

EDUCATION AS A MODERATOR IN PREDICTING ELECTRICAL/ELECTRONIC WASTE DISPOSAL BEHAVIOUR IN A TYPICAL EMERGING ECONOMY CONTEXT: THE CONCEPTUAL FRAMEWORK

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Abstract

This study centers on developing a robust conceptual framework for predicting electrical/electronic waste disposal behaviour in a typical emerging market while using education as a moderator. Although extant literature on pro-environmental behaviour abounds in the mainstream literature, studies that focus on developing conceptual framework on the predictors of waste disposal behaviour among youths in a typical emerging market like Nigeria is scarcely researched and under-reported. It is expedient to develop a robust conceptual framework that is suitable to a typical emerging market with huge informality like Nigeria. The theory of planned behaviour was extended. This study concludes that by incorporating education as a moderator in the relationship between extended variables like environmental knowledge and personal responsibility and key psychological constructs like attitude, subjective norms, and perceived behavioral control, the study offers a thorough understanding of the behavioral aspects supporting e-waste management in a typical emerging economy setting. The study's propositions have several important implications for theory, policy, and practice in the broader discourse on sustainable waste management in poor nations. The addition of education as a moderating variable to the Theory of Planned Behavior (TPB) gives a more comprehensive framework for analyzing e-waste disposal behavior among youths. From a theoretical aspect, the study adds to the richness of TPB by including education as a crucial moderator. Traditional TPB models focus on psychological determinants such as attitudes, subjective norms, and perceived behavioral control, without appropriately accounting for environmental and structural elements.

Keywords: Electrical/Electronic waste, Disposal Behaviour, Emerging Market, Youth, Education.

Introduction

Electrical and electronic waste (e-waste) refers to discarded or obsolete components of technological and telecommunication devices. The volume of e-waste has increased significantly in recent decades due to rapid technological advancement and the shortened lifespan of devices. Innovations such as artificial intelligence have further accelerated the obsolescence of existing technologies, necessitating frequent upgrades and thereby intensifying e-waste generation. The global disparity in e-waste management practices, as highlighted by Zhao (2023), reflects contextual differences between developed and developing economies. Kumar, Holuszko, and Espinosa (2017) observed that e-waste generation is directly correlated with a country's GDP, indicating that higher-income nations tend to produce greater volumes of e-waste. Awasthi *et al.* (2019) estimate global e-waste to exceed 44.7 million metric tons, with significant contributions from countries such as China and Nigeria. This underscores the

urgent need for effective e-waste management strategies, especially among young adults who are major consumers of electronic devices.

In Nigeria, improper e-waste disposal presents serious environmental and health risks. Lagos, the country's commercial hub, serves as a major entry point for imported used electronics. Osibanjo (2022) reports that over 500 containers of second-hand electronics enter Nigeria monthly, many of which are non-functional. The Basel Action Network estimates that 25–75% of the 400,000 used computers imported monthly are irreparable, often ending up as waste. This unchecked inflow of substandard electronics has contributed to widespread environmental degradation through pollution of air, soil, and water, with consequent health hazards including cancer, respiratory illnesses, and neurological disorders.

The growing threat posed by e-waste necessitates a deeper understanding of the behavioural patterns influencing its disposal. In particular, identifying the predictors of e-waste disposal behaviour among Nigerian youths is crucial for developing targeted interventions. Education has been identified as a critical moderating factor influencing pro-environmental behaviour. Scholars such as Meikle (2014), Gatzov (2020), and Ima (2022) emphasize that education enhances environmental awareness and fosters responsible waste disposal practices. Other relevant behavioural predictors include subjective norms, perceived behavioural control, environmental knowledge, and a sense of individual responsibility. Given Nigeria's demographic significance and the environmental implications of unregulated e-waste disposal, this study aims to explore the factors influencing e-waste disposal behaviour among youths in the South-South region. It also seeks to examine how educational status moderates these behavioural tendencies, thereby providing insights for policy formulation and environmental education initiatives.

