

Enhancing Environmental Sustainability through Recycled Plastics and Polyethylene in Port Harcourt Urban

Ayagere Selete Ayebaemi^{1*}, Bumaa Felix Neeka², Amakiri-whyte Belema Henry³, Aselemi Akeuloghonaan Ernest⁴, Iyowuna Jonah⁵, Ubani, Princewill⁶

^{1,2,3,4} Department of Architecture, Kenule Beeson Saro-wiwa Polytechnic Bori Nigeria

⁵Department of Surveying and Geomatic, Rivers State University Port Harcourt, Nigeria

⁶Department of Urban and Regional Planning, Kenule Beeson Saro-wiwa Polytechnic Bori Nigeria

*Corresponding Author

Abstract: The system of plastics and polyethylene recycling that enhance sustainable environment remains contemporary issues globally. This is relevant given the decline of marine debris, street and neighbourhood littering. However, this appears not to increase complete environment sustainability in the third world country like Nigeria going by both practices, statutory and strategic consideration. The research consequently unveils socio-economic implications of plastics and polyethylene recycling in Port Harcourt and analyse environmental sustainability through plastics and polyethylene recycling. In furtherance, the research acquired data via the plastics and polythene sustainable environment achievement (PPSEA) whereas standardized coefficient (beta) regression analysis and chi-square analysis method were the investigative tools employed. The result of the analysis revealed significant relation between plastics/polyethylene recycling and socio-economic characteristics at ($R^2 = 0.966$, significant at 0.01) clarifying 96.6% socio economic importance of recycled plastics and polyethylene (population, employment, income, household size and education). This implies that the five aforementioned are the socio-economic advantages of plastics and polyethylene recycling globally. The analysis added that significant relation occur between plastic/polyethylene recycling and environmental sustainability at ($x^2 = 126.44$, df 1, $p = 0.05 > 0.00$) in Port Harcourt urban space. This implies that recycling of plastics and polyethylene reduces dissimilar environmental pollution while the article resolved with recommendations on practices that advocate for the need and utmost concern of the government to embark on a strong environmental awareness programmes that educate both the households, streets, communities, authorities, cities and industries on healthy environment through plastics and polyethylene recycling of global standard.

Keywords: Environment, Sustainability, Recycling, Plastics, polyethylene and Enhanced

I. INTRODUCTION

Plastics and polyethylene recycling involves the efficient gathering or assemblage of scrap and rejected plastics/polyethylene materials for valuable reproduction and consumption of the renewed plastics scrap or produces. However, environmental sustainability could be enhanced through recycled plastics and Polyethylene materials

recognised as one of the scientific measures for global pollution control. outside the control of landfill and marine litter or debris, it is required that at least one of the survival sectors of any economy or nation must embraces recycled plastics and Polyethylene approaches (research work 2020).

But in sub-Sahara African of World, the recycled plastics and Polyethylene expected to enhance environmental sustainability are prone to restraints and succession of challenges owing to the statutory strategies and trend. However, it is indispensable to change this ugly position and improve the sustainability targeted on the built environment. the sustainability through the input of recycled plastics and Polyethylene increases creativity, productivity, revenue, participation, interaction, employment opportunities and household standard of living while the statutory agencies continue to serve as facilitators and guide (2020 field work).

The crucial role plastics and Polyethylene recycling plays in scientific and technologically advancement globally encouraged Olawale and Damilola (2019) who studied the opportunities in plastics recycling, policies, threat, technological effort and development of plastics recycling Nigeria. The authors stressed that destroying or assemblage of waste plastics is fundamentally compulsory in renovating the class of waste plastics into additional valuable practice of second-hand material through auxiliary reusing techniques either by extrusion, instillation or various recovering style. They maintained that a politicians, expert and media practitioner has given higher attention to plastics waste because of non-biodegradable and elimination trouble of the material. According to them, Plastics are resilient, frivolous and low-cost materials used by the multiple products while the production had observed extraordinary escalation and is projected for usage and eliminating other persistent difficulties worldwide. The additional request and practice of plastics and the disposal approach constitute environmental problem to land and aquatic territories unfriendly to man and animal safety, health and life hence financial growth, varying ingesting and production designs are resultant into fast proliferation in global emanation of waste plastics. Similarly,

