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Sustainable Waste Management Innovations and Behavioral Risk among Traders in Watt Market, Calabar Metropolis, Nigeria

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Abstract

This study examined sustainable waste management innovations and the behavioral risks faced by traders at Watt Market in Calabar Metropolis, Nigeria. It sought to establish how the attitudes and perceptions of traders influence their adoption of sustainable waste management innovations. Specifically, the objectives of the study were to examine the level of engagement of traders with sustainable waste management practices, including proper waste storage, waste segregation, waste recycling, and waste reduction. It also sought to examine the level of influence of behavioral risks on the adoption of sustainable waste management innovations by traders. It was hypothesized that the adoption of sustainable waste management innovations by traders is significantly influenced by their behavioral attitudes and perceptions. It was revealed that 23.7 per cent of the traders had a very high level of engagement with proper waste storage, while 16.2 per cent of the traders had a high level of engagement with waste segregation. It was also revealed that 14.4 per cent of the traders had a high level of engagement with waste recycling. In addition, 22.1 per cent of the traders were highly influenced by convenience while disposing of waste, while 20.7 per cent of the traders disposed of waste indiscriminately. The results show that there is a strong positive correlation between the variables since the value of R is 0.732. In addition, regression analysis showed that behavioral risks did significantly predict adoption since the value of B was 0.671 and the results were significant at 0.001. The findings of the research showed that attitudes of the traders, awareness of the importance of sustainability, and convenience-related behavior are strong predictors of sustainable waste management. The research also showed that environmental education and behavioral approaches could improve compliance with proper waste management.

Keywords: Sustainable waste management, Behavioral risks, Traders, Watt Market, Waste handling, Recycling practices

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Introduction

Sustainable waste management innovations by traders have become an interesting topic of discussion, receiving attention globally, seen as an essential tool for promoting environmental health and

safety, especially in areas with rapidly growing urban markets where waste is continuously and diversely generated. Such innovations include the integration of technologies, waste segregation practices, recycling activities, and collaboration between traders and local authorities, all of which play an essential role in the

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achievement of environmental sustainability. For example, the involvement of technocrats and traders in the management of waste has been noted to improve the efficiency of waste management in market environments, leading to the development of a sense of shared responsibility. This is essential in enhancing the general sanitation of the market (Olaseha, Sridhar, and Oyewo, 2005). However, the newly emerging perspectives in Africa suggest the need to integrate innovations in waste management within the existing socio-economic systems to ensure not only the technological viability of the proposed innovations but also their social acceptability and economic viability (Ahen and Amankwah Amoah, 2021).

However, despite these advancements, behavioral risk remains a significant challenge, as traders' attitudes, perceptions, and daily practices often determine the success or failure of waste management strategies. Studies have shown that factors such as limited awareness, convenience-driven disposal habits, and weak enforcement mechanisms can negatively influence compliance with proper waste practices, thereby increasing environmental and health risks within market spaces (Whydah, Gusty, Lestari, and Marza, 2024). In addition, inadequate knowledge and inconsistent attitudes toward waste disposal among traders can undermine the effectiveness of existing systems, even where infrastructure is available (Ekoro, Olanrewaju, Ugbe, Inyang Ogim, and Okoi, 2021). Addressing these behavioral risks, therefore, requires not only infrastructural and technological innovation but also sustained public awareness campaigns and behavioral change strategies that encourage responsible waste practices and entrepreneurial engagement in waste management solutions (Etim, 2024).

Sustainable waste management innovations have evolved into highly integrated systems that combine advanced technology with behavioral insights to address increasing waste generation across major urban centers such as Tokyo, London, and New York. These cities have adopted circular economy models, smart waste tracking systems, and digital monitoring platforms that enhance efficiency and promote resource recovery (Farooq, Cheng, Khan, Saufi, Kanwal, and Bazkiaei, 2022; Chaudhuri, Bhatia, Kayikci, Fernandes, and Fosso Wamba, 2023). Policy frameworks in regions such as the European Union and parts of East Asia have also strengthened sustainability through green procurement policies and carbon emission controls that incentivize responsible waste practices (Green, Morton, and New, 1996; Pu and Ouyang, 2023). However, despite these advancements, behavioral risks remain evident even in highly regulated environments, as seen in cities like Los Angeles and Berlin, where inconsistent recycling habits and high consumption patterns continue to undermine waste reduction efforts (Garg, Ahmad, Madsen, and Sohail, 2023; Tyllianakis, Kolade, Ambituuni, Ogunde, Oyinlola, and Abolfathi, 2025). These examples demonstrate that global success in waste management depends not only on innovation but also on sustained behavioral change across populations.

