaliki before 1996 was confronted with many environmental glitches as many streets were decorated with heaps of garbage and rivers were converted to dumping ground for domestic waste and human excreta. This scenario was annihilating as Uka (2013) confirmed that the World Youths Soccer Championship, slated for Nigeria in 1995 was cancelled due to the outbreak of cholera (an outcome of smeared environment) in Abakaliki.

Furthermore, Atta (2013), Isaac & Olamike (2007) and Ogwueleka (2009) pointed out that waste disposal engulfs all steps taken in controlling the generation, transportation and discharging of waste in a sanitary manner. This entails that the disposal of waste is mostly undertaken to reduce its effect on health and the environment. But, Asuquo et al. (2012) observed that waste disposal methods in Calabar, Cross River State and (Butu & Mshelia, 2014) in Kano, Nigeria included backyard burning, dumping in gutters, pits, on open spaces and on road sides; these are not different from the situation in Imo State, Nigeria. The cost of such indiscriminate disposal methods per Butu et al. (2013) and Omole & Alakinde (2013) is the degradation of the environment and unsustainability.

5.2 General conclusion

Based on the findings obtained from this study, and with regard to the study problem, we discovered from the variables under study that a good proportion of the waste management practices and strategies in Imo State, Nigeria have a negative effect on the environment. The results of the study therefore reiterated that the lack of environmental awareness and education are detrimental to the sustainability of the State's environment. The results further revealed that waste quantity and its distribution as well as the inability of the population to pay for proper waste disposal have negative feedback on themselves and the environment. As a result, heaps of garbage were found on streets/roads, in gutters/water channels and water bodies, on open spaces and even behind and in front of houses and shops/commercial settings. A reasonable proportion of the population expressed that close proximity and haphazard spread of waste led to a polluted environment as well as served as an avenue for disease outbreak and other illnesses.

The findings of this study further proved that many Imolites and non-Imolites gained a living via waste sorting and collection, and their various activities helped to put into use the abandoned items, which would have contributed to the degradation of the environment. Meanwhile, waste has untapped potential for increasing job opportunities and electricity which, the State and the country need. These opportunities and district heating from waste incineration have been proven fruitful in European societies like Germany; as the environmental benefit is much higher.

The result showed a strong concern for education and a clean environment as Imolites made use of the public waste bins, despite the deteriorating state and limited number of the bins on the one hand and the weight of the waste as well as the long distance between generation point and such bins on the other hand. Imolites generally believed that if such waste bins were stationed at all vicinities in the State, the rate of littering would be minimized.

Furthermore, Imo State, Nigeria has a huge potential for of waste streams. Not all waste from generation point end up at the landfill. The findings showed that even though some is burnt as well as buried, most of it is being recovered, used, refurbished and recycled. These activities are however informal.

5.3 Recommendations

Based on the findings of this study, we have the following recommendations to the different stakeholders, which if tactfully, carefully and judiciously implemented will go a long way to revamp, refurbish and enhance the society.

We recommend that more sensitization and awareness campaigns be done to educate the citizens about proper waste treatment and disposal methods. The stakeholders (private and public) should disseminate information about the sustainability of the environment in relation to waste treatment habits. The populace should be enlightened on the importance of the use of public waste bins (when available) and not beside a waste bin or other places 'not designed for waste dumping but are being used'.

It is recommended that public waste bins of adequate sizes and in good conditions should be placed at short walkable distance in every neighbourhood or vicinity. This will make them available for use by populace and fly-tipping and flying toilet traits as well as littering will be avoided. The waste bins should also be evacuated or emptied regularly to reduce or avoid odour. As well, it will destroy a possible formation of habitat(s) for disease-causing vectors. Regular/timely emptying of the waste bins will also inhibit the visiting of wild or stray (domestic) animals to such sites, which pose potential danger to adjacent houses and the population at large.

Given the indication that there is a shortage of waste pickup vehicles, we recommend that more of such vehicles and attendant workers be made available for waste pickup. This will go a long way to accelerate and facilitate the clearing/emptying of disposal sites/waste bins as well as the huge waste heaps that ooze horrible odour and obstruct traffic flow, especially after monthly environmental clean-up exercise.

Laws and policies should also be streamlined to prioritize waste management activities and more specifically waste disposal attitudes; and, these laws should be enforced and upheld. The government or ministry in the dispensation of such laws should bear in mind the financial ability (low income with a poverty level of 70.4% and preparation and eating habit (harvesting and conveying of food items in whole to the households/markets) of the populace. In this light, the government should make rules that put to use the organic waste that would be generated.

Statutes should also be made, implemented and upheld in favour of waste separation and against haphazard burning of waste. Hence, it is important to sort municipal waste in order to treat the different fractions according to the most preferable method for that fraction, a variety of treatment methods are needed to avoid landfill. The populace should be informed about the advantages of waste separation and the disadvantages of waste burning. They should be made to understand that waste materials could still be used (as raw material to produce a new product)/sold, recycled, refurbished or even incinerated to generate energy, which the country needs. These activities all create job opportunities as well as help sustain the environment as they make use of the waste items that would have been abandoned to degrade the environment and natural life.

5.4 Suggestions for further research

It is thought-provoking to track the progress of the liaison between waste management and environmental sustainability, e.g. the impact of waste management techniques and strategies on the environment in Sub-Saharan Africa. Thus, we believe that a similar research may be carried out in another State in the Federal Republic of Nigeria or in another Sub-Saharan country. This will enable a detailed study, as many other opinions will be looked into with possible solutions to help curb or restrain this issue of waste management strategies, which have negative effects on the sustainability of the environment. More so, the same study could still be carried out in Imo State, Nigeria using different working environments and different objectives from the main variables of the study.

In addition, in the waste management domain, it is imperative to 'move up the ladder' in the waste hierarchy suggested by Lansink (1979). The main step to take in the impending years is to find ways of minimizing waste amount and breaking the disparity between poverty and environmental sustainability, the correlation between economic growth and waste growth and the disproportion between education and environmental sustainability. What means are there to break/reduce the variation between poverty and environmental sustainability? How can waste amounts be decreased? How can we develop design and production processes in order to decrease generation? What kind of policies or policy instruments would be put in place to stimulate, establish and convey these processes and their progress with regard to the sustainability of the environment?

Furthermore, studies could be made on the encouragement of public-private sector participation in waste management, with both working hand in hand for better services and a sustainable environment. This can lead to the quantification of the landfill sorted items. That is, recognising waste picker groups, improving their working conditions and linking their activities to an environmental enhancement measure.

