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Effects of Bin Location on Waste Sorting Behavior in Junior High Schools: A Field Experiment

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Abstract

Solid waste management remains a pressing challenge that affects environmental quality and public well-being. This study examined the influence of bin location on waste sorting behavior among students in selected secondary schools in Lagos State, Nigeria. This study employed a 2 × 4 quasi-experimental design, in which bins for recyclable materials were placed in classrooms and corridors for a 10-day period. Recyclable waste collected was counted, weighed, and analyzed using descriptive and inferential statistics. The results showed that bin location marginally improved sorting behavior, with more materials deposited in classroom bins than in corridor bins. This finding suggests that bins placed in classrooms provide greater accessibility and convenience, thereby encouraging consistent sorting behavior, while bins in corridors are less effective due to distractions and increased foot traffic. The study concludes that strategic placement of bins can enhance students' participation in waste sorting and contribute to more sustainable waste management practices. School authorities are therefore encouraged to consider bin placement as a behavioral intervention to foster environmentally responsible habits among students.

Keywords: Nigeria, Recycling Behavior, Solid Waste Management, Waste Sorting
SDGs: Goal 4 (Quality Education) and Goal 12 (Responsible Consumption and Production)

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INTRODUCTION

Sustainable waste management has become an important issue worldwide due to its impact on human health, environmental sustainability, and economic development. Since the introduction of the Sustainable Development Goals (SDGs) in 2015 as a replacement for the Millennium Development Goals (MDGs), resource management and waste reduction have become a significant focus in global development efforts. SDG 12, Responsible Consumption and Production, specifically target 12.5, emphasizes the importance of significantly reducing waste generation through prevention, reduction, recycling, and reuse (UN, 2015). Waste sorting behavior is recognized as one of the most effective strategies for achieving this goal because it allows for the separation of recyclable materials from general waste, thereby reducing the burden on landfills, extending the lifespan of resources, and reducing pollution (Wu et al., 2020).

Previous research has shown that the success of waste sorting is not only influenced by individual awareness, but also by physical environmental factors that facilitate such actions. Studies by Radan et al. (2016) and Rosenthal & Linder (2016) found that strategically placing trash bins in school environments, particularly inside classrooms, can improve sorting accuracy due to easier access and direct supervision. Cohen et al. (2024) used agent-based simulations to show that the closer the bin location is to users, the higher the sorting accuracy rate, both in low- and high-population environments.

In addition to conventional approaches, technological innovations have been developed to support sorting behavior. Adrien and Ngaha (2019) introduced mobile bins carried by volunteers at public events to improve sorting compliance. Najmurrokhman et al. (2023) developed an automated bin with location sensors and realtime notifications via Telegram, while Loblobly et al. (2024) implemented a Supervisory Control and Data Acquisition (SCADA) system capable of detecting waste types and activating automatic sorting mechanisms. In Nigeria, studies by Okoye et al. (2019), Onuorah et al. (2023), and Oluwatuyi et al. (2020) revealed that waste sorting in schools is still rarely done due to inadequate facilities, poorly strategic bin placement, and low student awareness.

Recent developments show a combination of innovative technology and bin placement strategies to optimize sorting behavior. The use of smart bins with sensors, futuristic and educational designs, and standardized color systems has been proven to facilitate the sorting process and attract user participation (Putra et al., 2024). However, simple interventions based on physical environmental changes, such as moving bins to locations closer to users, remain relevant and practical, especially in schools with limited budgets and advanced technological facilities. Physical environmental changes align with Behavior Setting Theory (Barker, 1990), which emphasizes that physical space arrangements can significantly influence behavior.

Although many studies have highlighted the role of bin location in improving sorting behavior in developed countries and some developing countries (Deng & Zhang, 2019; Fritz et al., 2017; He & Wang, 2019; Yang, 2020), very few studies have examined this topic in Nigeria, particularly in public secondary schools in Lagos State. However, this local context presents unique challenges in the form of limited sorting facilities, the habit of disposing of waste without sorting, and the lack of integration of environmental education into the curriculum. The unavailability of empirical evidence in this context represents an important research gap that needs to be filled.

Based on this background, this study aims to examine the effect of bin placement (inside the classroom vs. in the corridor) on the waste sorting behavior of public secondary school students in Lagos State, Nigeria. Specifically, this study seeks to answer the question: Does the location of trash bins influence students' waste sorting behavior compared to a control group without intervention? By answering this question, the study aims to provide practical recommendations for waste management in schools and contribute to achieving SDG 12.5 targets at the local level.

