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Review Article

Green design or multiple re-useable product packaging as regards solid waste in selected areas in Awka Metropolis, Nigeria

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ABSTRACT

This study enumerates how product packaging amount to solid wastes among other Awka MSW constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria. Perhaps, there are locations with well managed or minimized packaging waste; accordingly, this study includes the review of some literatures on Awka MSW so as to note the extent of studies that have been published and made available in trendy media. Thus, the study is descriptive, literature-based and naturalistic observation -based in terms of estimated counting during the visitation to the selected areas. The findings reveal that studies on solid waste characterization, health, perception, behaviour of the populace in relation to solid waste and sustainability are ubiquitous. Still, the aspect of product packaging waste in the Awka metropolis has not been extensively studied; thus, present study fills this gap by aiming at unfolding green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria. However, this study in concord with prior studies shows that the product package among other solid waste occurs in a similar way in residential locations except other locations such as markets, schools, hospitals, municipal and industrial areas which have more of the litters of non-green packaging materials. Example is the plastic package with the largest quantity of generated solid waste within selected location in relation to other solid waste. Thus, the policy approach under which producers are given significant responsibility for waste prevention/diversion of post-consumer products should be ongoing through Private - Public Sector Partnerships (PPP) harmonized with EPR. This can be done by enhancing the concern of everybody (manufactures, consumers, organizations and other entrepreneurs including waste pickers/scavengers). Situation where by producers persuade the consumers through gainful or attractive means to return used product packages can be encouraged. Thus, the present study unfolds green design or multiple reuses of product packages as a means of attaining zero waste in Awka metropolis.

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INTRODUCTION

Green design can be synonymous to eco-friendly design or sustainable design. A sustainable design should reduce negative impacts on the environment, health or well-being of the people. To be eco-friendly is to be less threatening or harmful to the environment and the living organism, most especially human being. Similarly, green design involves the aspect of safe environment by focusing on waste prevention and organic environment void of toxicity. The length of product life, safety, waste management and to mention a few are important aspect of green design. This seems to be difficult to achieve in product packaging design of certain product as the manufacturers do make use of such non-green substance that requires some hazardous chemicals. Examples are components of solid wastes from electronic devices, automobiles, and to mention a few products. Thus, present study enumerates how product packaging amount to solid wastes among other Awka Municipal Solid Waste (MSW) constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria.

In quest of green design, the 10R principles should be the goal of contemporary designers and other stakeholders. The 10R includes the following; viz: Reduce, Reuse, Recycle, Renew, Refill, Repair, Re-manufacture, Replace, Refine and Remove [1]. It is the notion of present study that green design should harmonize human being, nature/environment and the products being used in a symbiotic association. For purpose of this symbiotic association, reducing the solid waste in the environment will benefit everyone because waste will be minimized. Reuse as a factor in green design will be economical in the sense that the manufacturers will not need to produce more of the product package because the available ones can be reused. This is also beneficial to everyone as the number of waste will be minimized. Thus, this approach can be more environmental friendly and enhance waste prevention as well as save money. 'Reuse' is somehow similar to refill in the sense that product content can be replace into the product package after the initial use. This aspect of reuse in green design is not new; but more innovation and technological development or certain logistics depleted this practice. It can be observed that this depleted practice as a result of certain logistics is a kind of backward attitude described by these phrases - 'grow first', clean up later' [2]. The 'grow first' notion will continue to create more waste if green designs are not put into use. In such situation, as the manufacturers are producing more non-green design then more profits are made (they are attached to benefit oriented aspects in order to have a better market of such product [3] but at the expense of more waste generation, environmental waste, exposure of people to hazardous toxic materials. It is also worthy of note that in a country like Nigeria, 'clean up later' is difficult to achieve. However, the government agencies are trying but the effort is not enough. Now, the pursuit of Sustainable Development Goal (SDG) is very germane to our wellbeing and stakeholders should be mindful of it. Stakeholders should try the possibility of reuse, refill, and recycle to mention a few in order to reduce the negative impact of non-green design on the environment [4]. Enterprises can also use it as a means of competitive advantage [5]. Thus, it can become means for strong driving force in the market towards sustainable consumption pattern [2]. This is because many stakeholders such as the manufactures will start to reduce waste disposal problems at the consumption and manufacturing level. Present study is of the notion that there should be reversal to the practice of 'reuse' in product packaging design especially in order to minimize solid waste. Thus, present study enumerates how product packaging amount to solid wastes among other Awka MSW constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria.

Design For Environment (DFE)

This is an innovative design approach where by environmental factors are considered very crucial in the design and manufacturing process of a product or service. DFE attempts to minimize the adverse influence of design on the environment. DFE is mutual to product life cycle in the sense that the raw materials, manufacturing and package design, distribution of the product, utilization or functionality of the product and end of life of such products are all considered. Thus, DFE is about better design, product performance as well as well-being of the ecosystem in the aspect of safety, health, and to mention a few. With this notion, present study acknowledges that green design is not new and several enterprises or stakeholders in the world have been making effort to operate according to DFE. However, this study recommends it not as a new development but a re-consideration of green design or multiple reuse product packaging as regards solid waste in selected areas in Awka metropolis. This justifies the notion of present study for exploring the existence of solid waste in Awka metropolis selected areas with the view to see how product packaging amount to solid wastes among other constituents of Municipal Solid Waste (MSW). Thus, this study generally appraises packaging as regards solid waste in selected areas in Awka metropolis with the view of recommending green design or multiple reuse-able product packaging.