Csaba, Edmund and Balint (2017), look at designing business solutions for plastic waste management to enhance circular transitions in Kenya. The author stressed that circular priorities advancement for economies failed validity test across the globe while high-income nations is confronted with the influences of their own depletion as emerging nations tolerate the externalities of these developed economies. However, the circular evaluation and the circularity level in Kenya's plastic material flow recorded low rate at 32.72% while the findings indicated that linear shortages of the plastic waste management system helps the stoppage of additional material leakage. But on the side of Business Model Canvas (BMC) tactic, the research suggested for entire corporate explanation that may advance the environmental sustainability.

Joshua, Innocent, Oladele and Roland (2019) stressed on first mainland historical analysis of mass introduction and ingesting different polymers and plastics in Africa and the related contamination possible. Using identified, collated and synthesised isolated global trade data on the ingress of polymers and plastics from different African countries. Analysis of The findings were carried out with the population of 856,671,366 from 33 African countries on accessible data of 10 years and above introduced roughly 86.14 Mt of polymers in elementary form and 31.5 Mt of plastic goods among 1990 and 2017 while 172 Mt of polymers and plastics appreciated at \$285 billion were smuggled between 1990 and 2017. The study further deliberate on the apparatuses of products and proved 230 Mt of plastics cross the threshold of Africa as the major portion were assigned as follows: Egypt (43 Mt, 18.7%), Nigeria (39 Mt, 17.0%), South Africa (27 Mt, 11.7%), Algeria (26 Mt, 11.3%), Morocco (22 Mt, 9.6%), and Tunisia (16 Mt, 7.0%). However, key plastic invention across the 8 African realms accounted 15 Mt from 2009–2015. Their analysis surrendered that ecologically complete of the management existence of left-over plastics via salvaging and vigour regaining recorded embryonic stage across Africa whereas reconditioning actions and current reclamation is common in little republics. Their work summarised that manufacturing and depletion of plastics must escalate in time to coming while measures are desired to attack the universal test. They added that assured policies and malleable sack prohibitions will decline future plastic usage and littering, as detailed in Rwanda Africa. Finally, their research also called for advanced solutions and mitigation measures that could initiate recyclable polymers and relative options for container.

In Kenya, Balint, Edmund and Csaba (2018) pointed that some of smaller nations in Africa are confronted with higher level problems because of plastic waste recycling. According to the authors country like Kenya gave compulsory directives for careful prohibition pointing at producers and users of plastic materials. But their prohibition failed to curtail the incessant practices of other plastic goods. The work further explained that circular important that was demarcated in innovative countries failed to be holistically effective for the

world generally, and reason being that advanced income nations encounter just the influences of their own plastic waste while developing nations endure the externalities of these developed economies. Accordingly, the attention of the developing countries of the world never focused on declining plastic comparative standard of usage but to manage the littered material flow.

Fobil, and Hogarh (2009) look at the practices, defies and predictions of plastic waste management methods in Ghana and suggests a new paradigm of minuscule charge and polluter tax system to handle such ecological eye sore. The authors thrown further light on present percentage of environmental weakening that continued until protracted measure called contaminators taxation system is injected into plastic wastes management organizations all over the districts. But pointed that plastics are always consumed lengthily from food and water wrapping due to integral goods like stumpy unpackaged masses and lifelessness which enhanced their suitable mover materials and little danger pollutants. Their research meted that plastic carafes and packets recycled to set iced water for selling state and to enable human in movement circumstances and prevalent across the region. The study finally concluded that bag insurrection are yet to be supported by relevant plastic waste management law that have littered different cities in sub-Sahara Africa with plastic wastes.

Joshua, Mary and Roland (2018) studied the initial inventory of plastics in Nigeria in the direction of the development of an effective plastics management frame. The research employed the current literature, United Nations database via harmonized system (HS) programmes of introduced data that concentrated on different polymer sorts and key produce sets enclosing plastic while mathematical Algebraic terms were applied for analysis on plastic materials. However, their findings detailed that Just about 14,200,000 tons of plastics in basic arrangement were introduced into Nigeria cities from 1996–2014. Also nearly 3,420,000 tons of the entire plastics were acquired as products materials and exactly 5,545,700 tons were recorded as foreign product modules together with 194,000 tons of plastic toys shifted over to Nigeria 6 years ago.