The responsible disposal of electronic waste (e-waste) is a critical issue in sustainability marketing and pro-environmental behavior research. This concern has intensified due to the increasing production and rapid obsolescence of electronic and telecommunication devices, accelerated by technological innovations such as artificial intelligence. Consequently, e-waste levels have risen globally, particularly in high-GDP nations (Zhao, 2023) and in developing countries, which often serve as dumping grounds for discarded electronics from wealthier economies (Sthiannopkao & Wong, 2013). Although substantial literature exists on e-waste disposal and pro-environmental behavior (e.g., Wang *et al.*, 2019; Borthakur & Govind, 2017; Issock, 2023; Nauman *et al.*, 2025; Xi *et al.*, 2025; Idris *et al.*, 2024; Islam *et al.*, 2025; Michael *et al.*, 2024; Sharma *et al.*, 2024; Sathyanarayana, 2025), most studies have focused on

developed contexts, making their findings less applicable to emerging economies like Nigeria. Given the informal nature of Nigeria's economy and the economic relevance of the South-South region, a localized investigation into the determinants of e-waste disposal behavior is warranted.

Notably, few studies have extended the Theory of Planned Behavior (TPB) to examine e-waste disposal among youths in developing regions, despite TPB's established relevance in explaining pro-environmental actions (Ajzen, 1991; Vijayen *et al.*, 2019; Michael *et al.*, 2024; Kumar & Shukla, 2025; Munir & Daud, 2024). Additionally, research addressing moderating variables particularly education status in the context of e-waste behavior remains limited. Given the economic activity and rising purchasing power of youths in Nigeria's oil-rich South-South region, there is a pressing need to explore their unique e-waste disposal patterns. This study, therefore, aims to fill this gap by developing a robust and comprehensive conceptual framework for empirically examining the predictors of e-waste disposal behavior among youths in the region, with particular attention to the moderating role of education status.

Review of Related Literature

Concept of Waste

The concept of waste is inherently relative. An object becomes waste once it ceases to serve its original purpose to its user. However, the same object may acquire value in another context, serving as a resource in a secondary function (Tsiboe & Marbell, 2004; WHO, 2015). For instance, discarded plastic or glass bottles may be reused by local beverage producers, demonstrating how waste is subjectively perceived. Scholars offer varied definitions of waste. Essuman (2012) defines it as any item its owner intends to discard. Augustino, Bahati, and Alexanda (2015) regard it as an object considered useless for its original function (Hoornweg & Tata, 2012; Rahman, Ai Ping, Mahmud, & Ramayah, 2025). Waste generation, particularly in urban areas of developing nations, contributes to sanitation challenges and environmental degradation. Human activities, residential, institutional, and commercial, inevitably produce waste, often in solid, non-gaseous forms.

According to the United States Glossary of Environmental Statistics (1997), waste comprises materials that are not marketable prime products and which the generator no longer requires. For example, widespread plastic use in universities contributes to environmental and health risks (Akunro, Ikumanoyi & Oluogunba, 2012; Gawande *et al.*, 2024; Newaz & Appolloni, 2024; Verma *et al.*, 2025). Puopiel (2010) concurs, identifying waste as any valueless substance discarded due to lack of utility. Historically, waste disposal was less

problematic due to lower population densities, but rapid urbanisation has intensified the issue (Shafial & Mansoor, 2003; Apprey *et al.*, 2024; Radzi *et al.*, 2024; Kankanamge *et al.*, 2025). Nigel (2005) characterizes waste as commercially valueless materials unless reprocessed. However, this view is contested, as objects discarded by one may be valuable to another. For example, an empty bottle may be reused or recycled despite its initial disposal. This reinforces the subjectivity in defining waste. Defra, as cited in Ogwueleka (2009), asserts that no universally fixed definition of waste exists; classification depends on contextual legal and regulatory interpretations. In contrast, the Council of the European Communities (1991) provides a detailed list of waste categories, including defective products, expired items, contaminated materials, and industrial residues.

The term "holder" refers to any individual or entity responsible for generating or possessing waste. The variability in national definitions and classification systems complicates global reporting (Wikipedia, 2010). The Encarta Dictionary (2009) outlines seven aspects of waste, including excrement, contaminated water, industrial byproducts, and unutilized materials. The Basel Convention similarly defines waste as objects discarded or mandated for disposal under national laws. The United Nations Statistics Division (UNSD), as cited in Ikechukwu (2011), describes waste as materials not considered primary products and no longer useful for production or consumption. Talichi (2010) extends this notion, arguing that any human activity that consumes resources without adding value constitutes waste.