5.5 Contribution to literature

There are a number of methodological issues that plague the literature on waste management in Sub-Saharan Africa or Developing Countries generally and its effect on the environment. The different types of strategies and practices that these societies perform and their myriads of indicators are confounding in many studies. Visiting many households, primary and secondary schools, waste dumping sites, market areas and shops and collecting data can be time-consuming, yet it provides primary data from a naturalist setting. Data was collected from households, shops, waste deposit sites and schools at three study sites. The data were both qualitative and quantitative that were used to arrive at conclusions. However, studies on the effects of waste management in Sub-Saharan Africa and on environmental sustainability is very rare or sporadic and so, this study contributed in enriching the waste management literature on the aforementioned topic in the Nigerian milieu or locale.

Taking a more insightful look into the different waste treatment strategies in Nigeria (open burning, road/street dumping, burying, NIMBYS, NIMHS and NIMSS as well as other fly-tipping and flying toilet activities) and establishing their relationships with the sustainability of the environment, which has not been explored in previous literatures as far as the Nigerian milieu is concerned, this work therefore heralded a novelty in the effect of waste management techniques on environmental sustainability.

Moreover, if one takes a keen look at the alarming rate of littering, fly-tipping and flying toilets as well as heaps decorate the streets in Sub-Saharan cities, and if we adhere to the fact that our globe is finite and that we did not inherit the environment from our forefathers rather we lend from our children, then it makes much sense to proliferate this literature so that the populace and stakeholders in Nigeria involved in waste management can harness from and effect changes that will benefit all and sundry.

5.6 Limitations of the study

Data collection was very tedious, time consuming and expensive. Most respondents took many days to fill and return the questionnaire copies making the researcher to visit them on several occasions. Some of them even misplaced the questionnaires and I had to reprint and re-administer. Even with these, some of them did not return their copies making the return rate to drop to 77.92%. Many of the respondents did not keep to appointments and time, which also increased the number of visits and consequently the cost. In addition, data was not (readily) available, and, in situations where there were made available, it was very expensive to acquire. All the interviewees refused to have their views recorded in any form. This made it difficult for such data to be transcribed for further analysis. They only accepted to be interviewed based on anonymity, before which I was thoroughly searched for fear that I was using a secrete recorder or camera. According to them, the country was living in perilous times with a lot of insecurity, so everyone was/is afraid. This was a great hindrance because I had to write, as fast as possible and such data could not be statistically analysed.

Furthermore, creating a spreadsheet and computing in an area with incessant power outage meant using much money to buy fuel for a standby generator for electricity. All this increased the cost of the work and study. The results of this research endeavour are also limited in the sense that they appraised waste management as a correlate of environmental sustainability only from one State with 27 LGAs out of the 36 States with 774 LGAs.

Appendices

Appendix 1 Questionnaire for households

Dear Respondents,

I am NGHEGWA ACHE Patience, a Doctoral student of the Julius-Maximilians-University Würzburg. I am currently carrying out research on waste management as a correlate of environmental sustainability in Imo State, Nigeria. Please feel free to express your opinions as frankly as possible. This is purely an academic exercise and any information disclosed will be treated as a matter of confidentiality between the researcher and the institution. Your objective contributions will be highly appreciated.

Instructions Participation in this activity is completely voluntary.
Please go through the instructions relevant to each question.

Details of Respondent

Name: ……………………………………………………………………………………
Local Government Area: ………………………………………………………………..
Street/Ward: …………………………………………………………………………….
Date: …………………………………………………………………………………….

The information requested is purely for academic purpose and will be treated confidentially. Thank you for accepting to complete the Questionnaire.

General Information

Please tick (√) in the appropriate boxes for your answer

1. Number of people currently living in the house ………………………………………

2. How long have you lived in this city?
   1. Below 5years ☐ 3. 11-20years ☐ 5. 31-40years ☐
   2. 5-10years ☐ 4. 21-30years ☐ 6. Above 40years ☐

3. What is your highest educational level?
   1. No school certificate ☐ 3. Primary ☐ 5. JSS ☐ 7. SSS ☐
   2. Vocational certificate ☐ 4. Masters ☐ 6. Ph.D. ☐ 8. Others ☐ 9. First degree ☐

4. What is your major occupation please? 1. Farming ☐ 3. Teaching ☐ 5. Other civil services ☐
   2. Business ☐ 4. Lecturing ☐ 6. Others *(specify)*…………

5. What is your monthly salary range please?
   1. Below ₦50.000 ☐ 3. ₦101.000-150.000 ☐ 5. ₦201.000-250.000 ☐ 7. ₦301.000-350.000 ☐
   2. ₦51.000-100.000 ☐ 4. ₦151.000-200.000 ☐ 6. ₦251.000-300.000 ☐ 8. Above ₦350.000 ☐

WASTE MANAGEMENT

'Waste' means **"any residue or left-over or by-product arising from plants, animals or human activities that are usually discarded"**

1. Have you ever heard about waste management? 1. Yes ☐ 2. No ☐

If yes, via which means? (One or more answers)

1. Over radio ☐ 3. In school ☐ 5. In place of worship (like church or mosque) ☐
2. Over TV ☐ 4. On a poster ☐ 6. In public meeting ☐ 7. Others (*Please state)*………

2. Have you ever been educated on proper waste disposal by the authorities?

1. Yes ☐ 2. No ☐

3. What type of wastes come out from your household? (*One or more answers*)

1. Electronic/electrical material ☐ 3. Plastics ☐ 5. Metal ☐ 7. Glass ☐
2. Food /organic waste ☐ 4. Paper/carton ☐ 6. Textile ☐ 8. Others ☐

4. In what type of container do you collect waste? (*One or more answers*)

1. Plastics ☐ 3. Tin/Can ☐ 5. Carton ☐
2. Old bucket ☐ 4. Old bag ☐ 6. Others (*Please specify*) …………………

5. What quantity of waste is generated in your household per day?

1. 1-2kg ☐ 3. 3-4kg ☐ 5. 5-6kg ☐ 7. Don't know ☐
2. 2-3kg ☐ 4. 4-5kg ☐ 6. 6-7kg ☐ 8. Others ☐