They maintained that exactly 17,620,000 tons of plastics were obtained on primary basis and considered as produces whereas the entire capacity of foreign plastic, new products obtained from malleable and plastic apparatuses profitable to the technosphere counted 23,400,000 tons. That the enormous number of plastic and supplementary polymers toward the inside technosphere of Nigeria possess a significant insinuations for aquatic mess, contamination, waste recycling and resource regaining. The work concluded that gigantic measurements of plastics are Nigerian technosphere together with below 12% of the subsequent waste accessing the recycling sector. The article called for workable administration of this particular important leftover and type of resource. They continued by stating that Possible moderating measures together with waste plastic reclaim, recycling, waste

translation to verve and suitable malleable controller strategic outlines.

Across the semi-urban and urban communities of Ogun State Nigeria, Oludele, Samuel and Adekanbi (2020) sampled 385 residents while qualitative and computable information were also employed to determine the identical information and practice of recycled plastic bottle built backgrounds, problems facing it, predictions and the method of advancement towards developing workable institutions and environment in Nigeria and yonder. However, their findings opined that there was a complete deliberation in the interior direction of related works obtained for approvals and delivered for strategy exploit.

John, Costas, Roland and EleniIacovidoua (2018) summarised the plastic waste administration and contamination problems on different chemical materials controlled in all plastic harvests that support polymer materials and its life extension. They explained that the value of all the extracts relied on all the workability of polymer material together with their possible pollution on soil, air, water and food that were broadly written in collected works and designated in this direction. The work demonstrated that some of the extracts may possibly move and unpleasantly cause close contact with human contact just like food interaction tools known as container. According to the authors these interaction relationship may be obtained from plastics on the cause of different salvaging and reclamation courses and on or after the goods were formed from the recyclers. However, they concluded that reprocessing or recycling need to be conducted in a manner that will safeguard the release of materials of high worry and pollution of second-hand products know to avoidable for guaranteeing the protection and good of human and environment always.

Subramanian (2000) struggled to address issues on solid wastes specifically plastic wastes in United States. His hard work revealed a positive outcome as municipal solid waste (MSW) generated yearly has activated a decline as 211.5 million tons generated in 1995 decline to 209.7 million tons since 1996 which demonstrated that recycling level and composting proportions is decrease. The work also stressed that landfills disposal decreased from 60.9 - 55.5% in 1996) while waste disposal via combustion increased as a result of increased efficacies of the present burners and their strength to reduce particulates and injurious vapours. However, the author maintained that Plastics remains a little but an important of the waste stream. According to him, the work recorded 317 million kg of extraordinary density polyethylene (HDPE) bottles and 294 million kg of polyethylene terephthalate (PET) bottles second-hand in 1997. In furtherance, work opined that the quantity of plastics that were used has full-grown significantly while the reprocessing of robust goods like automotive parts, carpets, electronics and related housings and material were discovered

Clara, Sally, Rafael and Kenneth (2012) disclosed that not any of the bio-oriented plastics under profitable use presently or

undergoing expansion were sustainable in all ramifications. Their result further demonstrated that bio-concerned plastics swotted make use hereditarily improved entities for the purpose of feedstock production or poisonous substances while converting them as fairly used materials, or copolymers obtained in non-renewable resources. The study concluded that in any decision to change orthodox petroleum-related plastics with bio-linked plastics, positions are required to apprehend the stream of the resources and their opposing effects on the entire structure of their life stages for the purpose of chosen a product that possess greater sustainable.

While researching plastics waste, Bupe and Charles (2017) detected the prominent carters for bearable development after-consumer bag plastic waste salvaging method in developed and developing nations. Additionally, they noted that waste emanated from Plastic stood as a type of management sustainable waste while many problems continue to reside in the administration of such kind of waste. However, numerous studies were carried out on determinants, drivers and factors manipulating bearable administration and salvaging of concrete waste and public solid waste. In continuation, their findings disclosed series of drivers on the side of economic, environmental and social facet as factors of bearable development of recovering structures for the final users that packet the plastic solid waste.

