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ASSESSING IMPACTS, GOVERNANCE FRAMEWORKS AND COMMUNITY-LED MITIGATION STRATEGIES ON PLASTIC POLLUTION IN CROSS RIVER STATE, NIGERIA

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Abstract
The study examined the impacts of plastic pollution, governance frameworks and community-led mitigation strategies on environmental sustainability in Cross River State, Nigeria. To achieve this, two research questions were posed. A descriptive research design was employed, with a population of 413,321 registered couples spread across the three Education Zones in Cross River State and sample size of 1,178 Respondents drawn through multistage sampling technique. The instrument used for the study is a structured questionnaire by the authors called "Plastic Pollution and Environmental Sustainability (PPAES) that was used for data collection and was validated by two experts in Measurement and Evaluation in University of Calabar. Cronbach alpha reliability method was used to test the reliability coefficients of .70 and .83. and data were analyzed using Pearson's Product-Moment Correlation, multiple regression analysis, Multiple regression analysis and simple linear regression. Findings revealed that Plastic pollution levels, Residents' awareness, Governance frameworks and Community engagement efforts did not significantly impact on environmental sustainability. The study concluded that, while community participation and public awareness are valuable, they must be accompanied by effective structural reforms to yield substantial sustainability outcomes.
Keywords: Impacts, Governance, Frameworks, Community-Led, Mitigation, Strategies, Plastic Pollution.

Introduction

A significant share of plastic waste originates from single-use consumer products such as packaging materials, sachet water bags, plastic bottles, shopping bags, and household containers. Other major sources include industrial plastics, agricultural films, construction materials, microplastics from personal care products, and abandoned fishing gear (Jambeck, et al, 2015). Poor waste management practices, particularly in developing regions, exacerbate plastic pollution. In many African countries, inefficient waste collection, inadequate recycling infrastructure, and open dumping contribute to high volumes of plastic litter entering waterways, drainage systems, and natural habitats. Consequently, Africa has been identified as a rising hotspot for plastic pollution, both presently and in the foreseeable future (Jambeck *et al*.,2015).

The persistence of plastic waste is a major concern, as many plastic types take hundreds of years to decompose. Research estimates that common plastics may require approximately 450 years to degrade, with an additional period needed for complete decay into microscopic particles (United Nations Environment Programme,2018). This durability results in the accumulation of large quantities of plastics in oceans, rivers, lakes, farmlands, and urban landscapes. Marine ecosystems are particularly vulnerable; an estimated 8 million metric tons of plastic enter global oceans every year, posing severe risks to marine biodiversity (Offiong, *et al,* 2018). Fish, seabirds, sea turtles, and marine mammals frequently ingest or become entangled in plastic debris, leading to suffocation, starvation, or injuries that may result in death.
The impacts of plastic pollution extend beyond ecological consequences. Blocked drainage systems caused by plastic waste contribute to urban flooding, spread of vector-borne diseases, and environmental degradation. Additionally, the burning of plastic waste is a common practice in many low-resource settings that releases toxic emissions that endanger public health and contribute to atmospheric pollution (Verma, *et al,* 2016). The economic costs are also substantial, with financial burdens related to waste management, reduced tourism appeal, and losses to the fishing and aquaculture industries.

Developing countries face heightened challenges in tackling plastic pollution due to scarce financial resources, limited community awareness, and competing development priorities. As a result, efforts to control plastic pollution require targeted, cost-effective strategies, including identification and management of "hotspot" areas where large volumes of plastics are likely to enter aquatic systems (Willis, *et al,* 2018). Strengthening environmental education, enhancing waste management systems, and promoting community participation are critical to addressing this escalating problem. The growing complexity of plastic pollution underscores the need for research, policy innovation, and multi-stakeholder collaboration. Understanding the sources, pathways, characteristics, and impacts of plastic waste is essential for designing effective interventions that safeguard ecosystems, protect public health, and promote sustainable environmental management.

Nigeria, as the most populous country in Africa, faces considerable environmental challenges, including plastic pollution. Rapid urbanization, industrialization, and a growing population have led to increased plastic consumption and waste. Despite efforts to manage waste, inadequate waste management infrastructure and public awareness contribute to the widespread issue of plastic pollution. It is widely believed that the Earth is choking on plastic, so plastic pollution induced by human activities has increasingly been seen as a global menace. One million plastic bottles are bought globally every minute, up to five trillion plastic bags are used annually, and even more than 400 million tonnes of plastic waste are generated annually (United Nations Environment Programme, 2021).