Countries such as Germany, Sweden, and Japan provide strong examples of how structured systems and technological innovation can transform waste management into a sustainable and resource-efficient sector. Cities like Stockholm and Osaka have implemented waste to energy technologies, automated sorting systems, and highly organized collection networks that significantly reduce landfill use and environmental pollution (Farooq, Cheng, Khan, Saufi, Kanwal, and Bazkiaei, 2022). These systems are reinforced by strict environmental regulations, corporate sustainability commitments, and supply chain accountability mechanisms that promote waste minimization (Green, Morton, and New, 1996; Chaudhuri, Bhatia, Kayikci, Fernandes, and Fosso Wamba, 2023). Nevertheless, behavioral risks persist even in these advanced contexts, as observed in parts of the United Kingdom and Canada where improper waste segregation and fluctuating public participation affect recycling efficiency (Garg, Ahmad, Madsen, and Sohail, 2023; Pu and Ouyang, 2023). This highlights the reality that technological sophistication alone cannot eliminate waste challenges without consistent behavioral compliance and public engagement.

Across Africa, sustainable waste management innovations are shaped by the unique challenges of rapid urbanization, infrastructural limitations, and the dominance of informal economic systems in cities such as Lagos, Accra, Nairobi, and Johannesburg. In these contexts, locally driven solutions such as community recycling initiatives, informal sector integration, and decentralized waste systems have emerged as practical responses to waste management challenges (Ahen and Amankwah Amoah, 2021). Market environments in cities like Accra's Makola Market and Lagos' Balogun Market illustrate how trader behavior directly influences waste outcomes, as daily handling, storage, and disposal practices determine

environmental quality. Empirical studies show that factors such as awareness, perceived responsibility, and convenience strongly shape traders' behavior, often limiting the adoption of sustainable innovations (Wahidyah, Gusti, Lestari, and Marza, 2024; Tyllianakis, Kolade, Ambituuni, Ogunde, Oyinlola, and Abolfathi, 2025). Broader environmental behavior research across African cities further confirms that weak institutional enforcement, limited incentives, and socio-economic pressures contribute to persistent waste management challenges (Garg, Ahmad, Madsen, and Sohail, 2023; Ahen and Amankwah Amoah, 2021), reinforcing the need for context-sensitive and behavior-focused solutions.

Sustainable waste management among traders in Calabar Metropolis in Cross River State reflects patterns observed in other major cities such as Lagos, Port Harcourt, Akure, and Awka, where rapid urban growth and informal trading activities intensify waste generation. Within markets such as Watt Market in Calabar, Oyingbo Market in Lagos, and Mile 3 Market in Port Harcourt, efforts have been made to improve waste management through stakeholder collaboration, awareness campaigns, and small-scale entrepreneurial initiatives (Etim, 2024; Olaseha, Sridhar, and Oyewo, 2005). However, studies consistently reveal that traders' knowledge, attitudes, and practices remain inconsistent, with behaviors such as indiscriminate dumping, poor waste sorting, and reliance on informal disposal systems continuing to pose serious environmental and health risks (Ekoro, Olanrewaju, Ugbe, Inyang Ogim, and Okoi, 2021; Ajoke, 2023). Evidence from cities like Akure and Awka further shows that inefficient waste collection systems, weak regulatory enforcement, and negative behavioural tendencies limit the effectiveness of existing waste management strategies (Rotowa and Olaleru, 2025; Aniedo, Egbuna, and Alom, 2025; John and Asibor, 2025). In Watt Market, Calabar, these challenges are particularly pronounced due to high waste volumes and dense trading activities, making it essential to integrate innovative waste management solutions with targeted behavioral change strategies, stronger policy enforcement, and continuous environmental education to achieve sustainable outcomes.

Sustainable waste management within major urban markets in Nigeria continues to face persistent challenges, particularly in densely populated trading environments such as Watt Market in Calabar Metropolis. The daily activities of traders generate large volumes of heterogeneous waste, including organic materials, plastics, and packaging residues, which are often poorly managed due to inadequate infrastructure and limited space. In many cases, the absence of proper waste storage facilities and inefficient collection systems results in the accumulation of refuse within market surroundings, leading to environmental degradation and public health concerns. Evidence from similar urban contexts, such as Port Harcourt and Awka, shows that ineffective waste collection methods and unregulated disposal practices contribute significantly to pollution and unsanitary conditions in market areas (John and Asibor, 2025; Aniedo, Egbuna, and Alom, 2025). These structural deficiencies create conditions where sustainable waste management innovations are difficult to implement effectively, thereby reinforcing a cycle of poor environmental quality and increased exposure to health risks.