METHOD

This study employed a quasi-experimental field design in which bin location served as the independent variable with two levels (inside the classroom and in the corridor), while the dependent variable was waste-sorting behavior, measured in kilograms of recyclable materials (paper, plastic bottles, and water sachets) deposited into designated bins. Given the ethical constraints that may limit random assignment in field settings, the quasi-experimental design was considered appropriate. Purposive sampling was used to select three schools: Alagbado Junior Grammar School (AJGS), Tomia Community Junior Secondary School (TCJSS), and Surulere Community Junior Secondary School (SCJSS). Based on criteria such as being located within the same educational district, having adequate infrastructure to support the intervention, and representing demographic diversity. Within each school, intact JSS3 classes were assigned to experimental conditions to minimize cross-group contamination. The study involved 556 students (246 males, 44%; 310 females, 56%) aged 13 to 19 years, with a mean age of 15.4 ± 8.2. Participants were distributed across eight experimental conditions according to their classes and intervention locations, ensuring that all individuals within a given condition were exposed to the same bin-location arrangement.

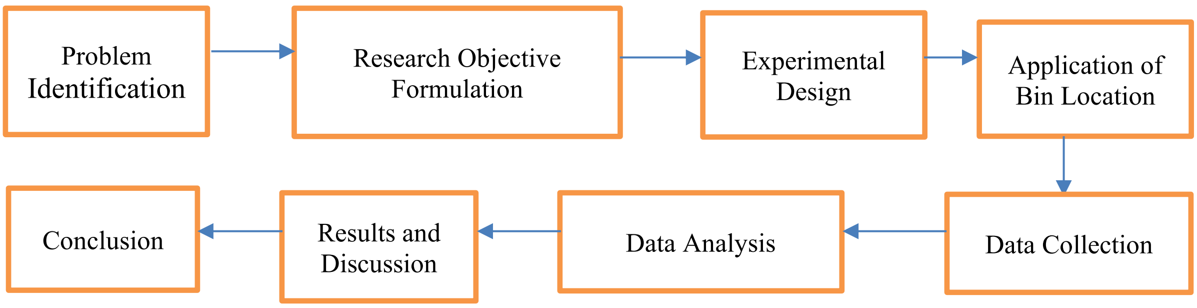


Figure 1. Research Flow Chart

Based on the research flow chart in Figure 1, the study began with the problem identification stage by observing issues in the field, namely the low level of waste-sorting behavior in schools. Once the problem was identified, the research objectives were formulated to examine the effect of bin location (inside the classroom and in the corridor) on students' waste-sorting behavior. The next stage involved designing the experiment using a quasi-experimental method, with bin location as the independent variable and waste-sorting behavior measured by the weight of recyclable materials as the dependent variable. Following the preparation of the experimental design, the intervention was implemented by placing color-coded sorting bins according to the experimental conditions (classroom or corridor) for different categories of recyclable materials. Data collection was carried out by weighing the accumulated recyclable items, including paper, plastic bottles, and water sachets, in each designated bin during the respective phases of the study (baseline, classroom phase, and corridor phase). The collected data were then subjected to descriptive and inferential statistical analyses to test the proposed hypotheses. The findings were subsequently presented in the results and discussion section to provide interpretation of the study outcomes. Finally, the research was concluded by summarizing the key findings and offering implications and recommendations for improving waste-sorting behavior in school settings.

(a)

(b)

Figure 2. Waste Sorting Bins Used in The Study: (a) Bins Located in Classrooms (Control Group), and (b) Bins Located in Corridors (Control Group).

Based on Figure 2, the study employed four color-coded sorting bins. The use of color coding aimed to facilitate the categorization of recyclable materials, reduce confusion, and promote accuracy in the sorting process. The blue bin was designated for paper, the green bin for plastic bottles, the yellow bin for water sachets, and the grey bin for other non-recyclable wastes. This color-coding system is supported by research indicating that clear visual distinctions and standardized bin systems can significantly enhance waste-sorting behavior by making the process more intuitive (Pilarezyk & Wichary, 2015). In addition, the semi-transparent design of the plastic bins allowed for a quick visual inspection of their contents, ensuring that waste sorting was carried out correctly. The recyclable materials collected were measured using a portable digital scale. Given the nature of this study, all research assistants were provided with adequate personal protective equipment (PPE), including rubber gloves, face masks, and protective clothing, which were essential to ensure safe handling of waste without compromising the integrity of the collected samples.