Francisco and Sigbritt (2008) stressed on the recent developments on the mechanical component of plastic recycling and concentrating on quality material production from waste realm that gave room for complete sustainable administration of resources and vigour. They noted that waste materials obtained from Polymeric must be measured as material for applied to produce fresh material over and done with reprocessing stages, including related position of the untapped remnant-oriented plastics and biopolymers obtained from the trend of renewable materials. Furthermore, their work maintained that numerous energies may be initiated to realise quality significant bound in plastics reproduction whereas the outcome demonstrated reproduced materials including inexpensive enactment before the market. The work concludes that dissimilar plans like re-stabilisation, upgrading and compatibilisation, and extra elastomers and plasters could advance the assembly and component of polymeric waste material. Amar, Singaravelu, and Jean and Manjusri (2018) opined that recycled original plastic products domicile at landfills could be perfectly transmitted and reorganised for combination for merged presentations which may equally bring about decline in necessity of unused petro-oriented products

In Netherlands, Bing, Jacqueline and Jack (2014) shed light on resolution sustenance for selecting the utmost appropriate arrangement of the classification methods of plastic waste the work added that the support is acquired with the assistance of enhanced inverse logistics linkage design that bring about the general recycling pattern higher effective and sustainable and coupled with the benefits of many stakeholders. The studies

applied combined integer linear programming (MILP) model that reduces transportation fair and environmental effect while joined starting point scenario stood as the present condition and additional scenarios were built with different premeditated measures. Their finding explained that present system settings of the starting point condition account effective in respect of logistics aspect but portrayed possibilities to applied tactical vicissitudes liable on the probability about accessibility of the expected recycling conveniences to handle plastic waste whereas their findings of all the verified scenarios proved equivalent of 25 % or higher carbon release associated to the present system. The research concluded that Plastics recycling is allowed to enhance environmental paybacks that records achievement through centres, spacing centres and pre-processors.

Neha, Pallav, Shruti, and Piyush (2013) stressed on the existing scenario of the plastic usage although their research goal gave the public with insight on the examination about the recycling method of plastic hard waste. They maintain that primary, secondary, tertiary, and quaternary are the four of recycling while fattening worth of plastics are similar to firewood, as creation of firewood might be an improved substitute. Therefore, the conversion technique of plastic into fuel beacons on pyrolysis and catalytic dreadful conditions were analysed in elaborate and a minor concept around the gasification is as well involved. As the study made effort to tackle the challenges of plastic waste clearance and deficiency of conformist fuel and enhanced defensible environment.

The study highlighted that level of economic expansion is unjustifiable in the absence of redeemable fossil vitality such as unpolished oil, unused gas, or else coal. As different replacements to fossil vitality like biomass, hydropower, and breeze vigour were likewise appropriate waste administration tactic and extra important facet. The work concluded that advancement and transformation inject enormous growth inside the processing of completely classes of commodities that produce waste in one way or the other. Since plastics remains one of the resources due to their varied variety of uses and pretty little price tag.

In Nigeria, lack of practical analysis and studies on enhancing environmental sustainability through recycled plastic and Polyethylene have created a gap and differences in understanding of the salient but important benefits of environmental sustainability through plastic and polythene. Against this background the research seek to determine how recycled plastics and polyethylene enhance environmental sustainability in urban environment of Port Harcourt.

II. METHODOLOGY

The quasi experimental design was employed for the research. It is non- randomized pre- post environmental assessment design. The study was held in Port Harcourt urban of Nigeria and a sample of 350 environmental experts from a population of 15,000 were selected and utilized for the research work. The instruments applied for data collection was Plastic and

Polythene Sustainable Environment Achievement (PPSEA). The instrument was designed by the researcher and was validated by experts in centre for environmental management from reputable university and polytechnic in Port Harcourt. The reliability coefficient of PPSEA 0.97 was adopted by the researcher using some items from local and international sustainable agencies on environment between 2015 – 2019 relevant to the investigation. It was made of two sections: A and B. Section A consist of bio- data such as profession in built environment, age, sex, income, time and socio economic treat.