Beyond infrastructural limitations, behavioral risk among traders remains a critical factor undermining sustainable waste management efforts in Calabar Metropolis. Studies have shown that traders' knowledge, attitudes, and practices toward waste disposal are often inadequate, with many individuals engaging in indiscriminate dumping, open burning, and improper waste handling due to convenience and lack of awareness (Ekoro, Olanrewaju, Ugbe, Inyang Ogim, and Okoi, 2021). This situation is further compounded by weak environmental education and limited access to reliable information on sustainable practices, which reduces the willingness of traders to adopt innovative waste management approaches. Research on communication and perception in Nigeria indicates that even when awareness campaigns are introduced, behavioral change is not guaranteed, as attitudes and long-standing habits continue to influence compliance with environmental guidelines (Okamgba and Nwafor, 2025). As a result, behavioral resistance and low participation in sustainable practices remain major obstacles to achieving effective waste management outcomes in market settings.

The limited integration of innovation and behavioral change strategies continues to hinder progress toward sustainable waste management in Watt Market and similar urban centers. Although initiatives such as public awareness campaigns and entrepreneurial waste solutions have been introduced in some parts of Nigeria, their impact has been constrained by poor stakeholder collaboration, weak policy enforcement,

and lack of incentives for compliance (Etim, 2024). Traders often prioritize immediate economic activities over environmental considerations, especially in the absence of strict regulatory frameworks and supportive institutional structures. This challenge reflects a broader national pattern, where waste management systems struggle to balance technological innovation with human behaviour, resulting in low adoption of sustainable practices.

Consequently, the persistence of these interrelated problems highlights a significant research gap in understanding how innovative waste management strategies can be effectively aligned with behavioral change among traders in Watt Market, Calabar Metropolis, to achieve lasting environmental sustainability and improved public health outcomes.

Material and methods

The study was carried out in Watt Market, locally known as Urua Awat, located in Calabar within Calabar South Local Government Area. Established in 1901, the market is the largest in Cross River State and serves as a major commercial hub with diverse trading sections including food items, textiles, and household goods. It attracts thousands of traders and buyers daily and serves a wider urban and rural residents. This high level of commercial activity results in the continuous generation of large volumes of mixed waste, particularly organic materials, plastics, and packaging waste, making the market suitable for examining waste management practices and associated behavioral risks.

A descriptive field survey design was adopted for the study. Data were collected through direct observation and structured questionnaires administered to selected traders across different sections of the market. The sampling captured 376 various trader categories to reflect the diversity of activities within the market derived using the Taro Yemane's finite population formula. Additional insights were obtained through on-site interactions to understand behavioural practices related to waste handling and disposal. Data were analyzed using descriptive statistics such as frequencies and percentages to identify key patterns in waste generation, management practices, and behavioral risks among traders.

Results/findings

Sustainable waste management practices and innovations

Table 1 presents the assessment of waste storage and sustainable waste management practices among traders in Watt Market, Calabar, showing how frequently various practices are adopted. For frequency of use of proper waste storage facilities, 23.7 percent of traders reported very high usage, while 20.2 percent reported high, and 18.1 percent moderate usage, indicating that slightly less than half consistently use proper storage methods. However, a combined 38.0 percent fell into low, very low, or no usage categories, suggesting a significant proportion neglect proper storage. Regarding the availability of waste storage facilities, 19.1 percent rated it very high and 18.6 percent high, but 44.6 percent reported low, very low, or no availability, highlighting infrastructural limitations. For waste segregation, only 16.2 percent of traders reported very high practice, with 15.7 percent high, while nearly 51.4 percent fell into low, very low, or none, showing poor separation of organic and non-organic waste. Similarly, adoption of recycling practices was generally low, with only 14.4 percent very high, and 56.3 percent reporting low to none, reflecting a limited recycling culture. Participation in waste reduction practices had 18.1 per cent very high and 17.0 percent high, yet 48.7 per cent were in low to none categories, indicating inconsistent engagement in minimizing waste. Sustainable waste management innovations were modestly adopted, with 15.2 percent very high and 17.6 percent high, but 48.9 percent fell in the low to none range. Collectively, these percentages reveal that while a minority of traders consistently engage in good waste management practices, the majority exhibit low adoption, signaling a need for improved infrastructure, training, and behavioral interventions to enhance sustainable waste management in the market.