Conclusively, while the definition of waste varies, the European Union's Waste Framework Directive (75/442/EC) provides a standard: an object is classified as waste until fully recovered and rendered non-hazardous to humans or the environment. Waste is not merely a theoretical construct but a tangible issue with significant ecological, health, and economic implications.

Electronic Waste Disposal Behavior

Electronic waste (e-waste) has emerged as a significant global concern, largely driven by the rapid obsolescence of electronic devices, especially in the telecommunication and technology sectors. This trend is accelerated by continuous advancements in artificial intelligence and other emerging technologies, which render existing devices outdated at an unprecedented pace. As a result, the volume of e-waste has increased substantially, exacerbating environmental and societal challenges due to inadequate disposal and recycling practices.

Zhao (2023) notes substantial differences in e-waste disposal behaviors across and within developed and developing countries. These disparities reflect variations in socio-economic status and technological adoption, necessitating context-specific strategies for managing e-waste effectively. Kumar, Holuszko, and Espinosa (2017) further demonstrate a positive correlation between national GDP and e-waste volume, reinforcing Awasthi *et al.*'s (2019) finding that global e-waste exceeds 44.7 million metric tons, with major contributions from countries such as China and Nigeria.

Effectively addressing this crisis requires urgent, coordinated efforts. Promoting responsible disposal behavior, particularly among young adults the primary users of electronic devices is essential. Given the environmental, social, and economic risks of increasing e-waste, a multifaceted and globally integrated approach is imperative to mitigate its adverse effects.

Pro-Environmental Behaviour

Researchers have used various terms to describe environmentally beneficial actions, such as environmentally responsible, ecologically significant, and environmentally conscious behaviour (Lee, Jan & Yang, 2013; Idris *et al.*, 2024; Islam *et al.*, 2025). This study adopts the term *pro-environmental behaviour* to refer to deliberate actions aimed at reducing the adverse environmental impacts of human activities or enhancing environmental quality (Jensen, Kollmus & Agyeman, 2002). According to Homburg and Stolberg (2006), such behaviour includes non-activist public actions (e.g., environmental petitioning), private sphere activities (e.g., buying recycled products), and organisational practices (e.g., sustainable product design). Kimmer (2007, as cited in Hadiyanto & Sawitri, 2014) conceptualises pro-environmental behaviour as a form of pro-social conduct intended to promote collective well-being. Caprara and Steia (2007) highlight the role of pro-social agency, which involves individuals' willingness to help, share, or care for others. As awareness of the environmental consequences of modern lifestyles grows, applied environmental psychology increasingly focuses on fostering behavioural change to support environmental sustainability (Jackson, 2005; (Hashim *et al.*, 2025; Rahman, Dusim, & Kassim, 2024).

Theoretical Framework

This study is anchored in the Theory of Planned Behavior (TPB) developed by Ajzen (1991). Although TPB serves as the core framework, it is adapted to address the specific context of pro-environmental behavior. The theory is particularly relevant for understanding factors influencing individuals' decisions regarding e-waste disposal and recycling. Its applicability to environmental behavior has been supported by prior studies, including those by Kumar (2019),

Aboelmaged (2020), Miner *et al.* (2020), and Wang *et al.* (2019). The TPB thus provides a robust foundation for achieving the central aim of this research.