6. How often is the waste container emptied?

1. Daily ☐ 3. Weekly ☐
2. Twice weekly ☐ 4. When filled ☐ 5. Others (*Please specify*) ………………

7. Where/how do you usually dispose of collected waste? (*One or more answers*)

1. At the communal depot /public bin ☐ 5. In the refuse collection vehicle ☐
2. By a valley/water body ☐ 6. By the road or street ☐
3. In a pit in own compound ☐ 7. Collected by cart pushers ☐
4. Thrown into bush/farm ☐ 8. On an open space ☐
9. Burnt ☐

8. What time do you usually carry collected waste to disposal site? 1. Mornings ☐

2. Afternoons ☐ 3. Evenings ☐ 4. Nights ☐ 5. Anytime ☐

9. Are there any approved disposal sites or public bins near your house? 1. Yes ☐ 2. No ☐

How long does it take to get there on foot? 1. 5-10mins ☐ 2. 11-15mins ☐
3. 16-20mins ☐ 4. 21-25 mins ☐ 5. 26-30mins ☐ 6. Above 30 mins ☐

What is usually used in carrying the waste to the public bin or disposal site? (*One or more answers*) 1. My car ☐ 3. *Keke* ☐ 5. With hand on foot ☐
2. Barrow ☐ 4. Hand cart ☐ 6. Others……………...

Who usually does the conveying/carrying to the public bin or disposal site?

1. Mother/wife ☐ 3. The children ☐ 5. Anybody ☐
2. Husband/father ☐ 4. House help ☐

10. How often are the nearest public bins/depots emptied/cleared?

1. Once a week ☐ 3. Daily ☐ 5. Never ☐ 7. Don't know ☐
2. Twice a week ☐ 4. Once a month ☐ 6. Not fixed ☐ 8. Others ☐

11. How can you describe the state of the public bin(s) near your house? (*One or more answers*)
   1. In a good state/condition ☐ 3. Adequate size ☐ 5. Don't know ☐
   2. Rusting/rotting/leaking ☐ 4. Inadequate size ☐ 6. Others (*Please specify*) ……

12. Would you agree to pay fees for the waste bins/depots to be emptied/cleared?
   1. Yes ☐ 2. No ☐

13. Do you think the waste disposal manner is a problem in your neighbourhood?
   1. Yes ☐ 2. No ☐

14. How do you describe the waste collection system in your vicinity or neighborhood?
   1. Good ☐ 2. Fair ☐ 3. Not good ☐ 4. Don't have ☐

15. Are you satisfied with the waste management practices in the State?
   1. Yes ☐ 2. No ☐

16. If the State were to launch source separation of wastes, will you support and practice it?
   1. Yes ☐ 2. No ☐

17. Are you aware waste picking is a waste management strategy and source of livelihood?
   1. Yes ☐ 2. No ☐ 3. Am not sure ☐

18. Which of the following waste management options have you heard about? (*One or more answers*) 1. Waste prevention ☐ 5. Waste reduction ☐
   2. Waste reuse ☐ 6. Energy recovery ☐
   3. Material recovery ☐ 7. Incineration ☐
   4. Waste recycling ☐ 8. Landfilling ☐

19. Which of them do you think is better for the State? (*One or more answers*)
   1. Waste prevention ☐ 5. Waste reduction ☐
   2. Waste reuse ☐ 6. Energy recovery ☐
   3. Material recovery ☐ 7. Incineration ☐
   4. Waste recycling ☐ 8. Landfilling ☐

20. Where do you pour waste or used water? (*One or more answers*)
   1. In my back yard/over the fence ☐ 3. On the road/street ☐
   2. In the gutter/water channel ☐ 4. Into the toilet ☐
   5. By valley/waterbody ☐
   6. It is used again (*Please specify the use*) ……………………………………………
   7. Others (*Please specify*) ………………………………………………………

21. Is Waste Management important to you? 1. Yes ☐ 2. No ☐
   If yes, please, briefly state why and if no, please briefly state why.
   ………………………………………………………………………………………..
   ……………………………………………………………………………………….

22. What do you suggest to improve or resolve the waste management issue in the State?
   ………………………………………………………………………………………….
   ……………………………………………………………………………………………..

ENVIRONMENTAL IMPACT AND SUSTAINABILITY

Environment means **"the living and non-living surroundings; natural or man-made that make life on earth possible."**
Waste management means **"what is done to waste after it has been generated."**
Sustainability means **"economic and social development that protects and enhances natural environment and social equity without compromising future needs".**

23. Have you heard of environmental sustainability? 1. Yes ☐ 2. No ☐

24. Does your family take part in the monthly environmental/sanitation exercise?
1. Yes ☐ 2. No ☐

25. Are you aware of any current environmental sustainability moves in the State?
1. Yes ☐ 2. No ☐

26. Do you know about the environmental impact of haphazard waste disposal?
1. Yes ☐ 2. No ☐

27. Have you heard about/seen waste related health problems in the State or your area?
1. Yes ☐ 2. No ☐
If yes, please state some…………………………………………………………..

28. What do you notice at and around public bins and/waste disposal sites?
(*One or more answers*) 1. Waste pickers ☐ 4. Many animals ☐
2. Dark flowing water ☐ 5. Many insects ☐
3. Fire/smoke/odour ☐ 6. Others ………………………

Please tell how concerned you are about these issues	Concerned	Not concerned
How concerned are you about environmental pollution in the State?	☐	☐
How concerned are you about the health impact of waste?	☐	☐
How concerned are you about environmental sustainability?	☐	☐

29. Would you say waste is a major issue currently affecting the State's environment?
1. Yes ☐ 2. No ☐

30. Do you think if waste bins are stationed in every neighbourhood in the State, the rate of waste spread on our streets and roads will be reduced?1. Yes ☐ 2. No ☐

31. Do you think there is enough information/sensitization about the environmental impacts of waste in the State or your LGA? 1. Yes ☐ 2. No ☐

32. Do you think most environmental issues in the State could be minimized if waste is properly managed? 1. Yes ☐ 2. No ☐

33. Overall, how would you rate the quality of the environment in the State as compared to the environment about 10 years' back? 1. Better ☐ 2. The same ☐ 3. Worse ☐

Thank you very much Sir/Madam for your time and the information provided.
You just contributed to the development and cleanliness of the State.
GOD BLESS YOU AND YOUR FAMILY!!!