PRODUCT PACKAGING

Packaging is the means of protecting products (such as food, electronics, manufactured good items, etc.) from damage. The aforementioned is the primary function of product packaging. It makes the delivery of products to be in good condition for the purpose of successful trade. This aspect of product packaging facilitates transportation, handling, storage and preservation. By putting DFE into consideration, lifecycle of packaging from production,

distribution and retailing, until the disposal of that package should be put into consideration [3]. Thus, the choice of raw materials for the packaging should be according to the 10R principles (it should be packaging materials that 'Reduce' environmental waste and other forms of hazards; stakeholders should be able to 'Reuse' the packaging materials in a beneficiary way; to 'Recycle' the materials should not be impossible, stakeholders should be able to 'Renew' the packaging material; to 'Refill' the product content should be reasonable and acceptable to the consumer; 'Repair', 'Re-manufacture', 'Replace', 'Refine' should be possible. In a nut shell, it should not give room for waste.

Having think of waste prevention, it may be sarcastic but reasonable to believe that aesthetic appearance of the product package should prevent waste in the environment. To certain consumers, product packaging may be very attractive or attention grabbing because of its graphic design. It is then surprising to find these attractive product package in the waste bin. Is it not an artwork? Because of the aesthetics of product packaging, people who love beautiful things should not trash them. Pedestrians who buy biscuit along the road trash the packaging immediately. The pedestrians also see metallic container (.e.g. can), paper (.e.g. carton), plastic and to mention a few all round littering the surrounding, by the roadside and even inside the waste bin [6]. Someone's mindset is that these product packages are graphically appealing and should not end as waste. Thus, present study enumerates how product packaging amount to solid wastes among other Awka Municipal Solid Waste (MSW) constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria.

Traditional and Modern Product Packaging

Traditional packaging such as plant leaves, bamboo baskets, animal skins or clay pots are typical early packages.

These are made from natural or organic materials such as banana leaf as seen in Figure 1 for food packaging. If we compare this traditional packaging with modern product packaging, it will be discovered that the transition is all about innovation and technological development.

Figure 1. Banana leaves as example of traditional packaging.

Both modern and traditional packaging still function as protection, preservation, containment and ease of distribution or transportation. But the aspect of marketing, communication, protection, preservation, containment and ease of distribution or transportation will be different due to the technological advancement.

It is naturalistic to pronounce that the traditional packaging will contribute to environmental pollution (.i.e. in aspect of temporary unpleasant odour, quicker decay or degradation which will eventual lead to green manure) but its pollution is symbiotic to the ecosystem unlike certain modern packaging such as plastic. The traditional packaging (.i.e. plant leaves and others) are biodegradable. Metallic packaging like tin/can will rust after some period of times; according to the Mumbai government it will degenerate between 100 to 500 years. Likewise, other modern product packaging materials like plastic also takes a very long time to degenerate. Then, green design which is an innovation for modern packaging can be seen to be modeled in accordance to the behaviour of traditional packaging.

In Figure 2, majority of the conspicuous solid waste are the discarded modern packaging materials. Plastic related package and metallic substance can be seen while others can be considered to be degraded by undergoing rapid decomposition. Paper which is one of the modern product packaging is considered environmentally friendly .i.e. biodegradable. It is one of the modern product packaging material considered to be according to green design. In Table 1, paper takes 10 to 30 days to decompose compare to other packaging materials which takes above 500 years to degenerate.

Figure 2. Various solid wastes which consists of discarded modern product packaging like metallic can and plastic bottles to mention a few.

Thus, present study enumerates how product packaging amount to solid wastes among other Awka Municipal Solid Waste (MSW) constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria

SOLID WASTE

Waste can be something which the owner no longer want at a given time and specific position because to him or her such things have no current or perceived market value

[7].If wastes are refuse, garbage or rubbish things that are derived from places of human and animal habitation, then they are as a result of the activities of nature .i.e. human being; however, waste that are biodegradables are more beneficial to nature. Hence, can be considered to be symbiotic [8].

Table l. Decomposition Rates of Solid Wastes [9]

Solid Waste	Approximate time of degeneration
Vegetable and fruit peels, leftover foodstuff, etc	A week or two
Paper	10 -30 days
Cotton cloth	2-5 days
Wood	10-15 years
Woolen items	1 year
Tin, aluminum, and other metal items such as cans	100 -500 years
Plastic bags	One million years
Glass bottles	Undetermined

The biodegradable ones are the decomposable refuse while the non-decomposable are not degradable. Thus, solid waste either non-biodegradable or biodegradable can be considered as unwanted substance either solid, semi-solid, liquid or non-gaseous products which are discarded as a result of human or animal activity. They consists of complex mixture of different substances present in such garbage, or food waste, paper, glass, cars and other household wastes in our surroundings which may be beneficial or disadvantageous to the ecosystem.

Threats to the environment and human health as result of the heaps of garbage (solid wastes) that pile up in neighbourhoods and ineffective management [10] is one of the aspects of the disadvantages in recent times in most Nigerian urban cities. Thus, present study enumerates how product packaging amount to solid wastes among other Awka Municipal Solid Waste (MSW) constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria

The Table 1 is a publication by the Mumbai government showing different rates of decomposition of Solid Waste. From Table 1, certain product packaging product such as plastic is estimated to take up to one million years to decompose. Tin, aluminum and other metals approximately takes between 100 to 500 years to decompose while glass bottles are undetermined. So, if ignored can wreck the environmental suitability and existence of any well-meaning people. Such deterioration in environmental quality affects adversely the health and longevity of human beings and other living organisms.