Section B consist of 35 multiple choice question on recycled plastics and environmental sustainability. The items were drawn based on some principle of sustainable environment such as integration of economic, environmental, social objectives across sectors, territories, throwaway behaviour of consumers and generation concerns. However, the instrument (PPSEA) was administered after sixteen (16) weeks to the environmental experts in Port Harcourt urban. The analysis was conducted by a research analyst after the questionnaires were returned. On the process, the research analyst was asked not to influence the analysis by increasing the scores obtained for examination deliberately.

III. RESULT AND DISCUSSION

Recycling of Plastics/ Polyethylene and Residents Socio-Economic Characteristics

There is a positive and strong rapport between plastics/polyethylene recycling and socio- economic characteristics of residents in the urban hemisphere called Port Harcourt. In this statistical analysis and view, the study conducted five different analyses using income, household size, population, employment and education. The breakdown was directed through the assistance of standardized coefficient (beta) regression analysis ($R^2 = 0.966$, significant at 0.01) clarifying 96.6% socio economic importance of recycled plastics and polyethylene. Then Adjusted $R^2 = 0.974$, designates 97.4% sureness probability of recycling of plastics/polyethylene relationship on socioeconomic characteristics of dwellers (population, employment, income, household size and education).

Population: in the same analysis, human population demonstrate complete and significant to the recycling or recycled plastic/polyethylene and its sustainable features in Port Harcourt environment at [$\beta = 1.052$; $t = 2.985$; $\rho = 0.000$ (< 0.01 significant level)]. The implication is that recycling plastics does not only enhanced sustainable environment but increases the populace money making venture and as well, increase and encourage human population and participation in plastics recycling sector. The analysis designated that 1.052 or (2%) human population increase in plastics recycling motivation also upshot to 1.052 resonate integration of urban residents into the sector. These details above forecasts that the advancement or increase in recycling of plastics that enhanced sustainable environment and development, the more urban

population are attract or increased in plastics recycling tendency of Nigeria.

Income: on the side of the plastics/polyethylene and residents income, the analysis supplied a connexion measurement of [$\beta = 1.039$; $t = 7.753$; $\rho = 0.000$ (< 0.01 noteworthy level)] in Port Harcourt mega city. The exploration put forward that the recycling of plastics that enhanced environment sustainability also increases resident’s income through the sale or purchase of internally or externally generated plastic waste. Apart from that, many residents of Port Harcourt urban engage in gathering and supplying of plastic waste to recycling industries to enhance their domiciliary standard of living and avoidance of litter. The analysis further directs that the light and medium industries charged with the responsibilities of plastics waste reprocessing gave a statistical account of (1.039), entailing that 2% increase in plastics waste recycling sector supports 1.039 increases of the residents income or financial status.

Education: The analysis regarding education and plastics recycling gave encouragement and significantly measured a correlation coefficient of [$\beta = 0.118$; $t = 2.935$; $\rho = 0.006$ (< 0.01 substantial level)]. The implication is that an increase in environmental and waste management education or awareness will increase or enhance safety plastics recycling method that boost sustainable environment through the reduction of land, water and air pollution. However, the educational awareness can be actualized through the conferences, seminars and other tutoring that anchored on plastics recycling and friendly environment. Whereas (0.118) environmental education or awareness on plastics recycling sector, contributes to 1% sustainable environment in Port Harcourt of Nigeria.

Employment: The explanation on the association of recycled plastics/polyethylene and generation of employment opportunities engaged the coefficient of [$\beta = 0.135$; $t = 2.296$; $\rho = 0.028$ (< 0.05 significant level)] in Port Harcourt urban area. The study put forward that ordinary 1% increase and innovations in waste plastic recycling will be commensurate to (0.135) increase of employment opportunities (0.135). The implication further submit that whenever plastics/polyethylene recycling sector record 1% increase, Port Harcourt urban also record 1% increase in her employment sector and reduce the unemployment experience of the timing youths characterized by inability of individual, group or society to provide for their basic necessities such as food, clothing and shelter etc.