Appendix 2 Questionnaire for shops

Dear Respondents,
I am NGHEGWA ACHE Patience, a Doctoral student of the Julius-Maximilians-University Würzburg. I'm currently carrying out research on waste management as a correlate of environmental sustainability in Imo State, Nigeria. Please feel free to express your opinions as frankly as possible. This is purely an academic exercise and any information disclosed will be treated as a matter of confidentiality between the researcher and the institution. Your objective contributions will be highly appreciated.

Instructions Participation in this activity is completely voluntary.
Please go through the instructions relevant to each question.

Details of Respondent
Name of market………………………………………………………………......................
Type of shop……………………………………………………………………………..
How long has this shop been here? ....
Today's date …………………………………………………………………………

WASTE MANAGEMENT

'Waste' mean **"any residue or left-over or by-product arising from plants, animals or human activities that are usually discarded".**
'Waste management/ treatment' means **"what is done to waste".**

Please Sir/Madam, tick (√) in the appropriate boxes for your answer

1. What type of waste come out from your shop? (*One or more answers*)
   1. Electronic/electrical equipment ☐ 5. Metal ☐
   2. Food/organic waste ☐ 6. Textile ☐
   3. Plastics/packaging waste ☐ 7. Glass ☐
   4. Paper/carton ☐ 8. Others ☐

2. In what type of container do you collect waste? (*One or more answers*)
   1. Plastics ☐ 3. Tin/can ☐ 5. Carton ☐
   2. Old bucket ☐ 4. Old bag ☐ 6. Other (*Please specify*) ………………

3. What quantity of waste is generated in your shop per day?
   1. 1-2kg ☐ 3. 4-5kg ☐ 5. 8-9kg ☐ 7. Don't know ☐
   2. 2-3kg ☐ 4. 6-7kg ☐ 6. 10-11kg ☐

4. How often is the waste container emptied?
   1. Daily ☐ 3. Thrice a week ☐ 5. When filled ☐
   2. Twice a week ☐ 4. Weekly ☐ 6. Others (*Please specify*) …………………

5. Where/how do you usually dispose of collected waste? (*One or more answers*)

1. Into public bin/ at communal depot ☐ 6. By the road or street ☐
2. By a valley/water body ☐ 7. Collected by cart pushers ☐
3. Into a hole at the market ☐ 8. On an open space ☐
4. Thrown in bush/farm ☐ 9. Burnt ☐
5. In the refuse collection vehicle ☐

6. What time do you usually dispose of collected waste?

1. Mornings ☐ 1. Afternoons ☐ 3. Evenings ☐ 4. Nights ☐ 5. Anytime ☐

7. How often are the public bins emptied/depots emptied or curbsides cleared?

1. Daily ☐ 3. Twice a week ☐ 5. Don't know ☐
2. Once a week ☐ 4. Thrice a week ☐ 6. Other (*Please specify*) ………………..

8. How can you describe the state of the public bin you use at the market? (*One or more answers*) 1. In a good state/condition ☐ 3. Adequate size ☐ 5. Don't know ☐
2. Rusting/rotting/leaking ☐ 4. Inadequate size ☐ 6. Others…………………

9. Would you agree to pay fees for the bins /waste to be evacuated? 1. Yes ☐ 2. No ☐

10. Do you think waste disposal is a problem in this market? 1. Yes ☐ 2. No ☐

11. How do you evaluate the state of waste collection in this market area?

1. Good ☐ 2. Not good ☐ 3. Fair ☐ 4. Don't have ☐

12. Are you satisfied with the waste management practices in the market?

1. Yes ☐ 2. No ☐

13. If the State launches waste separation at source, will you practice it in your shop?

1. Yes ☐ 2. No ☐

14. Where/how do you dispose of waste or used water? (*One or more answers*)

1. In front of my shop ☐ 3. On the road/street ☐
2. In the gutter/water channel ☐ 4. By a valley/water body ☐
5. On top of the waste heap ☐
6. It is used again (*Please specify the use*) ……………………………………………..
7. Others (*Please specify*) ……………………………………………………..

15. What do you suggest to improve the waste management issue in the market?

...……………………………………………………………………………………….
…………………………………………………………………………………………
…………………………………………………………………………………………

Environmental Impact and sustainability

'Environment' means **"the living and non-living surroundings; natural or man-made that make life on earth possible."**
'Sustainability' means **"economic and social developments that protect and enhance the environment and social equity without compromising future needs"**

Please tell how concerned you are about these issues	**Concerned**	**Not concerned**
How concerned are you about wastes & environmental pollution in the market?	☐	☐
How concerned are you about the health impact of wastes in the market?	☐	☐
How concerned are you about the quality of the market environment?	☐	☐

16. Have you heard of/seen health problems due to waste spread in the market?
    1. Yes☐ 2. No ☐
    If yes, please state some………………………………………………………………….

17. Would you say waste is a major issue currently affecting the market square?
    1. Yes ☐ 2. No ☐

18. Do you participate in the monthly sanitation/environmental exercise?
    1. Yes ☐ 2. No ☐

19. Do you think there is enough information/sensitization about the environmental impacts of waste in market? 1. Yes☐ 2. No ☐

20. Do you think most environmental issues in the market could be minimized if wastes are properly managed?1. Yes ☐ 2. No ☐

21. Overall, how would you rate the environmental quality of the market as compared to it 10 years' back?
    1. Much better ☐
    2. A little better ☐
    3. The same ☐
    4. A little worse ☐
    5. Much worse ☐

Thank you very much Sir/Madam for your time and the information provided.

You just contributed to the development and cleanliness of the market and the State.

GOD BLESS YOU AND YOUR BUSINESS!!!

Appendix 3 Questionnaire for schools

Dear Respondents,
I am NGHEGWA ACHE Patience, a Doctoral student of the Julius-Maximilians-University Würzburg. I'm currently carrying out research on waste management as a correlate of environmental sustainability in Imo State, Nigeria. Please feel free to express your opinions as frankly as possible. This is purely an academic exercise and any information disclosed will be treated as a matter of confidentiality between the researcher and the institution. Your objective contributions will be highly appreciated.

Instructions Participation in this activity is completely voluntary.
Please go through the instructions relevant to each question.

Details of Respondent
Name of the school: …………………………………………………………………………
What is the population of the school? …………………………………………………………
How long has the school been in existence (in this city)? ……………………………………...
Today's date: ……………………………………………………………………………………

Please tick (√) in the appropriate boxes for your answer

1. What type of waste is generated in your school? (*One or more answers*)
 1. Paper/cardboard ☐ 3. Plastics ☐ 5. Textile ☐
 2. Food waste ☐ 4. Metals ☐ 6. Glass ☐ 7. Others…………..