The word plastic had originated from "pliable" that can be defined as "easily shaped". Plastics can be conveniently modified from one shape to another based on their desired functionality. Plastics are also known as polymers or a "long chains of monomers," which are bonded to other identical sub-units to form a polymer. Polymers can be of natural origins, such as cellulose as the basic sub-units that make up plant cell walls and helps cells to adapt their functions (Sorieul, *et al*, 2016).
Examples of plastic wastes according to Varlık (2024), are Polyethylene terephthalate (PET) found in Water bottles, dispensing containers, biscuit trays; High-density polyethylene (HDPE) found in Shampoo bottles, milk bottles, freezer bags, ice cream containers; Low-density polyethylene (LDPE) found in Bags, trays, containers, food packaging film; Polypropylene (PP) found in Potato chip bags, microwave dishes, ice cream tubs, bottle caps, single-use face masks; Polystyrene (PS) found in Cutlery, plates, cups; and Expanded polystyrene (EPS) found in Protective packaging, hot drink cups.

Cellulose are bioplastic manufactured using softwood trees as the basic raw material is known as one of the most abundant biopolymers on earth. The first synthetic polymer was discovered around 1869 by John Wesley Hyatt. It was highly expensive as compared to polymeric materials (Evode, *et al,* 2021). By properly treating cellulose polymer derived from cotton fiber with camphor, John Wesley invented a plastic that could be changed into various shapes and made to reproduce natural substances including linen, horn, and tortoiseshell that could be useful in plastics production.

Bakelite a form of synthetic plastic, was initially discovered in 1909 as the first fully synthetic plastic which was not natural as cellulose. Scientists had been searching for a synthetic substitute for shellac, a natural electrical insulator that meets the final requirements of the rapidly electrifying system in the USA. Bakelite has more use and benefits rather than insulators of electric cables. It was also heat resistant, durable, and unlike celluloid, ideally suited for mechanical mass production. Due to their remarkable physical and chemical characteristics, plastics have become a major commodity worldwide and have several applications in commercial and industrial products. Due to high community demand, the large-scale production of Fibers and resins have increased worldwide (Frienkel, 2020). According to Organization for Economic Co-operation and Development [OECD] (2022), the amount of plastic waste produced worldwide has doubled over the past two decades, with just 9% being properly recycled and the majority ending up in landfills, burned, or leaked into the environment.

Plastic pollution is caused as a result of our ‘’throw away ‘attitude after exhausting or using the content of a plastic container like soft drinks, paints, chemicals and other consumables that are packaged in plastic containers. Most often, soft drinks, canned food, creams, chemicals, solvents, among others are usually packed in plastic containers for safe delivery to their ultimate consumers, who are the major culprits of plastic pollution. Collections from the use of sachet water, bottled water, and perfume among others are some classic examples of plastic pollution displayed into the environment. Nature has the power to decompose all types of wastes; however, plastic is a man-made waste that does not decompose for years thus polluting the environment (Meijer, *et al,* 2021).

However, the use of plastics comes with many harmful environmental impacts related to their production and poor methods of waste treatment. Around 9% of the generated wastes were recycled, which was a very minute quantity compared to total production. Approximately 80% of the generated wastes were reported to accumulate in landfills or in the natural environment (Gourmelon, 2015). Under different circumstances, ultraviolet light can decompose plastics into their monomeric constituents, including “microplastics”, which are highly complicated and almost impossible to recover (Li, *et al*, 2021); and disrupting food chains and disturbing human and environmental health (Zhao, *et al,* 2021).

The versatility of plastics has provided an efficient proof of hygienic and cost-effective packaging of food products like bread, rice, snacks, juices, spices, milk, edible oil, wheat flour, and confectioneries, and various types of pharmaceutical products. Due to increasingly high applications, these products generate huge post-utilization waste burden on the environment. Amid the COVID-19 pandemic, there was recorded an upsurge in the use of protective single-use equipment such as face masks made of plastics (United Nations Environment Programme, 2021), and take-away food **(**Shams, Alam & Mahbub, 2021), which has exacerbated an already bad situation of land and marine environments being affected by plastic littering. A rise of 44.8% in plastic waste can be attributed to packaging, and 13.2% to medical products during the pandemic **(**Sharma, *et al,* 2020).

Plastic pollution has emerged as a critical environmental challenge, with severe implications for ecological sustainability, public health, and economic development (Stoett, *et al,* 2024). Globally, over 300 million tons of plastic waste are generated annually, with a significant portion accumulating in water bodies, landfills, and urban environments (United Nations Environment Programme [United Nations Environment Programme, 2021). Nigeria, as the most populous country in Africa, faces an escalating plastic pollution crisis exacerbated by rapid urbanization, inadequate waste management infrastructure, and poor public awareness (Nwafor, Bartholomew, Ochuba & Aghaebe, 2024). In Cross River State, known for its rich biodiversity and extensive water systems, plastic pollution poses a direct threat to environmental sustainability by contaminating rivers, affecting marine ecosystems, and contributing land degradation (Offiong, *et al,* 2018).