Household size: the analysis that focused on size of household and recycled plastics shown statistics record of [$\beta = 0.123$; $t = 2.988$; $\rho = 0.005$ (< 0.01 significant level)]. This implies that increased in households size also enhanced household generated plastics that serves as raw material for recycling plastics industry in Port Harcourt environ. Moreover, the analysis advocates that (0.121) increase of household size; will also lead to 1% increase in household size generated plastics.

Table 1: Plastic/Polyethylene Recycling and Socio- Economic Characteristics of Residents in Port Harcourt

$R^2 = 0.966$ F – cal = 463.345	
Adjusted $R^2 = 0.974$	P = 0.0000
Standard erro = 4500.35244 α	sig = 0.01

Sources: field survey 2020

Adaptable	Std Coefficient (β)	T	P	Significant	Decisions
Household size(X1)	.123	2.988	.005	< 0.005	Positive
Employment (X2)	.135	2.296	.028	< 0.0028	Positive
Education (X3)	.118	2.935	.006	< 0.006	Positive
Income (X4)	1.039	7.753	.000	< 0.01	Positive
Population (X5)	1.052	2.985	.005	< 0.01	Positive

Source: field survey 2020

Chi-Square Analysis for Environmental Sustainability Through Plastics/ polyethylene recycling

Response s	Observed	Expected	d f	Sig. Level	X^2_{cal}	X^2_{cal}	Effect
Sustainable	155(55%)	205(95%)	1	0.05	126.44	3.84	H0
Unsustainable	10 (02%)	12 (03%)					

The breakdown of the studies held on table 3 explained that 55% of the Port Harcourt residents powerfully accepted and testified that plastics/ polyethylene recycling enhanced sustainable environment presently in developing countries and deed Port Harcourt city of Nigeria and its environs. In accumulation, the analysis further disclosed that Port residents of Nigeria observed 55% and 95% expected sustainable environment from plastics and polyethylene recycling activities as in contradiction to 5% of the sampled populace who disagreed to that effect. However, the calculated significance value of 126.44 established a higher mathematical value than the table value of 3.84 tested at 1 or single degree of freedom. The research inference detailed that recycled or recycling of plastics and polyethylene materials augment sustainable environment by reducing the littering and dumping of polyethylene and plastics scrap in unauthorised sites such as uncompleted buildings, road media, and undeveloped lands, along the streets, major and minor arterial and maritime environment.

IV. CONCLUSION

It may perhaps be holistically inferred that recycling of plastics and Polyethylene enhance developmental and sustainable environment when there is adequate and increase recycling of plastics waste that declines land and maritime litter including the connectivity to enhance socio-economic association within a geographical location. Irregular

sustainable environment prevail in all the layout of Port Harcourt as a result of varying amount of generated and recycled plastics/ polyethylene of the area in general. There is necessity for objectivity towards sustainable environment in more spatial method in order to benefit from healthy and friendly environmental decisions and generate further sustainable environment in Port Harcourt.

V. RECOMMENDATION

1. To enhance or secure sustainable environment in Port Harcourt, the government should take rapid accomplishment by insuring that light industries charged with plastics and polyethylene reproduction for consumption of the general public are located in various neighbourhood. So that household generated plastics and polyethylene scrap will be directly move to recycling destination on the consciousness of the generated families that ought to make enormous money from the recycling industries that used plastics waste as a raw material and as well decline the littering of physical environment and marine debris that has been a major challenge to city dwellers, physical planners and environmental managers.
2. The research advocate for the need and utmost concern of the government to embark on a strong environmental awareness programmes to educate both the households, streets, communities, authorities and industries that generate plastics waste to inculcate them on the need for a healthy environment through plastic and polyethylene recycling achievement. The study further deduced that government should compel all existing plastic and polyethylene recycling industries in Port Harcourt urban to provide enough trees and form buffers to restraint or minimize effluents occurrence during or on the course of plastics and polyethylene reprocessing.
3. For the fact that plastics and polyethylene recycling serves an central element that declines land and water pollution in Port Harcourt, standard and government owned recycling institution has to be considered in every planning scheme mainly now that recycling of plastics and polyethylene enhance quality environment and reduces unemployment in urban environs.

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