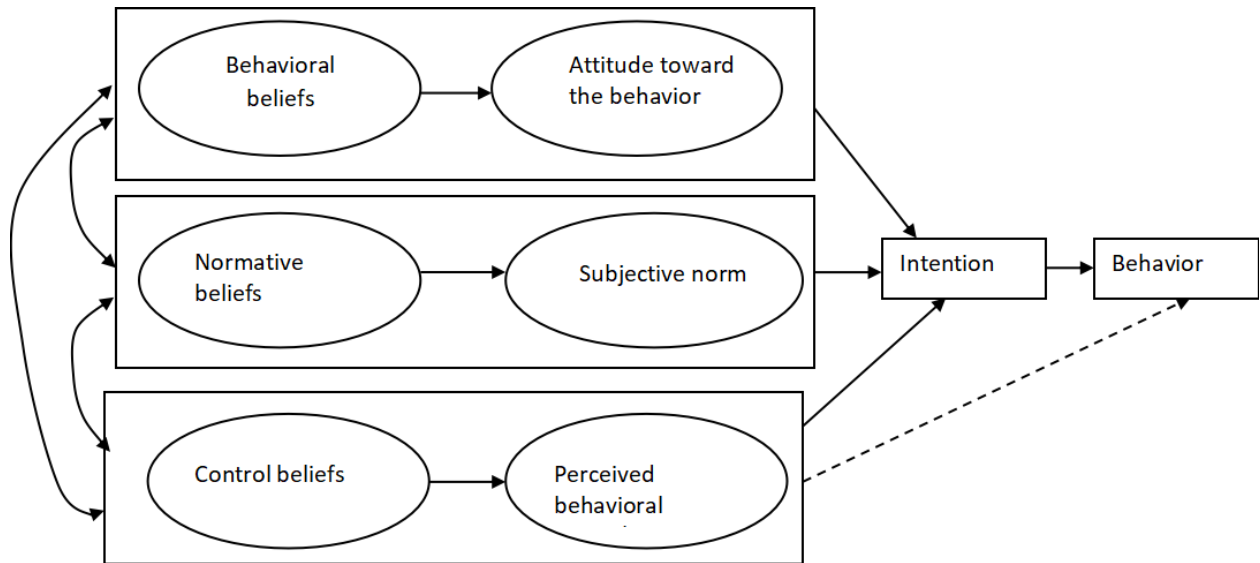


Figure 1: Theory of Planned Behaviour

Source: Ajzen, I. (1991). *The Theory of Planned Behaviour, Organizational Behaviour and Human Processes*, 50, pp.179-211.

Empirical Review

Sharma *et al.* (2024) explored factors affecting millennials' e-waste disposal behavior using the Theory of Planned Behavior (TPB), integrating electronic word-of-mouth (eWOM) and online collection portals. Their quantitative study of 305 millennials, analyzed via structural equation modeling, revealed that attitudes and subjective norms positively influence disposal intentions. Moreover, eWOM significantly impacts attitudes, while online portals moderate TPB constructs. The study highlights millennials as a key demographic in e-waste behavior but notes limitations due to its cross-sectional design, suggesting the need for longitudinal research. Newaz and Appolloni (2024) conducted a bibliometric and content analysis of 293 WEEE behavioral studies from Scopus and Web of Science, further examining 41 papers to identify research trends. They categorized the literature into circular economic behavior and behavioral spillover, clarifying research streams and gaps. The study provides a comprehensive mapping of WEEE behavioral research but is limited by database selection, recommending further in-depth analyses of specific research streams.

Issock (2023) investigated how materialism affects eco-friendly disposal and well-being in South Africa through a quantitative study of 420 electronic device users. Structural equation modeling showed that sustainable e-waste disposal enhances well-being despite high

materialistic tendencies, underscoring environmental behavior's positive psychological impact. Sabbir *et al.* (2023) examined determinants of intentions to participate in End-of-Life Electronic Products Exchange (EEPE) programs in a developing country using TPB and Attitude-Behavior-Context models. Data from university students and general customers, analyzed with SEM and SPSS, revealed subjective norms as the strongest predictor, followed by attitude and perceived behavioral control. Government interventions moderated attitude-intention links, emphasizing policy's role in shaping behavior. The study, however, is limited by its sample composition, suggesting further exploration of government influence mechanisms.

Garg *et al.* (2023) extended the TPB model by incorporating government policy, environmental concern, financial benefits, and awareness to explain young consumers' e-waste management intentions. Surveying 524 participants and employing partial least squares SEM, results indicated all factors significantly influenced intentions. The findings underscore a multifaceted motivational framework but call for longitudinal research to address the intention-behavior gap and enhance generalizability. Waris *et al.* (2023) assessed determinants of household intentions to adopt small-scale solar energy in Pakistan through an online survey of 370 families and partial least squares SEM. Public information, attitude, green norms, and perceived behavioral control emerged as key predictors. The study adds to renewable energy adoption literature but notes sample bias and recommends exploring economic incentives and policy effects.

Sajid and Zakkariya (2023) applied Innovation Resistance Theory to identify psychological and functional barriers to e-waste recycling among Indian metropolitan households. Using PLS-SEM on survey data, they found usage, value, risk, and tradition barriers significantly hinder recycling adoption. These insights aid policy formulation but are limited by single-city data, warranting broader investigation. Lyu *et al.* (2023) investigated factors influencing online engagement in e-waste recycling, integrating the probability model, innovation diffusion, and social cognition theories. Analyzing 475 samples via SEM, they found perceived innovation traits and social influence predict engagement, moderated by privacy, price fairness, and environmental concerns. The study enhances understanding of psychological drivers but suggests longitudinal and cross-cultural research for validation.