AIM AND OBJECTIVES

Present study enumerates how product packaging amount to solid wastes among other Awka Municipal Solid Waste (MSW) constituents with the view to unfold green design or multiple re-useable product packaging as achievable means of minimizing solid waste in Awka Metropolis, Nigeria. The specific objective is to investigate whether product packaging amount to solid waste in the similar manner across the selected location within Awka metropolis. Probably, there are locations where there are well managed and minimized packaging waste. Accordingly, the study includes the review of some literatures on Awka

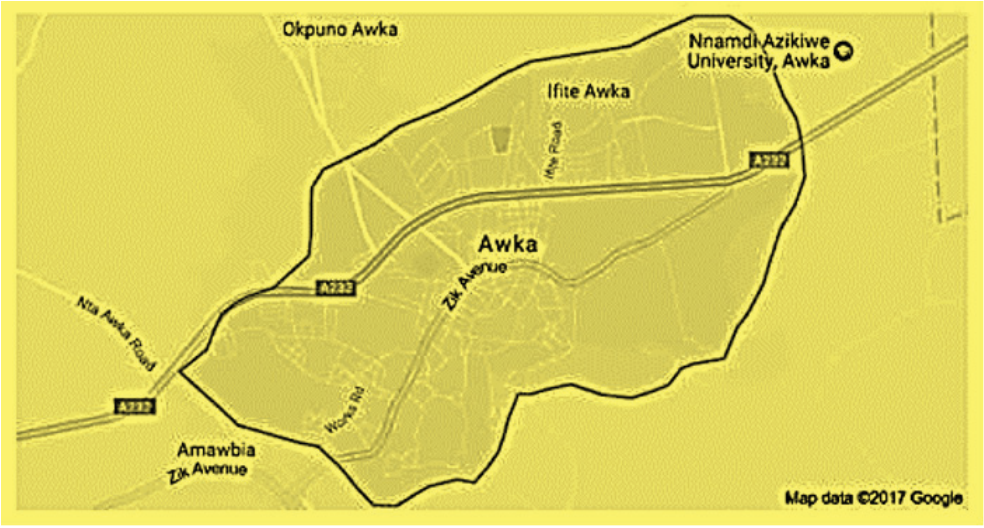

Figure 3. Closest places to Nnamdi Azikiwe University (NAU).

MSW so as to note the extent of studies that have been published and made available in trendy media.

SCOPE OF THE STUDY

This study focuses on selected Awka MSW as regards product packaging, and review of selected literatures on Awka MSW.

Study Area

The study area includes selected area in Awka, Anambra State in Nigeria. Figure 3 is the map showing the closest places to the Nnamdi Azikiwe University (NAU). Proximity to the NAU, is one of the criteria for choosing selected Awka MSW as regards product packaging, and review of selected literatures on Awka MSW.

METHOD

This study is descriptive and it is based on the review of selected prior literatures on Awka MSW as regards product packaging. The researchers searched for the statements '*Product packaging as integral components of solid waste in Awka Metropolis*' on the Google Chrome (GC), Semantic Scholar (SC), ResearchGate (RG) and Google Scholar (GS) on the February 4, 2023. Figure 4 shows the pie chart depicting the extent of related information obtained from the aforementioned sources.

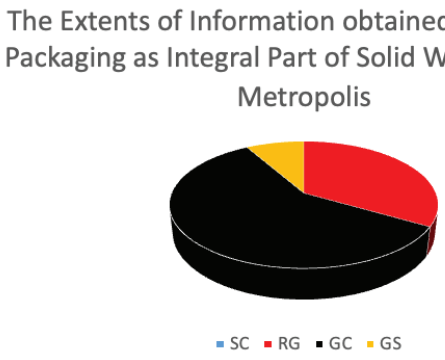

Figure 4. Pie chart of the extent of related information obtained from the GC, SC, RG and GS.

GC has the largest articles related to the scope of this study (see Figure 4); it provides the link to the journals of the articles or the other sources of the articles. Some of the PDF scholarly articles are downloaded directly from the GC without loading the exact source of the articles. Examples are the three (3) articles from different journals downloaded directly from GC; namely, International Journal of Environment and Pollution Research (IJEPR); Journal of Environment and Earth Science (JEES); NG- Journal of social Development (NG- JSD). By using set theory notation,

$$\{\{GS \cap GC\} \cup \{RG \cap GC\}\}' = \{\text{IJEPR, JEES, NG- JSD}\} \quad \text{(i)}$$

$$n\{\{GS \cap GC\} \cup \{RG \cap GC\}\}' = \{3\} \quad \text{(ii)}$$

The set notation in equation (i) and (ii) shows that there are three (3) articles not yet made available in GS and RG but are only in GC. Thus, it is intelligent to consult more than one internet sources in order to get suitable prior researches for this present study. The Venn diagram in Figure 4 shows the relationship that exist among the internet sources browsed for the purpose of this study. SC is disjointed from the rest because there are no related articles obtained from it.

In Figure 5, there is no intersection between GS and RG; it is surprising that available related articles are not simultaneously existing in both internet sources (.i.e. GS and RG). GC only behave as a link between GS and RG; thus, this proves that GC is a cross-platform web browser while other internet sources are media for academic scholars.

$$n\{GS \cap GC\} = 1 \quad \textit{(iii)}$$

Equation (iii) shows the intersection of GS and GC; only one article is simultaneously existing in both internet sources. This is a research published by MDPI Recycling (see equation iv). Equation (v) and (vi) show the intersection of RG and GC consisting of Journal of Applied Science and Environmental Management (JASEM), and Journal of Environmental Management and Safety (JEMS).

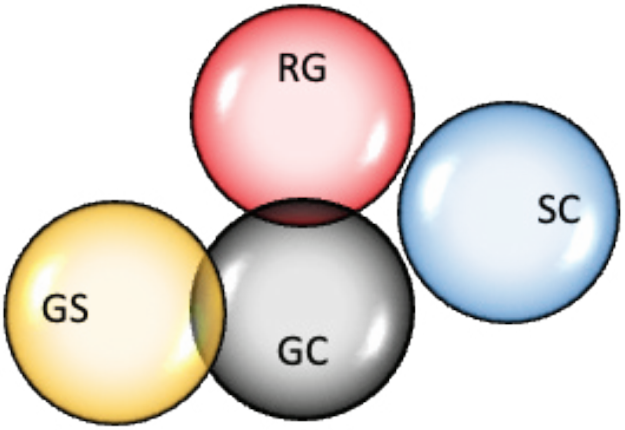

Figure 5. Venn diagram for the relationship between the GC, SC, RG and GS in terms of the selected journals.