2. What quantity of waste is approximately generated in your school per day?
 1. 50kg ☐ 3. 100kg ☐ 5. 150kg ☐ 7. 200kg ☐ 9. 250kg ☐
 2. 75kg ☐ 4. 125kg ☐ 6. 175kg ☐ 8. 225kg ☐ 10. Others (*Please state*)…..

3. In what type of container is waste collected in the school? (*One or more answers*)
 1. Plastic basket/bin ☐ 3. Tin/can ☐
 2. Old bucket ☐ 4. Carton ☐ 5. Others (*Please specify*) …………........

4. How often is the waste container emptied?
 1. Daily ☐ 3. Once in two days ☐ 5. Others (*Please specify*) ………..........
 2. Weekly ☐ 4. Once in three days ☐

5. Where/how do you dispose of collected waste? (*One or more answers*)
 1. At the communal depot/public bin ☐ 6. By road or street ☐
 2. By a valley/water body ☐ 7. Collected by cart pushers ☐
 3. In a pit in school premises ☐ 8. On an open space ☐
 4. Thrown into the bush/farm ☐ 9. Burnt within school premises ☐
 5. In the refuse collection vehicle ☐

If at the communal depot/public bin, how long does it take to get there on foot?
 1. 5-10mins ☐ 3. 16-20mins ☐ 5. Others (*Please specify*) …………………………. …
 2. 11-15min ☐ 4. 21-25mins ☐

What is usually used in carrying/conveying the waste to the above place (s)? (*One or more answers*)

1. School car ☐ 3. Tricycle ☐ 5. My personal car ☐
2. Hand cart ☐ 4. Barrow ☐ 6. Others (*Please state*) ....

Who usually does the conveying/carrying to the sites? (*One or more answers)*

1. Staff on duty ☐ 3. Students on punishment ☐ 5. Students/Pupils ☐
2. Late comers ☐ 4. Security/gateman ☐ 6. Others (*Please specify*) ……………..

If the waste is collected by the refuse collection vehicle or cart, how often do they come?

1. Daily ☐ 3. Twice a week ☐ 5. Monthly ☐
2. Weekly ☐ 4. Thrice a week ☐ 6. Termly ☐ 7. Others (*Please specify*) ………

If the waste is burnt, at what time?

1. Before school hours ☐ 2. During school hours ☐ 3. After school hours ☐

6. Does the school pay waste evacuation levy/fee? 1. Yes ☐ 2. No ☐
   If yes to whom? (*Please state*) ...…………………………………………………………..
   Is the payment per quantity or duration? 1. Quantity ☐ 2. Duration ☐ 3. Both ☐
   How much per kg/ton/truck? (*Please state*) ₦.………………………………………………..
   How much per week, month or term? (*Please state amount and period*) ₦.………………………..
   Do you consider the amount charged to be high? 1. Yes ☐ 2. No ☐

7. Does your school practice waste composting? 1. Yes ☐ 2. No ☐

8. Do you observe an environmental day/week in your school?1. Yes ☐ 2. No ☐

9. Is Environmental Studies/Education taught in your school? 1. Yes ☐ 2. No ☐

10. If the State were to embark on waste separation at source for onward treatment options like recycling, energy recovery, etc., would you enhance that in your school?
    1. Yes ☐ 2. No ☐

11. Do you think waste generation in your school can be minimized?
    1. Yes ☐ 2. No ☐
    If yes, please state how……………………………………………………………………...
    ……………………………………………………………………...
    If no, please state why ……………………………………………………………………
    ……………………………………………………………………...

12. Is the handling of waste a problem in your school? 1. Yes ☐ 2. No ☐
    If yes, what are some of the problems (*Please state*)
    ………………………………………………………………………………………………
    ………………………………………………………………………………………………

13. What do you think can be done to improve or remedy the situation? (*Please state*)
    ………………………………………………………………………………………………
    ………………………………………………………………………………………………

Thank you Sir/Madam for your time and the information provided. I am grateful. God bless you and the pupils/students in your care!

Appendix 4 Questionnaire for waste pickers

Dear Respondents,
I am NGHEGWA ACHE Patience, a Doctoral student of the Julius-Maximilians-University Würzburg. I am currently carrying out research on waste management as a correlate of environmental sustainability in Imo State, Nigeria. Please feel free to express your opinions as frankly as possible. This is purely an academic exercise and any information disclosed will be treated as a matter of confidentiality between the researcher and the institution. Your objective contributions will be highly appreciated.

Instructions Participation in this activity is voluntary.
Please go through the instructions relevant to each question.

Details of Respondent
Your State of origin: * ………………………………...… LGA of origin: ………………………..
Family status*: Married ………………………………. Single: …………………………………
Number of children* ……………………………………………………………………………
How long have you lived in this city? …………………………………………………………
Today's date: …………………………………………………………………………………..

WASTE MANAGEMENT

'Waste' mean **"any residue or left-over or by-product arising from plants, animals or human activities that are usually discarded"**

Please tick (√) in the appropriate boxes for your answer

1. How long have you been doing this job/work? …………………………………………………

2. What time do you usually work? 1. 6am-9am ☐ 3. 12-3pm ☐ 5. The whole day ☐
2. 9am-12pm ☐ 4. 3pm-6pm ☐ 6. Others (*Please state*) …

3. What type of items do you sort for? (*One or more answers*)
1. Paper/carton ☐ 5. Textile ☐
2. Plastics/Rubber ☐ 6. Glass ☐
3. Aluminium ☐ 7. Electrical/electronic items ☐
4. Metal/iron ☐ 8. Others (*Please state*)……………………………………………..

4. How many kilograms do you sort a day? 1. 5-10kg ☐ 3. 16-20kg ☐ 5. 26-30kg ☐
2. 11-15kg ☐ 4. 21-25kg ☐ 6. Others (*Please state*).