The study was conducted in three phases. The first phase involved baseline data collection to establish a reference point for waste-sorting behavior. Sorting bins were placed in both classrooms and corridors (see Figure 2) for five consecutive days, Monday through Friday. During this phase, the researchers and assistants collected, sorted, and weighed waste categorized into paper, plastic bottles, and water sachets to obtain initial measurements of sorting behavior. This baseline ensured that any changes observed in the experimental phases could be attributed to the intervention rather than pre-existing differences. In the second phase, sorting bins were placed inside selected classrooms and tied together with ropes to prevent relocation. In the control classrooms, only the existing bins were used. This phase lasted for 10 days, Monday through Friday, during which waste from each bin was collected, sorted by category, and weighed. After the classroom phase, the third phase was carried out by relocating the sorting bins to the corridors, where they were secured to fixed structures such as railings to maintain their positions throughout data collection. The same procedures of collection, sorting, and weighing were applied for 10 days. In the control condition for the corridor phase, the existing school bins were used, with collection and sorting performed by the researchers and assistants. This corridor phase enabled the researchers to evaluate whether bin location inside classrooms or in corridors had a measurable effect on students' waste-sorting behavior.

To maintain data integrity, two quality control measures were implemented. First, Inter-Observer Agreement (IOA) was conducted once weekly, in which the researcher re-weighed randomly selected waste samples to ensure consistency across observers. An IOA value of at least 90% was achieved, demonstrating the reliability of the data. Second, Procedural Integrity was ensured through daily inspections to confirm that all bins were in their designated positions and that no waste remained prior to the next collection period. The dependent variable in this study was waste-sorting behavior, measured through the weight of recyclable materials deposited in each designated bin: paper (blue bin), plastic bottles (green bin), and water sachets (yellow bin). Measurements were recorded in kilograms to ensure high sensitivity and objectivity, thereby capturing even minor changes in sorting behavior that might otherwise be overlooked by less precise methods. The collected data were analyzed using IBM SPSS Statistics version 26, applying both descriptive and inferential statistics. Hypothesis testing was conducted through Multivariate Analysis of Variance (MANOVA) and Bonferroni post-hoc tests, with a significance threshold of $p < 0.05$. This research protocol was reviewed and approved by the University of Ibadan Social Sciences and Humanities Research Ethics Committee (Approval Number: UI/SSHREC/2023/0146).

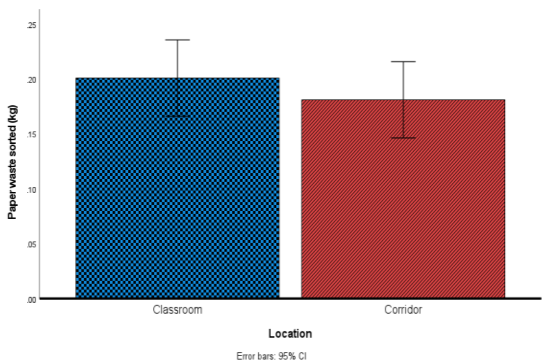
RESULTS AND DISCUSSION

The results showed that bin location had a significant effect on students' waste-sorting behavior in Junior High Schools, with differences observed when sorting bins were placed inside classrooms and in corridors compared to the control group. First, the descriptive statistics of the mean and standard deviation for the sorted waste materials (paper, plastic bottles, and water sachets) are presented in Table 1.

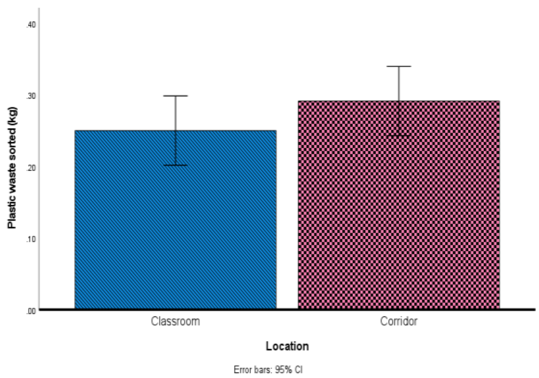
Table 1. Weight of Waste Collected (kg) in Kilograms of Recyclable Materials Sorted by on Locations