$$\{GS \cap GC\} = (MDPI\ Recycling\} \quad (iv)$$

$$n\ \{RG \cap GC\} = 3 \quad (v)$$

$$\{RG \cap GC\} = \{JASEM, JEMS, JEMS\}\} \quad (vi)$$

In equation (vii), there are no related article existing simultaneously in GC, GS and RG. The total numbers of articles are 8 as seen in equation (viii) which is the union of the sets.

$$n\ \{RG \cap GC \cap GS\} = \emptyset \quad (vii)$$

$$n\ \{GS\ U\ GC\ U\ RG\ U\ SC\} = 8 \quad (viii)$$

$$\{GS\ U\ GC\ U\ RG\ U\ GC\} = (MDPI\ Recycling, IJEPR, JEES, NG\text{-}JSD, JASEM, JEMS, JEMS, JEH) \quad (ix)$$

The result of the internet search shows eight research papers as seen in Table 2; thus present study reviews only these eight papers. Naturalistic observation also is involved during the visitation to selected areas in order to observe how product packaging forms integral components of solid waste in Awka metropolis (see Figure 6 for diagrammatic representation of the procedure for data collection).

RESULTS AND DISCUSSION

Figure 7 depicts the extent to which solid wastes in selected areas within Awka metropolis have been studied. Based on the findings from prior studies, solid waste in residential areas as well as dump sites are often examined by prior researches (see Figure 7). That is, there are more studies on the location of solid wastes within the residential areas as well as dump sites within Awka metropolis. Not much researches have been carried out on solid waste in locations like water bodies, road, abattoirs, abandoned building, market/commercial centres, and school offices to mention a few.

Table 2. Eight (8) Research Topics from Seven (7) Journals reviewed

S/N	Journal	Topic	Authors	Internet Sources
1	MDPI Recycling	A Statistical Regression Method for Characterization of Household Solid Waste: A Case Study of Awka Municipality in Nigeria	Ezeudu, Ozoegwu & Madu	GC and GS
2	IJEPR	Evaluation of People's Perception on Plastic Waste Management, A Study of Nnamdi Azikiwe University in Awka, Anambra State	Onwuka and Ajator	GC
3	JEES	Evaluation of Domestic Solid Waste Disposal in Two Selected Housing Estates in Awka, Anambra State (Case Study of Udoka and Real Estates)	Ozoemene, Obienusi, & Ezenwaji,	GC
4	NG- JSD	Effect of Solid Waste Management on Sustainability of Clean Environment that Promotes Healthy Living in Nigeria: A Study Of (ASWAMA) Awka, Anambra State of Nigeria	Obi, Orga, and Ogadimma	GC
5	JASEM	Survey of Waste Disposal Methods in Awka Metropolis	Bill, Chidi Christopher and Ewuzie	RG and GC
6	JEMS	Developing an Effective Urban Waste Management System for Sustainable Environment: A Case of Awka Capital Territory, Anambra State.	Okeke and Anukwonke	RG and GC
7	JEMS	Behavioural and Household Characteristics Influencing Solid Waste Generation in Awka, Anambra State, Nigeria	Egbu, Umunakwe, and Ogbonna	RG and GC
8	JEH	Solid Waste Management in Awka Metropolis and Public Awareness : Sensitizing the Populace Through the Use of Social Cartoons	Onwuekwe and Okoye	RG

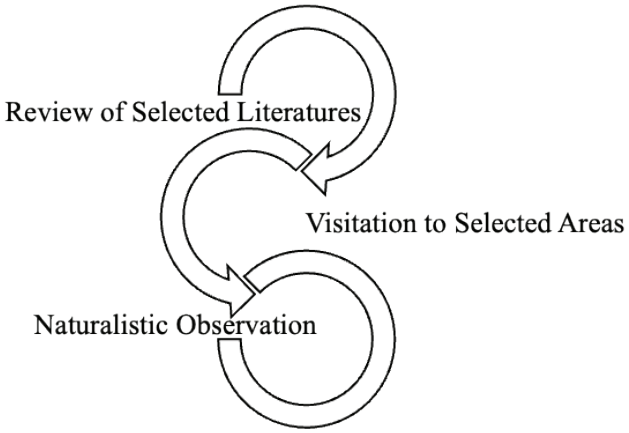

Figure 6. Procedure for data collection.

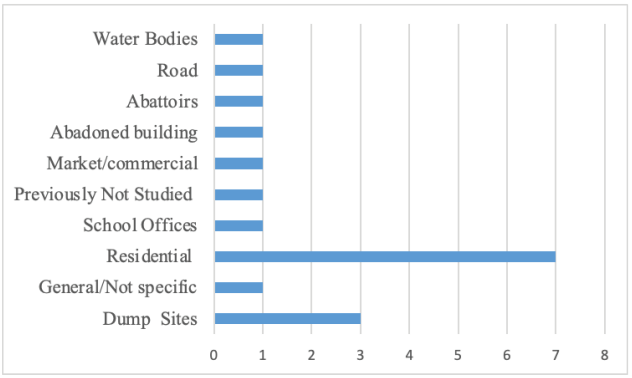

Figure 7. Locations of Solid Waste within Awka Metropolis based on prior studies.

Table 3 shows the selected areas within the Awka metropolis as studied by prior studies (.i.e. the eight (8) research papers reviewed in this current study). Studies on previously not studied location are scarce (see Figure 7). Also, studies that are generalized (.i.e. that are not specific to particular location) within Awka metropolis are few (see Figure 7). Having, based the rationale of current study on DFE, to re-examine the existence of solid waste in Awka metropolis selected areas with the view to see how product packaging amount to solid wastes among other constituents of Municipal Solid Waste (MSW) is considered significant to the scope of current study. Thus, present study will build on this existing body of knowledge in order to explore the existence of solid waste in Awka metropolis selected areas with the view to seeing how product packaging amount to solid wastes among other constituents of Municipal Solid Waste (MSW).

It can be assumed that the authors (.i.e.Ezeudu, Ozoegwu and Madu, [11]) probably studied locations where there are less of industrialized packaged products (see Table 3 and 4).