5. What do you do with sorted items? (*One or more answers*)1. Sell them ☐ 3. Recycle them ☐
2. Use them ☐ 4. Others (*Please state)*

6. If you sell them, how much is a kg of (*Please state the amount*) 1. Paper/carton ₦.......................
2. Aluminium ₦…… 3. Textile ₦ …….. 4. Electrical & electronic items? ₦…………….
5. Plastics/rubber ₦ ….6. Metal/iron ₦...... 7. Glass ₦ ….. 8. Others (*Please state*)……………

7. Do you have another job besides this? 1. Yes ☐ 2. No ☐

8. If no, is the money from this work enough to take care of you (and your family)?
1. Yes ☐ 2. No ☐

9. How much do you earn per day or month from this job? (*Please state*)…………………………..

Waste Pickers' opinions, experiences and challenges

10. Are you also schooling? 1. Yes ☐ 2. No ☐

11. What is your level of education? 1. No school certificate ☐ 2. Primary ☐ 3. JSS ☐
4. SSS ☐ 5. University Graduate ☐ 6. Vocational certificate ☐
7. Others (*Please state*)……………………………………………………………………

12. Do you like this work/job? 1. Yes ☐ 2. No ☐

13. Do you belong to an organization, group or association of waste pickers?
1. Yes ☐ 2. No ☐

If yes, what is the name? (*Please state*)

………………………………………………………

Is the association or group registered at the LG or State government? 1. Yes ☐ 2. No ☐

What is/are the function(s) of this association or group? (*Please state*)

…………………………………………………………………………………………

…………………………………………………………………………………………

If there is no waste pickers association or group, will you like to have one?
1. Yes ☐ 2. No ☐

15. Why did you choose this job? (*Please state*)
…………………………………………………….

…………………………………………………………………………………………

16. What are some of the challenges/difficulties you face in this work? (*One or more answers*)
1. Bites/attacks from animals and insects ☐ 2. Health Crises ☐
3. Injuries and accidents ☐ 4. Others (*Please state*)
………………………

17. What do you think can be done to remedy or improve the situation? (*Please state*)

Appendix 5 Interview guide for landfill site residents

Aim: to find out why they chose that site despite environmental difficulties

1. What is your State of origin please?
2. What is your family status?
3. Do you have children?
4. What is your occupation?
5. How long have you been living at his site?
6. Why did you choose to settle here?
7. How do you cope without lavatories?
8. What are some of the difficulties?
9. What do you think can be done to remedy the situation?

Appendix 6 Interview guide for landfill site owners

1. What is your State of origin please?
2. Do you own this land alone?
3. How many of you?
4. Was the land bought or inherited?
5. What is the size of the land?
6. Why is it being used as a waste dumping ground?
7. What do you mean by dangerous waste?
8. How much is the government paying each family?
9. How would you know what is dumped here daily?
10. Why did you not sell the land to the government and buy another one that is not a depression?
11. Don’t you think this waste will have negative effects on the house you will build or anything you will do here in the future?
12. What about the plastics and the iron; these ones don’t get rotten?

Appendix 7 Interview guide for waste traders (buying and selling)

1. What is your State of origin please?
2. What is your family status?
3. Do you have children?
4. How long have you been trading on waste items?
5. Do you have another job besides this one?
6. About how much do you earn weekly?
7. Are your earnings enough for you and your family?
8. What type of items do you usually buy?
9. What is the buying price per kg?
10. How much do you resell?

Appendix 8 Interview guide for the landfill manager/supervisor

1. What is your name sir?
2. When did you start working here?
3. Why dis piece of land?
4. How much is the government paying each family?
5. What is the size of the land?
6. How many public bins are in town?
7. Do they have specific stationing sites/places?
8. How many trucks transport the waste?
9. What happens on cleanup days with so much waste on the streets?
10. How many trips does each make?
11. What will happen when this pit is filled?
12. Do you experience difficulties supervising the work here?
13. What do you do during such times? And what else do you think can be done?
14. Can’t you talk to the governor about the negative effects of this site to the environment?

Appendix 9 Interview guide for hotel managers

1. when was this hotel established?
2. How many stars?
3. How many guests ledge here daily?
4. What types of waste are generated here?
5. In what type of container do you collect waste?
6. Approximately how many kg per day?
7. How often is the waste container emptied?
8. Where do you dispose of collected waste?
9. At what time?
10. Approximately how many litres of used/waste water is generated here daily?
11. Where do you dispose of used/waste water?

Appendix 10 Interview guide for the Imo State chairperson, NHA

1. What is your name sir?
2. How many hotels are in Imo State?
3. What exactly do you do as the NHA, Imo State chapter?
4. What categories of hotels are there in Imo State?
5. What are the criteria for the categories?
6. How many guests patronize the categories of hotels daily?
7. What types of waste are generated by these categories of hotels?
8. Approximately what quantity daily?
9. Why is the waste quantity more during weekends?
10. Why the price difference for waste evacuation services between the hotel categories?

Appendix 11 List of hotels in Owerri

LIST OF HOTELS

Chief Dr Nweke Ishmael Emeka (FHIBS)
Imo State chairman

Ng. Hotel Asso. from Chief Nweke
Imo State chapter

BREAKDOWN AND CATEGORIES OF HOTELS IN IMO STATE COMPILED BY

4 stars	• Shadw hotels Ltd (Egbeada)	• Candlewood hotel & suites (New Ow
	HOTEL NAME	**LOCATION (ADDRESS)**
	• Jonvita hotel - Orlu rd)	• G Tower hotels & tourism (New Ow)
	CATEGORY "A"	• Jacobs place (4 bradna drive WB)
7	Allseasons Hotel	• Bayview (Area B)
1. ✱ •	Imo Concord Hotel Ltd	New Owerri, by PH Rd
2. ✱	~~Modotel Nig Ltd~~ Rockview	Okigwe Rd Roundabout.
3. ✱	~~Imo Hotels Ltd~~ Bilton Continental Ltd	Assumpta Avenue .Ow
4. ✱	~~Lamonde Hotel~~ Full moon	Ugwu Orji Nek. Old Rd / off Akanchawa
5. ✱	Owerri Hotel Plaza	PH. Rd
6. ✱	Disney Hotel & Resort	Onitsha Rd
(19)	Immaculate suits (Area A) City Global (PHrd) Great wood (PHrd) Newton hotels Ltd (off P/H rd) Oriental Pillars • Haven suites • Ranpour hotels	
	CATEGORY "B"	
1.	All Seasons Hotel	New Owerri by P.H. Rd
2.	Links Hotels	New Ow by PH Rd
3.	Benchmark Hotel	Ikenegbu, Owerri.
4. ✱	Best way Hotels	Orlu Rd Ow.
5.	Shangri-La Hotel	Naze, Ow/Aba Rd
6.	Explicit lodge Ltd	New Ow.
7.	N.C.J. Suits	New Ow.
8.	Milton Hotels & Suits	Pot 539 Works Layout Ow.
9. ✱	Ideal Suits	World Bank Ow.
10 ✱	Aladimma Royal Suit	Aladimma Housing Estate Ow.