	Location	**Mean ± SD**	**N**
Papers	Classroom	0.20 ± 0.15	60
	Corridor	0.18 ± 0.12	60
	Total	0.19 ± 0.14	120
Plastic Bottles	Classroom	0.25 ± 0.18	60
	Corridor	0.29 ± 0.20	60
	Total	0.27 ± 0.19	120
Water Sachets	Classroom	0.12 ± 0.03	60
	Corridor	0.11 ± 0.02	60
	Total	0.11 ± 0.02	120
Combined Recyclables	Classroom	0.57 ± 0.30	60
	Corridor	0.58 ± 0.30	60
	Total	0.57 ± 0.30	120

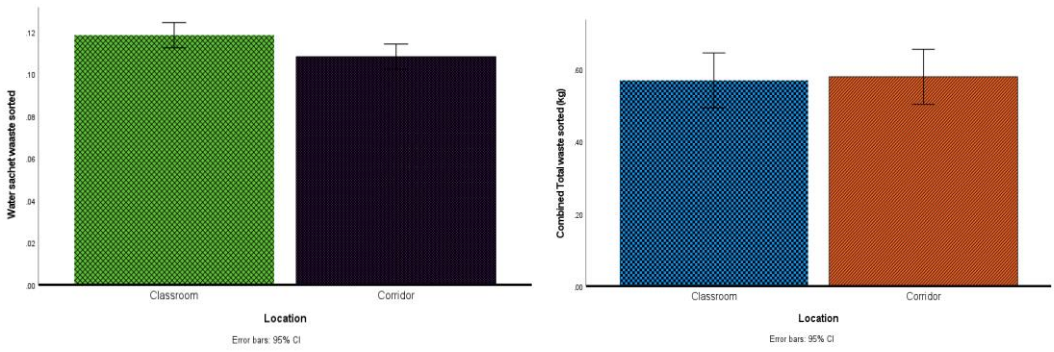
At the initial stage, Table 1 presents the descriptive statistics, including the mean and standard deviation (in kilograms) of recyclable materials sorted according to the different locations of the waste sorting bins. The findings indicate relatively small variations between the placement of bins inside classrooms and in corridors with respect to the number of recyclable materials sorted by the participants. To provide a clearer visual representation, these results are also displayed in bar chart formats in Figures 3.



(a)



(b)



(c) (d)

Figure 3. Weight of Recyclable Materials Sorted in Labeled Waste Bins Located in the Classroom and Corridor: (a) Paper, (b) Plastic Bottles, (c) Water Sachets, and (d) Combined Recyclable Materials.

Figure 3 presents the descriptive results of recyclable materials sorted across bin locations: (a) paper, (b) plastic bottles, (c) water sachets, and (d) combined recyclable materials. The mean weight of papers sorted was 0.20 kg in classrooms compared to 0.18 kg in corridors, indicating no substantial difference. For plastic bottles, the classroom condition yielded 0.25 kg, while the corridor condition yielded 0.29 kg, suggesting a marginal but negligible increase. Water sachets showed a slightly higher mean in classrooms (0.12 kg) than in corridors (0.11 kg), again reflecting minimal variation. Finally, the combined recyclable materials showed mean weights of 0.57 kg in classrooms and 0.58 kg in corridors, further confirming that overall bin location had little influence on students' sorting behavior. These descriptive findings suggest that bin placement alone did not substantially improve waste sorting, highlighting the potential role of other contributing factors such as student motivation, environmental awareness, and reinforcement mechanisms. To further validate these observations, inferential analysis was conducted using Multivariate Analysis of Variance (MANOVA) with Bonferroni post-hoc tests, in order to determine whether the observed differences were statistically significant across experimental conditions.