Plastic waste has a prolonged decomposition period, often lasting centuries, thereby disrupting natural processes and endangering biodiversity (Khoaele, *et al*, 2023). The pollution of bodies of water such as the Cross River and its tributaries leads to the degradation of aquatic life, negatively affecting fishing communities and water quality. Additionally, the accumulation of plastic waste obstructs drainage systems, exacerbating flooding risks in urban areas like Calabar. Addressing plastic pollution is crucial to ensuring environmental sustainability and protecting the livelihoods of communities dependent on natural resources in Cross River State.

The effectiveness of plastic waste management largely depends on public attitudes, awareness, and behavioural practices (Adjei, Song, Nketiah, Obuobi & Adu-Gyamfi, 2023). Studies indicate that individuals with higher environmental awareness are more likely to adopt sustainable waste disposal practices (Suryawan & Lee, 2024). However, in Cross River State, there remains a knowledge gap regarding

the consequences of plastic pollution and the importance of sustainable waste management (Ada, *et al,* 2023). Cultural perceptions, economic constraints, and lack of incentives often hinder proper waste disposal, leading to indiscriminate littering and open dumping of plastic waste (McAllister, 2015).

Educational campaigns and community-based interventions have shown promise in shifting public behaviour towards responsible waste management (Njeru, 2018). However, in the absence of consistent awareness programs and enforcement mechanisms, many residents continue to rely on unsustainable disposal methods. Understanding the attitudes and awareness levels of residents is essential for designing targeted interventions to promote effective plastic waste management practices in Cross River State.

Governance frameworks and policy enforcement play a pivotal role in addressing plastic pollution. In Nigeria, waste management policies exist at both national and state levels, including the National Environmental Standards and Regulations Enforcement Agency (NESREA) guidelines and local government sanitation policies (Nwokike, 2020). Despite these policies, enforcement remains weak due to insufficient funding, limited technical expertise, and lack of political will (Adeyanju, 2024). In Cross River State, governance inefficiencies have contributed to uncontrolled plastic waste accumulation, with limited recycling initiatives and poorly regulated landfill sites (Nwankwo, 2022). Effective policy implementation, combined with stringent enforcement mechanisms, is necessary to combat plastic pollution. Strengthening legal frameworks and ensuring inter-agency coordination can significantly enhance pollution control efforts in the state.
Community-driven initiatives have proven successful in mitigating plastic pollution in various parts of the world (Gonçalves, 2021). Localized strategies such as waste segregation programs, recycling incentives, and environmental advocacy groups contribute to reducing plastic waste (Wilson, Velis & Cheeseman, 2016). In Cross River State, community participation in plastic waste management remains relatively low due to inadequate public engagement and limited access to sustainable waste disposal facilities (Etim *et al*., 2021).

Encouraging active community involvement through participatory approaches can foster a sense of ownership and responsibility toward plastic waste management (Xiao, *et al*, 2017). Community-based recycling centers, stakeholder collaborations, and volunteer-led clean-up campaigns can complement governmental efforts in controlling plastic pollution. The implementation of effective plastic waste management strategies in Cross River State is constrained by several factors, including inadequate infrastructure, poor policy enforcement, and financial limitations (Kassah, 2020). Many urban and rural areas lack proper waste collection and disposal systems, leading to the proliferation of illegal dumping sites (Abila, Abila & Kantola, 2023). Additionally, recycling initiatives remain underdeveloped due to low investment in waste processing technologies and the absence of formalized waste collection structures.

Economic challenges also play a significant role in waste management inefficiencies, as local governments often struggle to allocate sufficient resources for environmental sustainability programs (Oyegoke, *et al,* 2023). Addressing these challenges requires a multi-stakeholder approach, integrating governmental, private sector, and community-driven efforts to enhance waste management strategies in the state. The effectiveness of policy implementation is crucial in strengthening governance strategies, raising public awareness, and fostering community-driven environmental initiatives (Pearson, Lebow-Skelley, Whitaker, Young, Warren, Williamson & Kegler, 2020). Policies addressing plastic pollution must be accompanied by practical enforcement mechanisms, financial incentives, and public engagement strategies (Karuppiah *et al*., 2021). In Cross River State, gaps in policy execution have hindered the success of plastic waste management programs. Investing in evidence-based policymaking, integrating behavioral insights, and ensuring multi-sectoral collaboration can improve policy effectiveness.