Dream Land Suites
• Titanic view hotel/suites

(2)

	CATEGORY "C"	
1.	East gate Hotel Ltd	Ugwu Orji
2.	Dreamland Hotel Ltd	World Bank Area A
3.	Real Hotel Ltd	World Bank Area A
4.	Legend Hotel Ltd	New Ow. by PH Rd
5.	Executive garden Hotel	Okigwe Rd
6.	Rapour Hotel Cat A	
7.	Elix Hotel	Orlu Rd
8.	Da-Arugo Int'l Hotels	Orlu Rd
~~9.~~	~~Kedan Int'l Hotels~~	Tetlow Uratta Street Ow.
10.	Prestige Royal Suits	~~Opp Nkwo Orji Mkt. Ow~~
11.	Suncity Hotels	3 Nkwere Strt, Works layout Ow.
12.	Stone Castel Hotel	New Ow. by RH. Rd.
13.	New Castel Hotel	Okigwe Rd Ow.
14.	Lodan Int'l Hotel	World Bank Ow.
15.	Lobic Meridian Hotel	MCC/Uratta Rd, Ow (Interview point)
16.	Grisp Royal Suits	P.H. Rd Ow.
17.	Daniels Court	Works Layout Ow.
18.	Bombolin Hotels Ltd	P.H. Rd Ow.
19.	Cradle Hotels	New Ow behind conberd Hotel Ow.
20.	Summer Suits	Works layout Ow.
21	Capitol Hotel	N22 Las Unogu Strt Ow.
	Benzia Hotel	Orji
		Nkd-old Rd
	Motels	
	CATEGORY "D"	
1.	Jay-Cay Hotel Resort	
2.	Grandeur Hotel	Jay-CAY Avenue, Okigwe Rd Ow.
3.	Mair Fair Hotel Suits	Aladimma Ow.
4.	Evatel Suits	Egbu Rd Ow.
5.	Royal Nodic Suits	Works layout Ow.
6.	Pine Wood Hotel	Ikenegbu Ow.
7.	Rose velt Suit	Orlu Rd Ow.
8.	Golden Palace	Egbeada Housing-Estate Ow.
		Workslayout

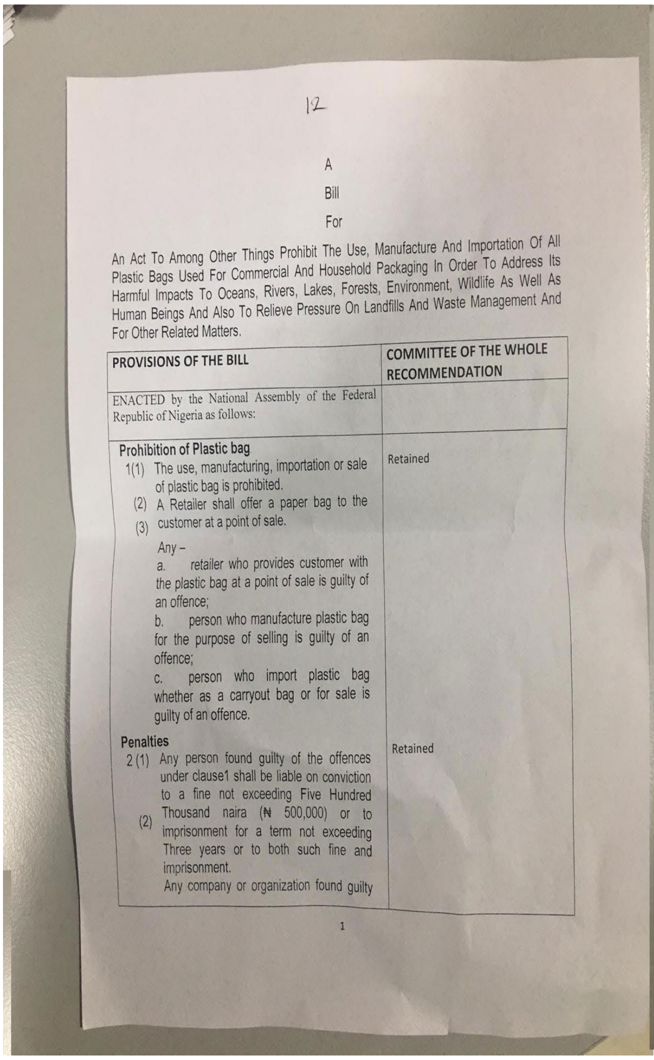
(3)

9.	Holly wood Int'l Hotel ___	Aladimma Ow.
10.	Cachez Suits _________	Ikenegbu Ow.
11.	Sterling Hotels_________	414 Wesley Avenue Aladimma Ow.
	Motels	
	CATEGORY "E"	
1.	Tripple "M" Motel ______	Works layout Ow.
2.	Mount Royal Hotel______	Amakohia Ow.
3.	Osgreat Eldorado Hotel__	14 Porket layout Ow.
4.	Kedan Int'l Hotel_______	Opp. Nkwo Orji Mkt. Ow.
5.	East end Hotel ________	
6.	Magnitude Hotel ______	Orji Ow.
7.	Hotel de Andrea________	
8.	Vivian Hotel Ltd_______	
9.	Hanna Hotel Ltd _______	
10.	Shedive Hotel Cat A	Amakohia/Akwakuma
11.	Houstonia Hotel_______	Orji Ow.
12.	Pelly Hotel Ltd_________	Okigwe Rd by Ukwugba) Ow.
~~13.~~	~~Eddice Int'l Hotl~~ Deo Juvante	~~Ugwu Orji~~ Egbu
14.	Frunds Garden Hotel___	Okigwe Rd Ow
15.	Blossom Star Hotel______	Irette.
	CATEGORY "F"	
1.	Horizontal Hotel Ltd___	Akwakuma Ow.
2.	Edinburgh Hotel Ltd ___	Plot 128 Ikenegbu Ow.
3.	Heavenly Hotel_______	Mcc/Uratta Rd Ow.
4.	Ambassador Hotel______	No 55 Mbaise Rd Ow.
5.	Dommino Paramount Hotel__________	Ihugba Strt Ow.
6.	Imo Paradise Hotel_____	Orji Ow
7.	Courtesy Hotel________	Orji Ow.
8.	Listan Hotel _________	Ugwu Orji
9.	Gon leeg Hotel_______	Obinze
10.	Eddico Int'l Hotel_______	Plot 196 Ugwu Orji Ow.