Table 2. Multivariate Analysis of Variance (MANOVA) of the Effects of Locating Waste Sorting Bins in the Classroom and Corridor

	Test Value	F	Hypothesis df	Error df	Sig.	Partial η^2
Pillai's Trace	0.134	4.460^b	4.000	115.000	0.002	0.134
Wilks' Lambda	0.866	4.460^b	4.000	115.000	0.002	0.134
Hotelling's Trace	0.155	4.460^b	4.000	115.000	0.002	0.134
Roy's Largest Root	0.155	4.460^b	4.000	115.000	0.002	0.134

Based on Table 2, the MANOVA results showed a significant multivariate effect of the treatment group on waste sorting behavior [Wilks' Lambda = 0.866, $F(4,115) = 4.46$, $p < 0.002$, $\eta^2 = 0.134$], indicating a meaningful difference in the amount of waste sorted between bins placed in the classroom and in the corridor. However, the effect size was relatively small (partial $\eta^2 = 0.134$), which means that the bin location accounted for only 13.4% of the variance in students' waste sorting behavior. This suggests that although the bin location had an influence, it was not the main determinant of sorting effectiveness. Pratomo et al. (2023) also emphasized that behavioral and contextual factors, such as environmental awareness, reinforcement strategies, and peer influence, often play a greater role in shaping sustainable waste management practices compared to infrastructure changes alone. These findings highlight the importance of integrating environmental education, awareness campaigns, and motivational strategies alongside infrastructure provision to encourage consistent waste sorting behavior. Furthermore, this study also compared waste sorting behavior based on bin location and type of recyclable material, with the univariate results presented in Table 3.

Table 3 presents the results of the Bonferroni post-hoc analysis comparing waste sorting behavior based on the location of waste bins for three types of recyclable materials and the combined recyclables. The Bonferroni multiple comparison analysis showed no significant differences in the number of recyclable materials sorted into bins placed in the classroom or the corridor for paper (-0.02, $p = 0.43$), plastic bottles (-0.04, $p = 0.24$), and combined recyclables (-0.10, $p = 0.85$). However, for water sachets, there was a significant difference in the quantity sorted in the classroom compared to the corridor (-0.10, $p < 0.05$), indicating that the location of the waste bin significantly improved sorting behavior for this type of material. This finding suggests that students were likely more motivated or reminded to properly dispose of water sachets when bins were located in more accessible or visible places, such as inside the classroom, where the consumption of sachet water occurs more frequently. The absence of significant differences for paper, plastic bottles, and combined recyclables implies that sorting behavior for these materials is less sensitive to bin location and may be more influenced by behavioral or contextual factors.

Table 3. Bonferroni Post-Hoc Analysis Comparing Waste Sorting Behavior Based on the Locations of Waste Sorting Bins Across the Three Recyclable Materials and Combined Recyclable Materials

Dependent variable (Recyclable Material Types)	Pairwise comparison	Mean Difference ± SE	p-value
Papers	Classroom vs Corridor	-0.02 ± 0.03	0.43
Plastic Bottles	Classroom vs Corridor	-0.04 ± 0.03	0.24
Water Sachets	Classroom vs Corridor	-0.10* ± 0.00	0.05
Combined Recyclable Materials	Classroom vs Corridor	-0.10 ± 0.05	0.85

*. The mean difference is significant at the 0.05 level.

The results demonstrated that the location of waste sorting bins had a measurable effect on sorting behavior, particularly for drinking water sachets. Bins located inside classrooms yielded better sorting outcomes compared to those positioned in corridors, supporting Barker's (1990) behavior setting theory, which posits that behavior is shaped by the immediate physical and social environment. The proximity of classroom bins to students facilitated immediate disposal and promoted more consistent sorting practices. Conversely, bins placed in corridors offered greater convenience in fast-paced environments but simultaneously introduced behavioral challenges, such as reduced attention span and frequent movement, which necessitate rapid message delivery to ensure effective sorting (Aikowe & Mazancová, 2021; Widyaningrum et al., 2020). Furthermore, the findings suggest that the sorting of certain recyclable materials, such as paper and plastic bottles, was less sensitive to bin location. This highlights the need for infrastructure-based interventions to adopt a material-specific approach, taking into account both the type of recyclable waste and the behavioral context in which it is generated.

The location of waste bins would affect sorting behavior in educational settings. However, when bins are located in corridors it may not encourage the same level of compliance due to factors such as reduced supervision and the transient nature of these spaces compared to when waste sorting bins are located in the classrooms. This finding aligned with that of Radan et al. (2016) who examined waste management practices in various schools and found that classrooms equipped with designated bins for different waste types achieved higher sorting accuracy. The presence of these bins within the classroom environment made it convenient for students to dispose of waste correctly, reinforcing positive recycling behaviors (Osotuyi et al., 2025; Stanley et al., 2018).