Plastic may be one of the greatest developments to have improved human life in the twentieth century (Pilapitiya & Ratnayake, 2024). Plastics have replaced natural materials, as a cheaper and more cost-saving

option, and also a quicker way to package food and carry shopping. In contrast, Smith and Brisman, (2021) asserted that the popularity of plastics has also meant a rise in plastic waste, which brings its own economic, environmental, and social issues. They add that the environmental problems from plastic waste are exacerbated by the nature of plastics to be durable and non-biodegradable. When improperly disposed, plastics gather around the city, choking drains, threatening small animals, damaging the soil, and polluting the beaches. Attitudes are referred to because, they have been found to influence certain subjective norms, which translate into behavioral patterns (Ajzen, *et al,* 2018). Individual or group awareness and attitudes towards waste generation and management are therefore critical in the effort to respond to the waste management challenge.

The socio-economic and environmental burdens associated with plastic pollution fall disproportionately on vulnerable populations, especially those whose livelihoods depend on fisheries, agriculture, and tourism. Despite ongoing efforts, the effectiveness of community-based mitigation approaches such as local recycling programmes, awareness and advocacy campaigns, and the adoption of sustainable alternatives to plastic use remains insufficiently documented within the context of Cross River State. Additionally, there is limited empirical evidence on how local governance mechanisms and public private partnerships can strengthen plastic waste management systems and advance broader environmental sustainability objectives.

In light of these gaps, this study aims to assess the impacts of plastic pollution, appraise the existing governance frameworks, and investigate the contributions of community-driven initiatives toward reducing plastic waste in Cross River State. Addressing these issues is essential for informing evidence-based policymaking and promoting sustainable environmental practices that are consistent with both national and global sustainability agendas.

Research Hypotheses

The following hypotheses were formulated to guide the study:

1. Challenges in implementing effective plastic waste management strategies do not significantly influence environmental sustainability in Cross River State.
2. The effectiveness of plastic waste policy implementation has no significant influence on environmental sustainability in Cross River State.

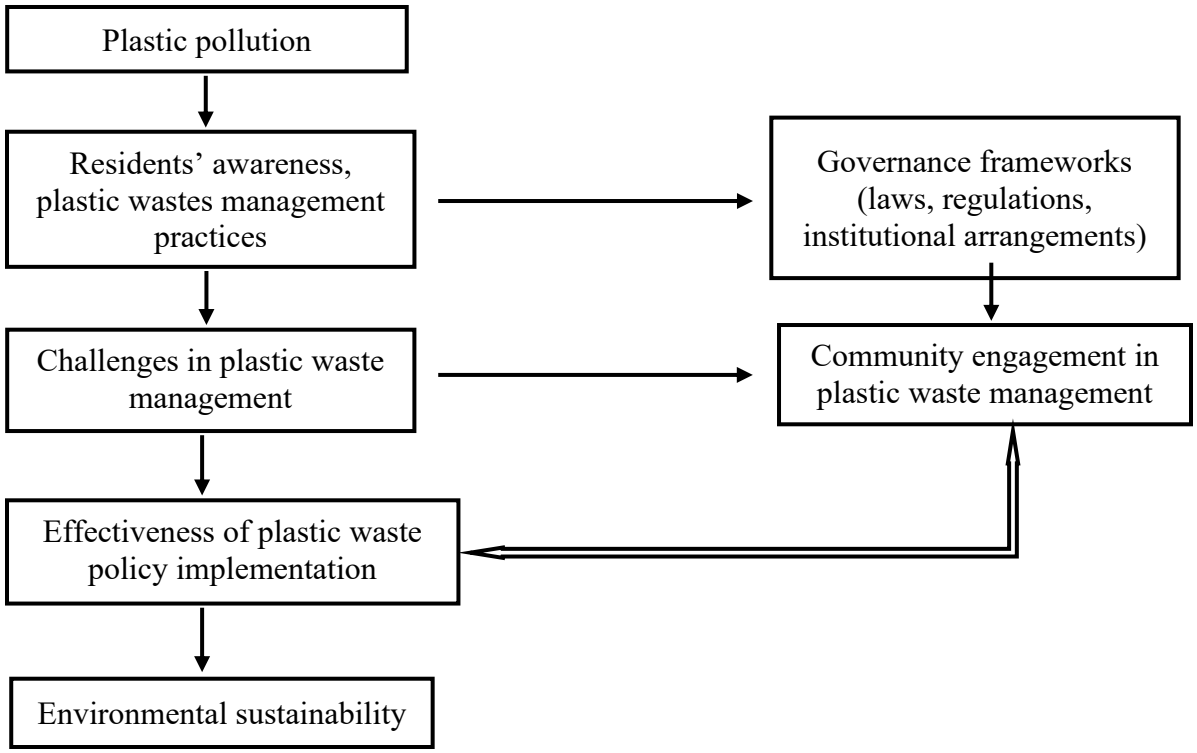

FIGURE 1: Conceptual framework of plastic pollution, human and institutional factors, challenges, and environmental sustainability in Cross River State, Nigeria.