This is because majority of the solid waste are organic which is believed to be more related to green environment. In another more positive way, it can be assumed that the few plastic which are found in the environment can also be minimized further by adhering to the 10R principles (.i.e. Reduce, Reuse, Recycle, Renew, Refill, Repair, Re-manufacture, Replace, Refine and Remove). Onwuka and Ajator [12] also affirms that majority of the people never conceive the idea of re-using the solid waste (see Table 4); thus, they dispose them anyhow or incessantly. Eventually, more solid waste are generated because the 10 R principles are not followed. This can be the reason for the composition of the dump sites as studied by Ozoemene et al. [13] which are more of plastics and other non-biodegradable. This also attest to the fact that the solid waste within the selected areas in Awka metropolis can be further minimized if green design or multiple reuse is inculcated.

The study according to Egbu et al. [17], shows that the wealthy people generates more solid waste because they purchase more products that are industrially processed and packaged in different form of product packages such as glass bottles, can, and paper to mention a few. As a study carried out on residential location, the study shows that the putrescible form of the solid waste are the highest of the solid waste. The putrescible are more of food related

Table 3. Selected Awka Area as studied by the Authors

S/N	Selected Awka Area	Authors
1	Previously Not-Studied Location	[11]
2	Three (3) Hostels in Nnamdi Azikiwe University	[12]
3	Two (2) Selected Housing Estate	[13]
4	Surroundings of the Dump Sites in Awka	[14]
5	Some Dump Sites and School/Office premises in Awka metropolis	[15]
6	Waste Disposal Points around Residential, Commercial Settlements/Market Areas and Abattoirs; Natural Features and Water Bodies' .e.g. rivers; Abandoned Roads and Buildings etc used as Dump Sites in Awka.	[16]
7	Residential neighbourhoods of Awka.	[17]
8	No specific location within Awka metropolis but it concerns the inhabitants or populace	[18]

Table 4. The focus and findings of prior studies

The Focus of the Eight (8) Prior Studies	Findings of the Eight (8) Prior Studies
Zero-intercept first-order polynomial regression used for household solid waste characterization [11]	The results from the proposed method proved more accurate when compared with traditional averaging techniques (.i.e. organic (73.2%), plastic (8.0%), recyclable (20.3%) and to mention a few).[11]
Perception and awareness of people about plastic waste and the process of pyrolysis [12]	Lack of awareness on the process of pyrolysis, thus they handle waste anyhow [12]
Composition of these solid waste at the dump sites; as well as performance & whether MSW has effects on the health of the inhabitants [13]	Composition of dump sites includes non-biodegradable such as plastics, polythene bags, and scrap metals. Also, respondents are aware that solid waste can affect health of the inhabitants [13].
Challenge & extent of Anambra State Waste Management Authority (ASWAMA) operation of enhancing clean environment [14],	Operations of ASWAMA in solid waste management have not been effective in ensuring a sustainable and clean environment in Awka, Anambra State [14]
Waste disposal method and perception of the respondents [15]	People have particular preferred disposal method (e.g. burying and burning ,etc) without consideration for health and risky consequences [15]
Sustainable plan for the effective management of solid waste [16]	ISWM, IIF and PPP undertaken in a consultative manner remain as the plan that can guide the technological, social, financial options for the Awka metropolis to move towards becoming a zero waste city [16]
Explanation of the nature of generated household solid waste by using planned behaviour and rational economic behaviour theory [17].	Putrescible forms the highest component of solid waste and some of the ways by which solid waste in the aspect of clothing and books have been reduced is by passing them over to the extended family for reuse. The more the income of the people the more, the amount of generated solid waste [17]
Using cartoon illustrations for information dissemination to sensitize inhabitants of Awka metropolis on the consequences of indiscriminate refuse disposal [18]	The study demonstrates the possibility of using Cartoon illustration towards attaining green environment [18].

substances such as waste from vegetables, and fruits to mention a few. Less non-biodegradable .i.e. non-putrescible are also present compared to the putrescible. Having assumed that majority of the people never conceive the idea of re-using the solid waste [12], then it can be believed that solid waste can be minimized if green design or multiple reuse are practiced.

This suggestion is not the duty of the populace (i.e. consumers) but the policy makers, government, health organization, designers and the manufacturer. These stakeholders can make the 10 R principles (.i.e. Reduce, Reuse, Recycle, Renew, Refill, Repair, Re-manufacture, Replace, Refine and Remove) to be part and parcel of the social environment. Thus, to reduce waste disposal problems at the consumption and manufacturing level will be more realistic.

Onwuekwe and Okoye [18] just like radio or TV broadcast also used cartoon illustrations to sensitize the inhabitants of the Awka metropolis on the consequences of indiscriminate refuse disposal (see Table 4). These cartoon illustrations should be used as mural paintings on the wall of public places. Also, the cartoons can be included in the newspapers, magazine and other print media prominent within Awka metropolis. From observation, the numbers of explanations that might be provided by cartoon illustrations, mural paintings, publicity design, TV or radio broadcast are not enough to bring about zero waste environment in Awka metropolis. Moreover, Obi et al., [14] findings show that the operations of ASWAMA in solid waste management have not been effective in ensuring a sustainable and clean environment in Awka, Anambra State (see Table 4). Although, the government are trying to apply some measures in the aspect of providing incinerators and disposal of waste within the Awka metropolis.

Okeke and Anukwonke, [16] also opined that Integrated Solid Waste Management (ISWM), Integration of the Informal Sector (IIF) and Private - Public Sector Partnerships (PPP) undertaken in a consultative manner serve as the master plan that can guide the technological, social, financial options for the Awka metropolis to move towards becoming a zero waste city (see Table 4).