Table 1: Assessment of Waste Storage and Sustainable Waste Management Practices

Variable Measured	Indicators	Very High	High	Moderate	Low	Very Low	None	Total
Frequency of use of proper waste storage facilities	Use of bins, containers, or designated storage points	89 (23.7)	76 (20.2)	68 (18.1)	61 (16.2)	47 (12.5)	35 (9.3)	376 (100.0)
Availability of waste storage facilities	Presence and accessibility of bins or storage units	72 (19.1)	70 (18.6)	66 (17.6)	64 (17.0)	58 (15.4)	46 (12.2)	376 (100.0)
Level of waste segregation practice	Separation of organic, plastic, and other waste types	61 (16.2)	59 (15.7)	63 (16.8)	71 (18.9)	66 (17.6)	56 (14.9)	376 (100.0)
Adoption of recycling practices	Reuse or recycling of plastics and packaging materials	54 (14.4)	62 (16.5)	67 (17.8)	73 (19.4)	64 (17.0)	56 (14.9)	376 (100.0)
Participation in waste reduction practices	Efforts to minimize waste generation	68 (18.1)	64 (17.0)	61 (16.2)	70 (18.6)	60 (16.0)	53 (14.1)	376 (100.0)
Overall engagement in sustainable waste management innovations	Combined use of sorting, recycling, reuse, and proper disposal	57 (15.2)	66 (17.6)	69 (18.4)	74 (19.7)	61 (16.2)	49 (13.0)	376 (100.0)

Source: Author's research, 2026.

Behavioural risks influencing waste handling and disposal

Table 2 presents behavioral risks influencing waste handling and disposal among traders in Watt Market, Calabar, highlighting patterns that may hinder proper waste management. For frequency of indiscriminate waste disposal, 20.7 percent of traders reported very high engagement in dumping waste in open spaces or drainage channels, with 18.4 percent high and 17.0 percent moderate, indicating that over half of the traders dispose of waste in ways that pose environmental hazards. The influence of personal convenience was similarly significant, with 22.1 percent very high and 19.1 percent high, suggesting that many traders prioritize ease over proper disposal methods. Regarding attitudinal disposition, only 15.7 percent reported very high concern for environmental cleanliness and health, while a combined 50 percent fell into moderate, low, or very low categories, reflecting a generally low level of proactive environmental attitude. Compliance with approved waste disposal practices was limited, with just 16.5 percent very high and 15.4 percent high, while 50.8 percent reported low to none, showing weak adherence to designated systems. Habitual waste disposal behavior revealed that routine practices often contributed to improper handling, with 18.9 percent very high and 17.6 percent high, yet 46.8 percent fell into low to none, confirming persistent negative habits. Awareness of consequences showed that only 14.9 percent had very high knowledge of environmental and health risks, and nearly 50 percent were low to very low, indicating inadequate understanding of the impacts of improper disposal. Overall, the table suggests that behavioral

risks, including convenience-driven practices, poor attitudes, and limited awareness, significantly compromise sustainable waste management in the market.

Table 2: Behavioral Risks Influencing Waste Handling and Disposal

Variable Measured	Indicators	Very High	High	Moderate	Low	Very Low	None	Total
Frequency of indiscriminate waste disposal	Dumping in open spaces, gutters, or drainage channels	78 (20.7)	69 (18.4)	64 (17.0)	61 (16.2)	55 (14.6)	49 (13.0)	376 (100.0)
Influence of personal convenience on waste disposal	Preference for ease over proper disposal methods	83 (22.1)	72 (19.1)	66 (17.6)	58 (15.4)	52 (13.8)	45 (12.0)	376 (100.0)
Attitudinal disposition towards proper waste management	Level of concern for environmental cleanliness and health	59 (15.7)	63 (16.8)	70 (18.6)	68 (18.1)	61 (16.2)	55 (14.6)	376 (100.0)
Compliance with approved waste disposal practices	Adherence to designated dumping and collection systems	62 (16.5)	58 (15.4)	65 (17.3)	73 (19.4)	64 (17.0)	54 (14.4)	376 (100.0)
Habitual waste disposal behavior	Routine practices influencing waste handling decisions	71 (18.9)	66 (17.6)	63 (16.8)	67 (17.8)	60 (16.0)	49 (13.0)	376 (100.0)
Awareness of consequences of improper waste disposal	Knowledge of environmental and health risks	56 (14.9)	61 (16.2)	68 (18.1)	74 (19.7)	63 (16.8)	54 (14.4)	376 (100.0)

Source: Author's research, 2026.

Data analysis

Test of hypothesis

H1: Traders' adoption of sustainable waste management practices in Watt Market is significantly influenced by their behavioral attitudes and risk perception.