Source: The Researchers (2026)

Research Method

Ethical Considerations

Primarily, the researchers obtained an approval from the research and ethics committee of the University of Calabar, to execute the study. They further obtained informed consent from participants to fill and sign. The purpose of the research was clearly explained to the participants, and they were further assured of strict confidentiality and anonymity.

Design and Procedure

A descriptive research design was adopted for the study. The area covered in this research was Cross River State of Nigeria. Cross River State is a coastal state in south-south Nigeria, bordering Cameroon to the east. It is located in the South-South geo-political zone of the Federal Republic of Nigeria. The population of this study comprised of all registered couples (as target audience for most of the household waste generated are from them) in each LGAs councils marriage registry in Cross River State. Information obtained from National Bureau of Statistics, 2020 reveals that there are four hundred and thirteen thousand three hundred and twenty-one (413,321) registered couples spread across the three Education Zones in Cross River State of Cross River State. This made the total population of the study to be four hundred and thirteen thousand three hundred and twenty-one (413,321) subjects.

This study adopted a multistage sampling procedure, which involves the combination of different sampling methods tailored to the characteristics of the population under investigation. At the first stage, purposive sampling was employed to select three education zones – Calabar, Ikom, and Ogoja – based on their demographic and geographic relevance to the objectives of the study.

In the second stage, simple random sampling was used to select Local Government Areas (LGAs) within each education zone. Specifically, three LGAs were randomly selected from the Calabar zone, and two LGAs each from the Ikom and Ogoja zones. A lottery method was adopted for this purpose: each LGA was assigned a unique number, and numbers were randomly drawn to determine the selected LGAs.

At the third stage, stratified sampling was utilized to ensure proportional representation of registered couples across the selected LGAs. The researcher targeted 40% of the registered couples within the selected LGAs, using official records from the marriage registries. Stratified sampling involves dividing the population into homogeneous subgroups (strata) and selecting samples from each stratum in proportion to their presence in the population.

During the administration of the research instrument, accidental sampling (also known as convenience or opportunity sampling) was applied. This non-probability method involved administering questionnaires to registered couples who were available and willing to participate at the time of distribution. This process continued until the required number of participants from each LGA was reached.

Finally, Taro Yamane's formula was used to determine the sample size for each zone, based on a 5% margin of error. This methodological framework ensured a balanced and representative sample of the target population – registered couples in the selected LGAs across the three education zones of Cross River State. The total sample size for the study was 1,178 respondents who registered as couples duly married at the Local Government Council marriage registry. The instrument used for this study titled: Questionnaire on Plastic Pollution and Environmental Sustainability: Assessing Impacts, Governance Frameworks, and Community-Led Mitigation Strategies in Cross River State, Nigeria structured by the researchers. The instrument was divided into four sections: Section A, B, C and D. Section A of the questionnaire was designed to obtain information on the demographic variables of the respondents (Gender). Section B of the questionnaire was designed to measure the plastic pollution levels, section C measured other variables such as residents' awareness levels, and plastic waste management, governance frameworks on plastic waste management, community engagement on plastic waste management, challenges in implementing effective plastic waste management strategies and the effectiveness of plastic waste policy implementation. Similarly, section D was designed to measure environmental sustainability. The questionnaire was administered on selected registered couples in LGA council's marriage registry in Cross River. The instrument has 48 items (1 for section A, 1 for section B, 36 for section C and 10 for section D) on a modified 4-point Likert scale ranging from Strongly Agree (SA), Agree (A), Disagree (DA) and Strongly Disagree (SD).

The instrument was validated by two experts in Measurement and Evaluation in University of Calabar, Calabar To ascertain the internal consistency of the items, Cronbach alpha reliability method was used which the result ranged of .70 to .83 The questionnaire was administered to the respondents by the researchers in the communities with the help of three research assistants.

Results

The results of the study are presented hypothesis-by-hypothesis. Each hypothesis was tested at 0.05 level of significance**.**

Hypothesis 1

Challenges in implementing effective plastic waste management strategies do not significantly affect environmental sustainability in Cross River State. A multiple regression analysis was conducted to examine the impact of financial, logistic, and regulatory challenges on environmental sustainability in Cross River State. The result is presented in table 1.