In contrast, reliance on corridor bins often led to improper waste disposal, attributed to the lack of immediate access and oversight. Further research by Rosenthal and Linder (2016) supported these findings, indicating that bin location is a critical factor in promoting recycling behaviors. Their study demonstrated that when bins are conveniently located, such as within classrooms, students are more likely to engage in proper waste sorting. Additionally, the study by Radan et al. highlighted that in schools where bins were only placed in corridors, there was a higher incidence of waste being improperly sorted or discarded inappropriately. This underscores the importance of strategic bin placement in fostering effective waste management practices within educational institutions.

The lack of significant differences for other waste types challenges the general assumptions about spatial location that it universally enhances waste sorting behavior (Nnonyelu & Niu, 2024; Shi et al., 2021). These findings align with result which emphasized that while convenience is a critical factor, the effectiveness of bin location would depend on complementary interventions such as the use of visual prompts and awareness campaigns (Uye & Olapegba, 2025). Therefore, the strategic location of waste bins within classrooms, as opposed to solely in corridors, plays a pivotal role in enhancing waste sorting behaviors among students. While ensuring easy access to appropriate disposal locations within the immediate environment encourages responsible waste sorting and which in turn supports sustainable solid waste management goals (Aremu & Vijay, 2016; Bakare, 2018).

The implication of this study for theory is that it expanded Barker's (1990) behavior setting theory by demonstrating how environmental and task-specific variables, such as bin location can influence waste sorting behaviors. In addition, the study highlights the limits of spatial location as a universal determinant of behavior. Moreover, the implication for practice is that waste management systems in learning institutions should prioritize placing waste sorting bins in classrooms and corridors to maximize participation in waste sorting behavior (Debrah et al., 2012). Finally, the study offers actionable insights for institutions seeking to improve their waste management practices, especially, the most talked about green economy. It provides evidence-based guidance on the placement of waste sorting bins to facilitate waste sorting behavior thus fostering sustainable behaviors.

In terms of the Sustainable Development Goal 12 which is on *Responsible Consumption and Production* and specifically, Goal 12.5 which calls for '*substantial reduction in waste generation through prevention, reduction, recycling and reuse*', this study calls for waste sorting activities through appropriate and strategic location of waste bins for the collection of recyclable materials as secondary raw materials, keep the learning environment clean and free of health hazards to the students, reduce pollution, and protection of the Earth for future generation. The baseline data collected in this study showed no conscious efforts in waste sorting behavior by the students in the three Junior High Schools selected for the study. However, by the end of the study, students demonstrated interests in waste sorting activity because of the provisions and locations of waste sorting bins in their classrooms and corridors compared to the control groups.

The study proffers the following recommendations. First, the learning institutions should ensure that waste sorting bins are strategically located in areas of high visibility and accessibility such as classroom entrances, hallways and common areas. Furthermore, environmental education programs should incorporate interactive lessons on waste sorting behavior, supported by hands-on opportunities to apply these skills in real-world contexts.

CONCLUSION

This study demonstrated that bin location, whether in classrooms or corridors, had a moderate influence on the waste sorting behavior of junior secondary school students. Specifically, the placement of waste sorting bins affected the handling of materials such as paper, plastic bottles, and water sachets, with classroom bins generally yielding more effective sorting outcomes. Nevertheless, the study acknowledges several limitations that suggest directions for future research. Differences in environmental factors between classrooms and corridors, such as foot traffic, ambient noise, and overall activity levels, were not fully controllable despite the use of a quasi-experimental design and control group. Moreover, the two-week intervention period provided sufficient insights into short-term behavioral changes but may not adequately capture long-term shifts in waste sorting behavior. Therefore, future studies should consider longer observation periods and explore additional contextual factors to better assess the sustainability of waste sorting interventions in school environments.

AUTHOR CONTRIBUTIONS

Peter Olamakinde Olapegba: Conceptualization, Methodology, Formal Analysis, Investigation, Writing - Original Draft, and Writing - Review & Editing and **Emmanuel Etim Uye**: Conceptualization, Methodology, Formal Analysis, Investigation, Writing - Original Draft, and Writing - Review & Editing. All authors have read and approved the final version of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that Generative Artificial Intelligence and other assistive technologies were not excessively utilized in the research and writing processes of this manuscript. Specifically, ChatGPT was used for brainstroming idea and Grammarly for language check. All AI-generated content has been thoroughly reviewed and edited by the authors to ensure accuracy, completeness, and adherence to ethical and scientific standards. The authors take full responsibility for the final version of the manuscript.

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