PPP consists of the government and private sector cooperation to be responsible for solid waste collection and treatment. ISWM focuses on designing a new waste management system, or rationalize an already existing one while the IIF consists of other sectors of solid waste management

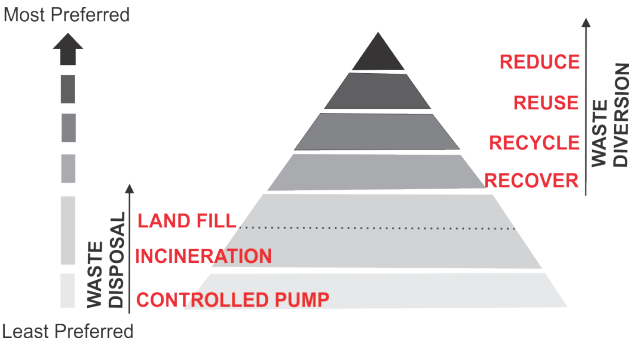

Figure 8. Level of preference for Integrated Waste Management by the World Bank.

that are not in anywhere operating with the government or recognized organization [16].

It seems that the government and other stakeholders focus on the least preferred waste management such as land fill and incineration to mention a few (see Figure 8).

The most preferred waste management by the World Bank such as Reduce, Reuse, Recycle and Recover to mention a few waste diversion are not yet well focused on by the government and other stakeholders. Expecting consumers to be engage in this aspect of waste diversion is not realistic because they do not have the capability or potential to do such. Majority of the consumers are not aware of pyrolysis, thus they handle waste anyhow [12]. From the study of Bill et al., [15], the populace have preferred method (.e.g. burning and burying) of refuse disposal which may not be favourable to health and well-being (see Table 4). Thus, less responsibility should be expected from the populace in order to attain green environment as many of them are not obliged or obligated to take appropriate step. Let the producers of these products (such as packaged food, beverages and to mention a few) as well as other stakeholders oblige, persuade and obligate the people through impressive and effective means. The policy makers, government, health organization, designers and the manufacturer have more capability and responsibility to reduce waste disposal problems at the consumption and manufacturing level. This is because they have more power to positively influence the possibility of reuse, refill, and recycle to mention a few in order to reduce the negative impact of those solid wastes generated as result of the consumption of their products which consumers buy. It can be envisioned that the involvement of these stakeholders .i.e. the enterprises can be as well used as a means of competitive advantage. Thus, it can become means for strong driving force to move towards becoming a zero waste environment.

Classification of the Focus of the Eight Reviewed Studies as Regards Present Study

Solid waste characterization: Solid waste characterization involves the collection and sorting of solid waste so as to ascertain the types of materials. Present study used naturalistic observation by visiting selected areas within Awka metropolis so as to see how product packaging amount to solid wastes among other constituents of Municipal Solid Waste (MSW). Estimates of the amount product package seen are done by estimating in percentage and not by weighing. Present study fails to use Zero-intercept first-order polynomial regression for household solid waste characterization as done in prior studies.

Perception and Behaviour: This aspect deals with the people living in the environment where these solid waste are generated. It is the activities .i.e. the behaviour of these people that definitely lead to the generation of these solid waste. They are consumers; thus, they will definitely exhibit consumption behaviour. The level of welfare of the citizens and the high number of working people can reflect the behaviour in terms of kinds of waste that could be generated by their activities. In the aspect of product package waste, a study reveals the amount of organic wastes (kitchen wastes, park and green wastes) and packaging waste (paper, cardboard, bulky cardboard, plastics, glass, metals and bulky metals) through the activities of some citizens [19]. This kind of behaviour forms the main parameter for environmental pollution [20]. For instance, more than one thousand billion liters of packaged beverages are consumed worldwide [20]. If 1,292 billion liters of packaged beverages are recorded to have been consumed worldwide in 2020, then the waste generated by the consumption of beverage products has increased in recent years [20]. Thus, present study used naturalistic observation to see how product packaging amount to solid wastes among other constituents of Municipal Solid Waste (MSW) in Awka metropolis.

Health: Present study is not focusing on the health aspect of solid waste in Awka metropolis. However, it is expected that when solid wastes are illegally disposed along road sides, sewage canals and reserved open spaces they contribute to floods and breeding of rodent vectors that eventually spread diseases such as intestinal schistosomiasis and soil transmitted helminths [21]. Prior studies have shown that people are careless about consideration for health and risky consequences [15] in Awka metropolis in terms of handling solid waste.

Disposal Method: Present study is not focusing on the disposal method of solid waste in Awka metropolis as other prior studies have done. Prior studies have shown that people have particular preferred disposal method (e.g. burying and burning, etc) in Awka metropolis.

Sustainability: It covers preferences that aim that creating long-term value and competitive advantage by considering eco-friendly factors. This relates to the aspect of green design or multiple reuse which this study aims at recommending.

PRODUCT PACKAGE WASTE AMONG OTHER SOLID WASTES IN SELECTED AWKA METROPOLIS

Selected locations include residential, market, hospital, school, municipal, and industrial location. Wastes from food, pure water bags, cloths, polythene, tins, paper, plastics, empty cartons, glass, sticks, leather; enamel plate, ceramics, metals, leaves, grass, rubber, and wood to mention a few are observed to be littering the residential locations. In the market places, wastes from food, plastics, polythene, pure water, empty cartons, paper, wood; cloths, leather, tins, ash, rubber, leaves, grass, metals, ceramics, fabrics, bricks, glass, and bottles to mention a few also litters the area. Few broken glass, glass bottles, plastics, paper, polythene, pure water, and few food waste are among the solid waste around school premises. In the hospital, laboratory wastes, surgery wastes, pathological wastes, maternity wastes, syringes, expired drugs and chemicals are among the wastes observed. However, these are properly disposed in the hospitals. Those waste found littering certain part of the hospital premises include plastic bottles and other types of plastics inside the gutter. Discarded large motor parts, large appliances, furniture, refrigerators, tyres, metal scraps, dirt, silt from gutters, leaves, content of refuse, cloths, plastics, paper, pure water satchels are found as waste in the municipal locations. In the industrial locations, Solid wastes resulting from industrial processes and manufacturing operations, wood, plastic and metal scraps, hazardous wastes, radioactive materials, conduit pipes, wire insulation scraps, nails, blocks, cement bags, and to mention a few are present.