The overall model was statistically significant, $F(3,1174) = 659.971$, $p < .001$, indicating that these three challenges collectively contribute to explaining environmental sustainability. The mean score for environmental sustainability was $M = 24.57$, $SD = 1.33$. The mean scores for the challenges were: Financial Challenges Implementation: $M = 4.88$, $SD = 0.52$. Logistic Challenges Implementation: $M = 7.30$, $SD = 0.46$. and Regulatory Challenges Implementation: $M = 3.80$, $SD = 0.40$.

TABLE 1

Multiple regression analysis predicting environmental sustainability from challenges in plastic waste management strategies (N = 1178)

R	R^2	Adjusted R^2	Std. Error of the Estimate			
.792[a]	.628	.627	.81208			
Variable		B	Std. Error	β	t	Sig.
Constant		38.599	0.504	-	76.593	.000
Financial challenges in Implementation of plastic waste management strategies		-1.602	0.049	-0.631	-32.433	.000
Logistic challenges in Implementation of plastic waste management strategies		-0.329	0.055	-0.114	-5.986	.000
Regulatory challenges in implementation of plastic waste management strategies		-0.999	0.067	-0.298	-14.984	.000

F (3, 1174) = 659.971, p < .001. Dependent Variable: Environmental Sustainability.

The model demonstrated a strong correlation between the independent variables (financial, logistic, and regulatory challenges) and the dependent variable (environmental sustainability), with $R = 0.792$. The R^2 value of 0.628 indicates that approximately 62.8% of the variance in environmental sustainability can be explained by the three challenges. The Adjusted R^2 of 0.627 suggests that the model provides a good fit for the data. The ANOVA results confirmed the significance of the model, with $F(3, 1174) = 659.971$, $p < .001$. This indicates that the combination of financial, logistic, and regulatory challenges significantly explains the variance in environmental sustainability.

The coefficients results reveal the individual effects of each challenge:

- Financial challenges in implementation: The regression coefficient for financial challenges was $B = -1.602$, $\beta = -0.631$, $p < .001$, indicating that for every one-unit increase in financial challenges, environmental sustainability decreases by 1.602 units. This demonstrates that financial challenges have a significant negative impact on environmental sustainability.
- Logistic challenges in implementation: The regression coefficient for logistic challenges was $B = -0.329$, $\beta = -0.114$, $p < .001$, showing a significant but weaker negative relationship. For each one-unit increase in logistic challenges, environmental sustainability decreases by 0.329 units.
- Regulatory challenges in implementation: The regression coefficient for regulatory challenges was $B = -0.999$, $\beta = -0.298$, $p < .001$, indicating a negative relationship between regulatory challenges and environmental sustainability. For every one-unit increase in regulatory challenges, environmental sustainability decreases by 0.999 units.

The results of the multiple regression analysis indicate that financial, logistic, and regulatory challenges significantly affect environmental sustainability in Cross River State. Specifically, all three challenges have a negative relationship with environmental sustainability, with financial challenges having the strongest negative impact. The model explains 62.8% of the variance in environmental sustainability, suggesting that while these three challenges play an important role, other factors not included in the model may also influence sustainability outcomes.

Hypothesis two

The effectiveness of plastic waste policy implementation has no significant influence on environmental sustainability in Cross River State. A simple linear regression was conducted to examine whether the effectiveness of plastic waste implementation significantly predicts environmental sustainability in Cross River State. The result is presented in table 2.

The results in Table 2 revealed that the model was statistically significant, $F (1, 1176) = 383.17$, $p < .001$, indicating that the effectiveness of policy implementation significantly contributes to explaining variance in environmental sustainability. The model yielded an R^2 value of .246, suggesting that approximately 24.6% of the variance in environmental sustainability is explained by the effectiveness of plastic waste policy implementation. While this is a moderate level of explanatory power, it indicates that policy effectiveness is an important factor in shaping environmental sustainability outcomes.

The regression coefficient ($B = 0.633$, $p < .001$) indicates a positive and significant relationship between policy effectiveness and environmental sustainability. This means that as the effectiveness of plastic waste policy implementation increases, environmental sustainability also

improves. The standardized beta coefficient (β = .496) further shows a moderate to strong effect size.

Contrary to the null hypothesis, the results demonstrate that the effectiveness of plastic waste policy implementation significantly enhances environmental sustainability in Cross River State. Thus, policy implementation plays a meaningful role in promoting environmental outcomes.

TABLE 2
Simple Linear Regression Predicting Environmental Sustainability from Effectiveness in Plastic Waste Policy Implementation (N = 1178)

R	R^2	Adjusted R^2	Std. Error of the Estimate			
.496a	.246	.245	1.15499			
Predictor		B	SE	β	t	p
(Constant)		20.682	0.202	-	102.536	.000
Effectiveness in plastic waste policy implementation		0.633	0.032	0.496	19.575	.000

$R^2 = .246$, $F(1, 1176) = 383.17$, $p < .001$.