(4)

		REMARKS: at least ₦20,000= monthly for effective and regular evacuation of refuse	
		CATEGORY "G"	
1.		Ladida continental	Egbu...
2.		Elix Hotel Ltd	
3.	*	Oasis Hotel	Olu rd, Egbeada
4.		Stayfine Hotel	Akwakuwa
5.		Vercity Hotel	No 5 Archdealon Dennis Ikenegbu Ow.
~~6.~~		Cathys suites	Akwukuma
~~7.~~	*	~~New Stadium Hotel~~	World Bank
8.		Hotel de Andrew	~~Ikenegbu Ext. Ow~~
9.		Home best Hotel	Uratta Ow.
10.	*	Dunlil Hotel	Ow. Municipal
			Ow. Municipal
		REMARKS: at least ₦15,000= monthly for effective and regular evacuation of refuse	
		CATEGORY "H" GUEST HOUSES	
1.		Sylvado Guest House	
2.		Park Avenue Guest House	Mcc Rd Ow.
3.		Summit Int'l Guest House	Amakohia
~~4.~~		~~Princess Guesthouse~~	Okigwe Rd Ow.
5.	*	Rimo Guest House	Ikenegbu extension
6.	*	Triumphal Guest House	Naze Ow.
7.		James Hotel	No 15 CBN Quatrs Ow.
8.		Bonanza Guest House	104 Lobo Ext Ow.
9.		Goliz Guest House	
10.		Reggae Guest House	No1 Udonna Close Mbieri Rd Ow.
11.		Phagdan Rest House	Mcc/Uratta Rd Ow.
12.		Keddni Hotel	No4 Bus Stop Nekede.
13.		Aku Guest House	No 4 Bus Stop Nekede
14.		River side Hotel	Lobo Strt. Ow.
15.	*	Geomil Guest House	Uzoma bus stop Nekede
	*	Starplex guesthouse	Mcc/Uratta Rd Ow. Area A

Appendix 12 Bill prohibiting use of plastic bags in Nigeria



12

A

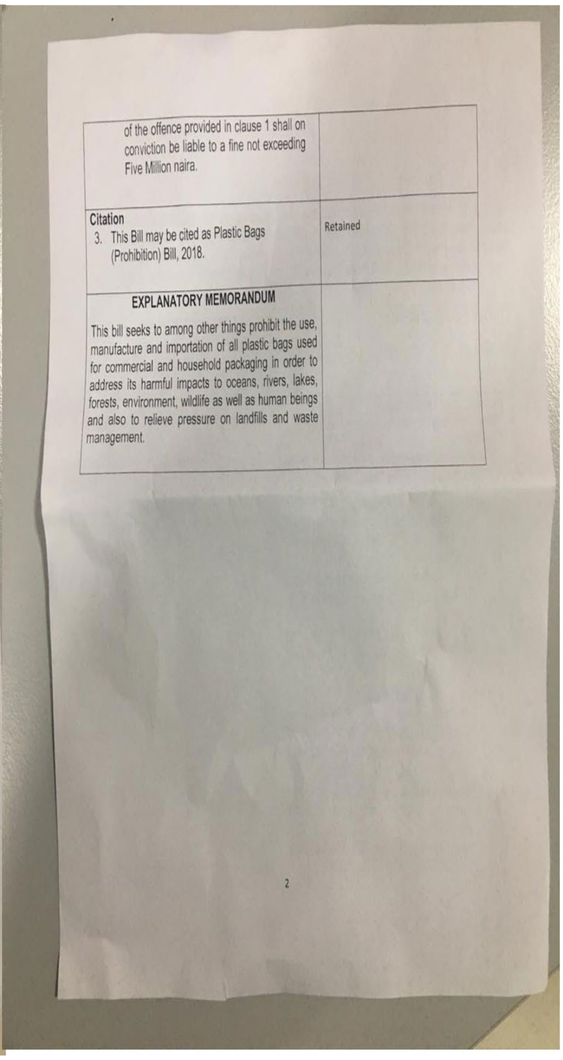
Bill

For

An Act To Among Other Things Prohibit The Use, Manufacture And Importation Of All Plastic Bags Used For Commercial And Household Packaging In Order To Address Its Harmful Impacts To Oceans, Rivers, Lakes, Forests, Environment, Wildlife As Well As Human Beings And Also To Relieve Pressure On Landfills And Waste Management And For Other Related Matters.

PROVISIONS OF THE BILL	COMMITTEE OF THE WHOLE RECOMMENDATION
ENACTED by the National Assembly of the Federal Republic of Nigeria as follows:	
Prohibition of Plastic bag 1(1) The use, manufacturing, importation or sale of plastic bag is prohibited. (2) A Retailer shall offer a paper bag to the customer at a point of sale. (3) Any – a. retailer who provides customer with the plastic bag at a point of sale is guilty of an offence; b. person who manufacture plastic bag for the purpose of selling is guilty of an offence; c. person who import plastic bag whether as a carryout bag or for sale is guilty of an offence.	Retained
Penalties 2 (1) Any person found guilty of the offences under clause1 shall be liable on conviction to a fine not exceeding Five Hundred Thousand naira (₦ 500,000) or to imprisonment for a term not exceeding Three years or to both such fine and imprisonment. (2) Any company or organization found guilty	Retained

1



of the offence provided in clause 1 shall on conviction be liable to a fine not exceeding Five Million naira.	
Citation 3. This Bill may be cited as Plastic Bags (Prohibition) Bill, 2018.	Retained
EXPLANATORY MEMORANDUM This bill seeks to among other things prohibit the use, manufacture and importation of all plastic bags used for commercial and household packaging in order to address its harmful impacts to oceans, rivers, lakes, forests, environment, wildlife as well as human beings and also to relieve pressure on landfills and waste management.	

2

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Declaration

I hereby declare that the dissertation submitted by me entitled "Waste Management as a Correlate of Environmental Sustainability in Sub-Saharan Africa: The example of Imo State, Nigeria" was done independently and exclusively using the literature and tools provided. The sources quoted have been marked as such. This work has not been submitted to any other examining authority.

Würzburg, July 2019	Nghengwa Ache Patience