Figure 9 shows the estimates of the observation in terms of frequency depicted by the use of bar chart. Also, Friedman test is conducted to determine whether product packaging form an integral components of solid waste in the same way in the selected location within Awka metropolis. Every foreign manufacturer as well as local producers have to enter into agreement with the government concerning the waste prevention in as much as their products are been consumed in such region. Paper package as shown in Figure 9 is one of the ways by which package contribute to solid waste. It is present in all the selected areas with a mean rank of 4.36 by using Friedman's analysis by rank. Compare to other solid waste which are not among product packages, there are lesser waste caused by paper package. There are little paper packages in the municipal and industrial locations. This is assumed to be because they decomposes easily (10-30 days).

However, there are more of paper packages in the residential and school areas. In the overall, safe environment by focusing on waste prevention and organic environment void of toxicity have been manageable in the aspect of paper packages in Awka metropolis. Green design is very well in place in paper package while multiple reuse is not obvious among the users of paper package.

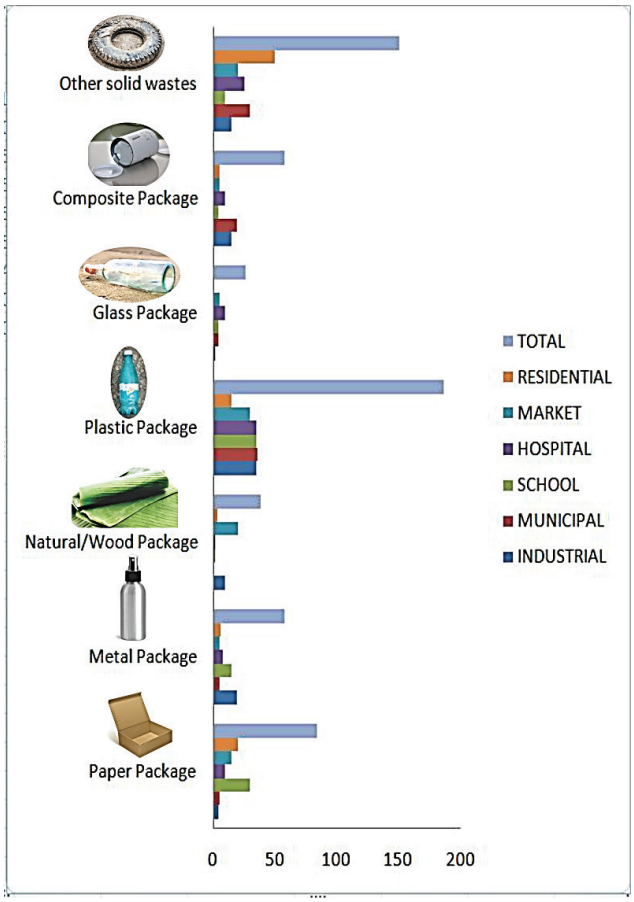

Figure 9. Level of Package Waste in Relation to Other Solid Wastes.

It is surprising that metal packages (mean rank =3.71) do not cause more solid waste. This is assumed to be as a result of the level of recycling that might be happening to the metal packages. The influence of the scavenger which can be classified among the PPP have reduced the quantity of metal package in Akwa metropolis. Compare to other solid waste which are not among product packages, there are lesser waste caused by metal package because a lot of the 'would-be' wastes are picked up by the scavengers. In Figure 9, there are little metal packages in the market, municipal and residential locations because of the influence of the scavengers who are everywhere sourcing for metal packages. Thus, the recycling of metal packages have not allowed more solid waste to be generated in Awka metropolis.

Compare to other solid waste which are not among product packages, there are lesser waste caused by natural/wood package. This is because the use of wood for packaging is declining. Wooden crate is no more popularly used compare to how it was previously used several years ago (see Figure 10). The natural ones such as baskets made from raffia, cane and palm trees still found littering the market areas.

Figure 10. Wooden crate.

With a mean rank of 2.21, natural /wood packages compare to other solid wastes have not generated waste beyond management except the baskets in the markets and wood dusts/ blanks in industrial locations. There are little or no natural/wood packages in the school, municipal and residential locations. In the overall, safe environment by focusing on waste prevention and organic environment void of toxicity have been manageable in the aspect of natural/ wood packages in Awka metropolis.

It is also surprising that glass packages (mean rank =2.0) do not cause more solid waste. Even though, a lot of products like beer, wine, and mayonnaise to mention a few are contained in glass package there are lesser waste of this kind of package. This is assumed to be as a result of the level of multiple reuse and recycling that might be happening to the glass packages. The influence of the scavenger which can be classified among the PPP have reduced the quantity of glass package in Akwa metropolis. Also, some itinerate workers go from house to house buying glass packages. Compare to other solid waste which are not among product packages, there are lesser waste caused by glass package because a lot of the 'would-be' wastes are picked up by the scavengers. In Figure 8, there are little or no glass packages among waste around residential locations because of the influence of the multiple reuse and scavengers who are everywhere sourcing for glass packages. Restricted location such as school and hospital where these itinerate workers cannot freely enter still consist of glass package refuse waste (see Figure 8). Thus, the multiple re-use and recycling of glass packages have not allowed more solid waste to be generated in Awka metropolis.

Compare to other solid wastes which are not among product packages, there are lesser waste caused by composite package (mean rank = 3.43). Example of other solid waste (mean rank = 5.57) not among the product packages is tyre (see Figure 9). Only plastic packages (mean rank = 6.71) in relation to other solid waste in Awka metropolis have the largest quantity of generated solid waste. This is assumed to be due to the fact that many products are contained in plastic materials. Ranging from soft drink, fruit drink, and milk drink to other edible or non-edible products [22]. This popularity can cause the increasing number of plastic package among other solid wastes in Awka metropolis. Thus, there is need for green design or multiple reuse of plastic packages in order to attain safe environment devoid of waste and toxicity in a long term perspective.