Discussion of findings

Governance frameworks in plastic waste management and effect on environmental sustainability

The findings of the Pearson Product Moment Correlation analysis reveal a statistically significant, strong negative relationship between governance frameworks in plastic waste management and environmental sustainability in Cross River State, Nigeria. The strength and direction of this correlation suggest that as governance and enforcement measures increase, perceptions of environmental sustainability decline.

While the statistical significance of this relationship is clear, the interpretation requires caution. The strong negative correlation, though compelling, does not imply causation and may be influenced by confounding variables not accounted for in the analysis. For instance, stricter governance measures may be reactive responses to worsening environmental conditions, or residents may perceive enforcement efforts as ineffective or punitive, thereby lowering their perception of sustainability outcomes.

This finding diverges from prior studies that highlight the positive role of governance frameworks in enhancing environmental outcomes. For instance, Wilson et al. (2015) demonstrated that strong policy enforcement in countries like Rwanda and Kenya significantly curtailed plastic waste through effective bans on single-use plastics. Similarly, Nyathi and Togo (2020), in their systematic review of plastic bag policy effectiveness across African countries, concluded that

consistent enforcement, alongside public education, is crucial for successful plastic waste management. Their work highlights that while policies exist, their impact is often undermined by weak enforcement mechanisms, lack of stakeholder buy-in, and the absence of sustainable alternatives.

In the Nigerian context, Eze and Chukwuemeka (2022) identified specific challenges to effective plastic waste governance in Cross River State, including poor regulatory compliance, inadequate funding, and inter-agency coordination issues. These institutional weaknesses may explain why increased governance efforts do not correlate with improved sustainability outcomes in the present study. Instead, they may reflect public frustration or disillusionment with government-led initiatives perceived as inefficient or poorly implemented.

Therefore, while the current findings are statistically significant, they contrast with the broader literature that supports the positive influence of robust governance and enforcement on sustainability. This discrepancy may point to contextual challenges within Cross River State, such as ineffective implementation, lack of stakeholder engagement, or insufficient community participation. Addressing these systemic issues could transform governance frameworks into more effective tools for promoting environmental sustainability.

Moreover, Adeyemi (2017) found that incentivizing community involvement through awareness campaigns and financial rewards improved waste disposal behavior in Nigeria. However, the same body of literature also acknowledges key limitations – such as inadequate government support, lack of infrastructure, and poor coordination – which often hinder the success of community-driven waste initiatives (Ogunbode et al., 2020). These constraints may explain the negative correlation observed in the current study, as residents who participate in plastic waste management efforts might be disillusioned by a lack of institutional backing or visible impact, leading to reduced perceptions of environmental sustainability.

While the current findings indicate a weak and negative relationship between community engagement and environmental sustainability, this contrasts with existing literature that underscores the positive role of community participation. The discrepancy likely reflects contextual challenges in Cross River State, including insufficient infrastructure, low governmental support, and the absence of well-coordinated community-based programs. Addressing these barriers through structured partnerships, awareness campaigns, and capacity-building could enhance the effectiveness of community participation in achieving environmental sustainability.

Challenges in implementing effective plastic waste management strategies and effect on environmental sustainability

The multiple regression analysis examined the influence of financial, logistic, and regulatory challenges on environmental sustainability in Cross River State. As reported in Table 10, the overall model was statistically significant, indicating that these three categories of challenges, when considered together, significantly predict environmental sustainability. The model accounted for 62.8% of the variance in environmental sustainability, suggesting a strong explanatory power. Individually, each of the predictors – financial, logistic, and regulatory challenges – demonstrated a significant negative relationship with environmental sustainability, with financial challenges exerting the most pronounced effect. These findings imply that as these challenges intensify, environmental sustainability tends to decline. Although the model identifies other factors not

included in the analysis that may also influence sustainability outcomes, the results clearly underscore the importance of addressing these systemic barriers.
Contrary to the statement that these challenges do not significantly affect environmental sustainability, the results show that they do, in fact, have a significant and negative effect, both collectively and individually. Therefore, the conclusion in the statement appears inconsistent with the actual statistical findings, which suggest otherwise.

These findings align with the Eze and Chukwuemeka (2022) who identified inadequate infrastructure for waste collection, lack of recycling facilities, and weak policy enforcement as primary obstacles to effective plastic waste management in Nigeria. Similarly, Evode et al. (2021) emphasized that while plastic use supports industrial development, the absence of effective post-consumer waste management strategies poses serious environmental risks. Their study highlighted the critical need for integrated and well-resourced plastic waste management systems to mitigate these risks.