Thukral *et al.* (2023) conducted a systematic review of 85 Web of Science articles on consumer awareness, behavior, and perceptions of e-waste recycling. They identified eleven key behavioral factors, with motivation as central. The review notes a lack of research on consumer

knowledge regarding e-waste processing, recommending increased awareness campaigns and further investigation into consumer education. Vijayan *et al.* (2023) surveyed 228 Indian families to examine behavioral intentions toward e-waste recycling. Using hierarchical regression, they found attitude and subjective norms positively influence recycling intentions, while recycling goals, habits, and convenience affect actual recycling behavior. Interestingly, perceived behavioral control negatively correlated with recycling intention, highlighting complex behavioral dynamics within households.

Laequddin, Kareem Abdul, Sahay, and Tiwari (2022) examined factors influencing safe electronic waste (e-waste) disposal among Indian consumers using a questionnaire-based cross-sectional survey. Data analysis via descriptive statistics and partial least squares-structural equation modeling (PLS-SEM) revealed that awareness, convenience, subjective norms, producer initiatives, and regulations positively affect safe disposal intentions. Mohamad, Thoo, and Huam (2022) investigated Malaysian consumers' e-waste recycling behavior through the extended Theory of Planned Behavior (TPB). An online survey of 159 respondents, analyzed using structural equation modeling, identified moral obligation as the strongest predictor, followed by perceived convenience.

Arkorful, Shuliang, and Lugu (2022) studied household waste separation in Ghana, applying an integrated model combining TPB and the Norm Activation Model with data from 707 households. Structural equation modeling showed that awareness of consequences influenced attitudes and norms, which in turn affected behavioral intentions. While attitude and personal norms significantly predicted intention, perceived behavioral control did not have a direct effect. The study highlights the importance of awareness, attitudes, and norms for waste separation, offering guidance for policymakers, but notes that causal inferences are limited by the cross-sectional design.

Siddiqua *et al.* (2022) explored e-device purchase and disposal behaviors in the UAE using a quantitative design and ANOVA analysis on questionnaire data. Results indicated that age and field of specialization significantly influenced e-waste knowledge. Ma *et al.* (2021) conducted a meta-analysis on the TPB's effectiveness in explaining recycling behavior. They found subjective norm and perceived behavioral control had limited explanatory power due to measurement constraints. A sample size of at least 600 was deemed necessary for reliable results. The study emphasized that research design, socioeconomic factors, and waste type affect TPB applicability and called for improved measurement tools.

Nyeko, Mlay, Amerit, and Nyero (2021) examined e-waste collection and disposal intentions in Uganda through PLS-SEM on survey data from 346 employees. Personal benefits positively influenced behavioral intentions, while environmental benefits had no significant effect. Visual images of e-waste and associated risks partially affected intentions. Arbues and Villanua (2021) used econometric analysis in Spain to identify factors influencing households' intentions to separate electronic waste. Environmental concern and individuals' origin significantly affected separation behavior.

Aboelimged (2021) enhanced the TPB framework by integrating recycling intentions among young consumers in a developing country. Using PLS-SEM, the study demonstrated improved predictive power for e-waste recycling intentions, highlighting the model's relevance for youth demographics. Dhir *et al.* (2021) introduced the Behavioral Reasoning Theory (BRT) to analyze e-waste recycling attitudes and intentions among 774 Japanese consumers using structural equation modeling. The study differentiated between 'reasons for' and 'reasons against' recycling, showing positive effects of 'reasons for' on attitudes and intentions, moderated by environmental evaluation. It noted limitations in generalizability and suggested further research on demographic moderators and long-term effects of interventions.

Wang *et al.* (2021) investigated household waste sorting intentions in China by extending TPB with environmental control variables. Analysis of 441 questionnaires using structural equation modeling and regression found environmental regulation, perceived behavioral control, and attitude significantly influenced intentions. Knowledge, moral obligation, and personal engagement moderated the relationship between perceived control and behavior. The study noted limitations in generalizing beyond household waste and the cross-sectional design. Dhir *et al.* (2021) applied valence theory to Japanese consumers' e-waste recycling behavior, incorporating values such as compatibility and environmental concern. Structural equation modeling of 774 respondents indicated that these values and perceived benefits positively influenced recycling intentions. The study acknowledged limits in causal inference and generalizability and called for research across cultures and over time.