The result of that analysis indicates that the null hypothesis should be rejected at a significant level of 0.05, χ^2 (6) = 27.174, p = 0.000 (see Table 5). Thus, the way product packaging (.i.e. paper, metal, plastic, glass, natural /wood and composite package) form an integral components of solid waste in Awka metroplis are not similar within the selected location within Awka metropolis.

Also a T-test is conducted to determine whether product packaging as integral of other solid waste in previous study on residential location occurs in similar way as this present study. The result of the T-test score indicates 0.3002 at p-value of 0.05 (t=0.3002; df = 8; p = 0.05, two-tailed) which is less than p-value. Thus, the null hypothesis is accepted (.i.e. the product package among other solid waste occurs in similar way in the residential locations).

RECOMMENDATION

This study recommends green design or multiple re-use of product package as way of attaining zero waste environment in Awka metropolis. The 10R principles should be the goal of the stakeholders. Packaging can be subjected to taxes, re-use and re-cycling requirement. The policy that affect product design should also affect the disposal means of the product. Companies producing these products can be held responsible for the disposal of the product by a particular fee and take up the responsibility of recycling every waste as result of their products' consumption. Similar policy such as Deposit Refund System (DRS) can also be adopted. DRS is a recycling system in which consumers pay a small deposit value for bever- age containers, which can be refunded upon return of the used container to a collection point [20]. This is to avoid costly disposal of waste. EPR is a policy approach under which producers are given a significant responsibility of treatment or disposal of the post-consumer products. The

Table 5. The rejection of null hypothesis at a significant level of 0.05

Null Hypothesis	Test	Sig.	Decision
Product packaging form an integral components of solid waste in the same way in the selected location within Awka metropolis	Friedman Test	000	Reject the null hypothesis

government should spread their tentacles through Private - Public Sector Partnerships (PPP) to mannufactures of various products in order to establish this policy. This can be more effective in a developing country if PPP and EPR are harmonized. This will ensure government, non-government organization, and individuals participation in attaining Zero waste. This harmonization can be implemented by ensuring effective monitoring and compliance. EPR should not be responsible for only the financial burden but reduce packaging waste through necessary collaboration, incentives and encouragement with various stakeholders in the distribution chain of their products as well as other contractors or the general public (consumers). This can be achieved by harmonizing PPP and EPR. The entrepreneurial aspect of the private sector and quest for opportunity to invest by contractor can create more dynamism, finance and better managerial efficiency when EPR and PPP are harmonized. The public sector which includes the government and the populace will create social responsibility, involvement, and better compliance to the implementation of zero waste through the harmonization of EPR and PPP. This will relief the burden of the authority's waste management budget, due to higher effectiveness and access to external finance from both EPR and PPP. As a result of such harmonization, the waste pickers or scavengers will not be cut off from the system because there will be avenue for them to operate under PPP. Even when EPR systems are implemented by manufacturing companies setting up their own collection systems with the provision of incentives to households will be avenue for such as category of entrepreneur to be involved. This is because the avenue will upgrade the practice of the waste picker to be dignified and admirable as result of the link they will have with the producers of such products/brand. Thus, the harmonization of these policies can help reach a sustainable and inclusive solution**.** The government can ascertain this inclusive and sustainable solution through mandatory and government led, comprehensive financial responsibility , clear communication and training on EPR systems, and engagement of waste pickers.

CONCLUSION

Studies on solid waste characterization, health, perception, behaviour of the populace in relation to solid waste and sustainability are ubiquitous but the aspect of product packaging waste in Awka metropolis have not been extensively studied. Based on these prior studies, the residential locations have been more widely studied than other locations within Awka metropolis. The finding of present in concord with prior studies shows that the product package among other solid waste occurs in similar way in the residential locations. However, the situation of product packaging waste to other solid waste is not similar in other locations (i.e. market, schools, hospitals, municipal and industrial areas). This study recommends DFE not as a new development but a re-consideration of green design or multiple reuse product packaging as regards solid waste in selected areas in Awka metropolis. Green design should harmonize human being, nature/environment and the products being used in a symbiotic association. For purpose of this symbiotic association, reducing the solid waste in the environment will benefit everyone because waste will be minimized. This is also beneficial to everyone as enterprises can also use it as a means of advantage to help the acceptability of brand as it can become means for strong driving force in the market towards sustainable consumption pattern. This is because many stakeholders such as the manufactures will start to reduce waste disposal problems at the consumption and manufacturing level. Thus, policy approach under which producers are given a significant responsibility of waste prevention/diversion (.i.e. persuading the consumers through gainful or attractive means to return used product packages to the producers) of the post-consumer products should be ongoing through Private - Public Sector Partnerships (PPP). Companies producing these products can be held responsible for the disposal of the product by a particular fee and take up the responsibility of recycling every waste as result of their products' consumption. Improved or similar policy such as Deposit Refund System (DRS) can also be adopted . Situation where by producers persuade the consumers through gainful or attractive means to return used product packages can be encouraged. This should not stop the job opportunity of the waste picker/scavenger. Green design or multiple re-useable product packaging should be integrated to production or manufacturing cycle. The government should spread their tentacles to EPR harmonized with Private - Public Sector Partnerships (PPP) in order enhance the concern of everybody (manufactures, consumers, organizations and other entrepreneurs). Every foreign manufacturer, importer as well as local producers have to enter into agreement with the government concerning the waste prevention in as much as their products are been consumed in such region. Thus, present study unfolds green design or multiple reuse of product package as a means of attaining zero waste in Awka metropolis.

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CONFLICT OF INTEREST

The authors declare no potential conflicts of interest regarding the research, authorship and/or publication of this article.

DATA AVAILABILITY

The data used to support the findings of this study are included within the article.

AUTHOR'S CONTRIBUTIONS

All authors contributed equally to bring out this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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