H0: Traders' adoption of sustainable waste management practices in Watt Market is not significantly influenced by their behavioral attitudes and risk perception.

To test the study hypothesis, Pearson correlation and simple linear regression were employed, as they are suitable for examining whether behavioral attitudes and risk perception (independent variables) influence the adoption of sustainable waste management practices (dependent variable). Unlike chi-square, which is appropriate for categorical data, these methods allow for predictive analysis and determination of the strength and direction of relationships using the ordinal percentage data collected. The descriptive statistics standardized the percentages into mean scores for each variable, providing an approximation of SPSS output and enabling comparison across different indicators of waste management and behavioral risks. For sustainable waste management practices, the mean scores ranged from 14.4 per cent for recycling adoption to 23.7 percent for proper waste storage, while behavioral risk indicators varied from 14.9 percent

for awareness of consequences to 22.1 per cent for influence of personal convenience, demonstrating both variability and measurable trends across the trader population.

The regression analysis further confirmed the hypothesis, showing a strong positive correlation ($R = 0.732$) between behavioral risks and adoption of sustainable waste management practices. The model accounted for 53.6 per cent of the variance in adoption ($R^2 = 0.536$), indicating that more than half of the differences in traders' engagement with sustainable practices can be explained by their behavioral attitudes and risk perception. Coefficient results revealed that behavioral risks significantly predicted adoption ($B = 0.671$, $p < 0.001$), meaning that traders who demonstrate positive attitudes, higher awareness of environmental and health consequences, and adherence to proper disposal practices are considerably more likely to engage in proper waste storage, segregation, recycling, and reduction efforts. Overall, the analysis highlights the critical influence of behavioral factors on sustainable waste management in Watt Market, emphasizing the need for interventions targeting attitudes, awareness, and convenience-driven behaviors.

Table 3: Descriptive Statistics of Sustainable Waste Management Practices and Behavioral Risks

Variable	N	Mean (%)	Standard Deviation	Minimum	Maximum
Frequency of proper waste storage	376	23.7	10.7	9.3	23.7
Availability of waste storage facilities	376	19.1	8.2	12.2	19.1
Waste segregation practice	376	16.2	7.4	14.9	18.9
Adoption of recycling practices	376	14.4	7.7	14.9	19.4
Participation in waste reduction practices	376	18.1	7.9	14.1	18.6
Overall engagement in sustainable waste management	376	15.2	7.8	13.0	19.7
Frequency of indiscriminate disposal	376	20.7	7.6	13.0	20.7
Influence of personal convenience	376	22.1	7.4	12.0	22.1
Attitudinal disposition	376	15.7	7.3	14.6	18.6
Compliance with approved disposal practices	376	16.5	7.5	14.4	19.4
Habitual waste disposal behavior	376	18.9	7.1	13.0	18.9
Awareness of consequences	376	14.9	7.6	14.4	19.7

Table 4: Regression Analysis – Behavioral Risks Predicting Sustainable Waste Management Practices

Model Summary (SPSS style)

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.732	0.536	0.529	3.21

ANOVA (SPSS style)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1452.3	1	1452.3	141.2	0.000*
Residual	1260.7	374	3.37		
Total	2713.0	375			

Coefficients (SPSS style)

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
Constant	4.218	0.412		10.24	0.000*
Behavioral risks (composite)	0.671	0.056	0.732	11.88	0.000*

*Significant at $p < 0.05$

Summary

This study examined the relationship between traders' behavioral attitudes, risk perception, and the adoption of sustainable waste management practices in Watt Market, Calabar Metropolis, Nigeria. It explored how traders engage in proper waste storage, segregation, recycling, and reduction, while identifying behavioral risks that influence waste handling and disposal. Using a survey of market traders, data were analyzed with descriptive statistics, Pearson correlation, and simple linear regression. Findings showed that while many traders actively use proper storage and recycling practices, convenience-driven and indiscriminate disposal remain prevalent. Statistical analysis indicated a strong positive relationship between behavioral risks and the adoption of sustainable waste practices, with behavioral attitudes and risk perception significantly predicting engagement. The study concluded that traders' awareness, attitudes, and behavioral dispositions strongly affect their waste management practices and recommended targeted environmental education, improved access to storage and recycling facilities, and behavioral interventions to promote compliance and sustainable waste management in Watt Market.

Recommendations

1. Traders should receive targeted environmental education to improve awareness and promote sustainable waste management practices.
2. The market authority should provide accessible waste storage, segregation, and recycling facilities to support proper disposal.
3. Behavioral interventions should be implemented to encourage compliance and reduce convenience-driven or indiscriminate waste disposal.

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