Additionally, Nzeadibe et al. (2020) noted that financial constraints, low public engagement, and poor stakeholder collaboration significantly hinder waste management initiatives across Nigerian communities. Their research supports the current study's identification of financial and logistic constraints as key determinants of sustainability outcomes. Okonkwo (2019) also pointed out the underutilization of informal waste pickers in Cross River State, who, despite their contributions to plastic recycling, lack formal support and recognition, further reinforcing the need to strengthen institutional and regulatory frameworks.

The findings from the multiple regression analysis confirm the critical role of financial, logistic, and regulatory challenges in shaping environmental sustainability in Cross River State. These results are consistent with existing research and highlight the need for targeted policy interventions, increased investment in waste infrastructure, and institutional reforms to enhance sustainability outcomes in the region.

The effectiveness of plastic waste policy implementation and enhancement environmental sustainability.

The results of the simple linear regression analysis presented in Table 11 examined whether the effectiveness of plastic waste policy implementation significantly predicts environmental sustainability in Cross River State. The findings revealed that the model was statistically significant, suggesting that improvements in the effectiveness of policy implementation contribute meaningfully to enhancing environmental sustainability outcomes. This indicates a moderate to strong positive effect, implying that as policy implementation becomes more effective, environmental sustainability also improves.These results contradict the initial assumption or null hypothesis that the effectiveness of plastic waste policy implementation does not significantly enhance environmental sustainability. Instead, the statistical evidence supports the alternative – that effective policy implementation positively and significantly influences sustainability. This underscores the critical role of not just policy formulation but also its execution in addressing environmental concerns related to plastic waste.

Furthermore, these findings are consistent with the United Nations Environment Programme (UNEP, 2021) that highlightted that well-structured waste management policies – such as plastic

bands and extended producer responsibility (EPR) frameworks – are effective tools for reducing plastic pollution and promoting environmental sustainability. These policies, when effectively implemented and enforced, foster accountability across the plastic lifecycle, from production to disposal.

Similarly, Macheca et al. (2024) advocate for evidence-based, systemic strategies rather than blanket bans on plastics. Their study emphasizes the importance of scientifically grounded solutions, such as targeted policy interventions, sustainable economic models, and improved plastic waste management systems, as practical ways to mitigate environmental harm. While the authors acknowledge the limitations of biodegradable plastics and the complexity of full-scale recycling, they argue that policy effectiveness, supported by international cooperation and research, remains central to solving the plastic crisis.

The regression results affirm that effective implementation of plastic waste policies has a significant and positive impact on environmental sustainability in Cross River State. This finding aligns with the broader body of literature, which consistently underscores the importance of actionable and enforceable policies in addressing the environmental challenges posed by plastic waste (UNEP, 2021; Macheca et al., 2024). The implication is clear: for environmental sustainability to be realized, attention must shift from policy design alone to robust implementation and monitoring frameworks.

Conclusion

This study assessed the impacts of plastic pollution, governance frameworks, and community-led mitigation strategies on environmental sustainability in Cross River State, Nigeria. Drawing on empirical data, in conclusion, the findings reveal a complex and multifaceted relationship between plastic waste management efforts and sustainable environmental outcomes in the region. Contrary to conventional expectations, plastic pollution levels, residents' attitudes and awareness, community engagement, and governance enforcement frameworks were not found to have a meaningful or positive influence on environmental sustainability. These results suggest that while awareness and participation are important, they are not sufficient in their current form to drive significant environmental change.

The findings underscore the need for a shift from fragmented, community-level initiatives and policy rhetoric toward more coordinated, well-funded, and strategically implemented actions. Addressing systemic challenges, investing in infrastructure, and enhancing institutional capacity are essential for achieving sustainable environmental outcomes in Cross River State.

Recommendations

Based on the findings of the study the following recommendations are proposed:

1. Re-evaluate community engagement strategies: Although community engagement showed no significant impact in its current form, it remains a critical component of sustainability when properly structured. Authorities and NGOs should adopt participatory approaches that involve communities in co-designing waste solutions, backed by capacity-building, incentives, and sustained educational campaigns.
2. Enhance inter-agency collaboration and policy integration: Poor policy enforcement and weak governance frameworks point to a need for better coordination among environmental,

health, and municipal authorities. Establishing a multi-stakeholder task force on plastic waste management can facilitate integrated planning and accountability.

3. Incentivize the informal sector and recycling entrepreneurs: Informal waste collectors and recyclers play a vital role in managing plastic waste in Cross River State. Formalizing and supporting these actors through training, financial incentives, and legal recognition can increase the efficiency and scope of recycling efforts.

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