Ananno *et al.* (2021) surveyed 915 Bangladeshi consumers to assess attitudes and willingness to pay (WTP) for e-waste recycling. About 38% were willing to pay 5–10% of product cost. WTP correlated positively with environmental awareness, income, and education, though most expected government cost-sharing. The study offers insights for policymakers but cautions about sampling bias and suggests deeper exploration of WTP determinants.

Proposition Development

Attitude and E-waste Disposal Behaviour

Attitude significantly influences consumer behaviour towards products (Ghen & Liu, 2004) and is a reliable predictor of behavioural intention (Bock & Kim, 2002; Huang & Chuang, 2007). Specifically, Tweneboah-Kudoh, Adams, and Nyarku (2019) identify attitude as the strongest determinant of waste disposal behaviour.

P1: *Attitude will positively and significantly influence e-waste disposal behaviour among young adults.*

Subjective Norms and E-waste Disposal Behaviour

Subjective norms, referring to perceived social pressure to perform or avoid certain behaviours, are critical predictors of behavioural intention (Tsai, 2009). This position is supported by Tweneboah-Kudoh *et al.* (2019) and Vijayen *et al.* (2023), who emphasize its impact on e-waste recycling behaviour.

P2: *Subjective norms will positively and significantly affect e-waste disposal behaviour among young adults.*

Perceived Behavioural Control and E-waste Disposal Behaviour

Perceived behavioural control reflects individuals' perception of ease or difficulty in performing a behaviour (Ajzen, 1991). Factors such as time, resources, and situational constraints influence this perception (Tsai, 2009). Prior studies confirm its strong predictive power in e-waste recycling (Vijayen *et al.*, 2009; Fehegaray & Itansstein, 2016; Wang *et al.*, 2019).

P3: *Perceived behavioural control will positively and significantly affect e-waste disposal behaviour among young adults.*

Environmental Knowledge and E-waste Disposal Behaviour

Awareness of the environmental consequences of e-waste significantly shapes disposal and recycling behaviour (Alzubaodi, Slade & Dwivedi, n.d.; Borthakur & Govind, 2018). When consumers understand the risks of improper e-waste handling, they are more likely to act responsibly.

P4: *Environmental knowledge will positively and significantly influence e-waste disposal behaviour among young adults.*

Individual Responsibility and E-waste Disposal Behaviour

An individual's sense of responsibility, both moral and conventional, plays a pivotal role in environmental behaviour. Kumar (2019) highlights the influence of personal responsibility on

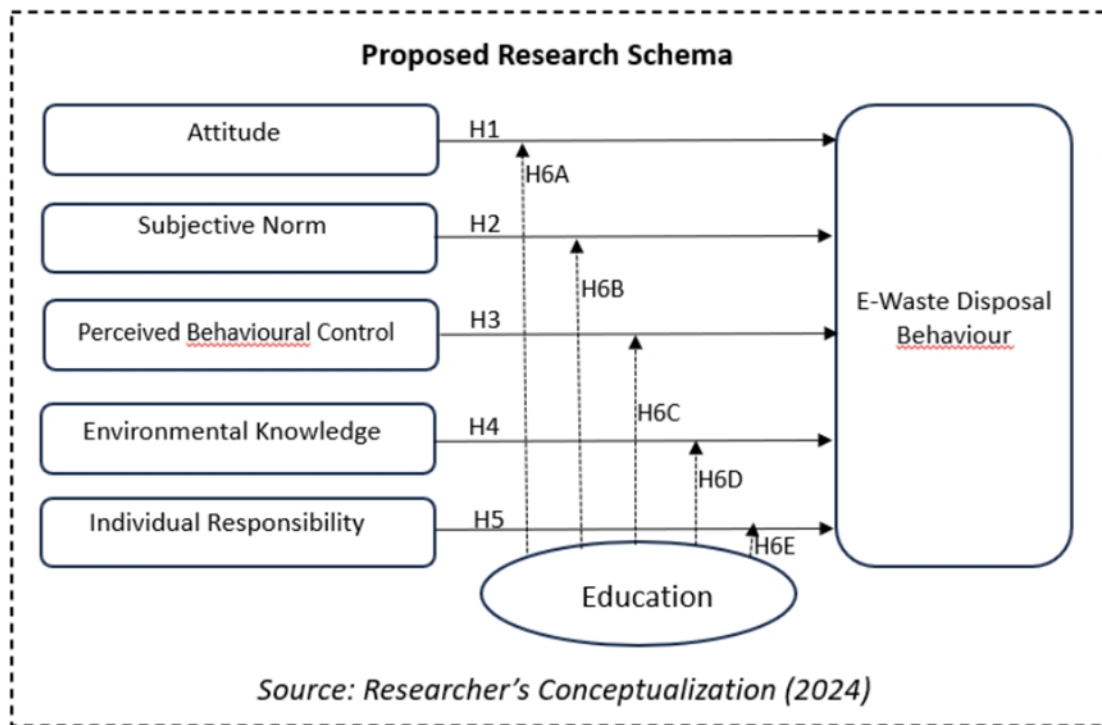
e-waste practices among young adults.

P5: Individual responsibility will positively and significantly affect e-waste disposal behaviour among young adults.

Moderating Role of Education Status

Formal education has been widely recognized as a moderating factor in waste disposal behaviour (Meikle, 2014; Gatzov, 2020; Stoller, 2018; Langton, 2007; Ima, 2022; Kumar, 2020; Kolbe, 2019; Bora, 2021). This study classifies education into two levels: high (tertiary) and low (secondary and below). In developing contexts such as Nigeria, the role of education in moderating behavioural predictors among youth remains underexplored.

P6a–P6e: Education status moderates the relationships between attitude, subjective norms, perceived behavioural control, environmental knowledge, individual responsibility, and e-waste disposal behaviour.



Conclusion

Using the Theory of Planned Behavior (TPB) as a lens, this study has investigated how education influences the way that young people in South-South Nigeria dispose of e-waste. By incorporating education as a moderator in the relationship between extended variables like environmental knowledge and personal responsibility and key psychological constructs like attitude, subjective norms, and perceived behavioral control, the study offers a thorough

understanding of the behavioral aspects supporting e-waste management in a typical emerging economy setting.

Finally, a multifaceted approach including structural, educational, and behavioral components is needed to solve Nigeria's expanding e-waste problem. Through the emphasis on education as a moderating factor, this study emphasizes the necessity of demographically-sensitive and context-specific treatments. In rising economies, significant progress toward attaining environmental sustainability can only be done by using an inclusive and comprehensive strategy.

Implications

The study's propositions have several important implications for theory, policy, and practice in the broader discourse on sustainable waste management in poor nations. The addition of education as a moderating variable to the Theory of Planned Behavior (TPB) gives a more comprehensive framework for analyzing e-waste disposal behavior among youths. From a theoretical aspect, the study adds to the richness of TPB by including education as a crucial moderator. Traditional TPB models focus on psychological determinants such as attitudes, subjective norms, and perceived behavioral control, without appropriately accounting for environmental and structural elements. Therefore, by empirically proving that educational attainment influences the strength and direction of the correlations between these constructs and e-waste disposal behavior gives a more comprehensive framework for analyzing e-waste disposal behavior among youths.

The proposition also has significant practical consequences. For policymakers, the findings highlight the importance of including environmental education in the formal school curriculum *et all* levels of schooling. This will allow for early exposure to environmental knowledge, critical thinking, and value-oriented learning, all of which encourage pro-environmental behavior. Furthermore, youth-centered treatments must take into account the target demographic's different educational backgrounds. Campaigns to promote proper e-waste disposal should not take a one-size-fits-all strategy. Instead, tactics should account for the various levels of cognitive processing, awareness, and behavioral predispositions linked with educational attainment.

Another practical implication is the development and implementation of community-based projects that promote environmental responsibility. NGOs and civil society organizations should use education's moderating influence to develop tailored programs. Workshops, town hall meetings, and environmental clubs can be used to foster discourse and

community action, especially in underprivileged areas with few educational possibilities. Environmental practitioners and waste management agencies can use the study's findings to improve existing infrastructure and logistics for e-waste disposal. Improving access to recycling sites, implementing take-back programs, and offering disposal incentives can all help youths feel more in control of their behavior.

Finally, the study's implications for further research are worthwhile. The proposition that education moderates the effect of psychological variables on e-waste disposal behavior warrants additional exploration across regions and demographic groupings. Future research can look into how other socio-demographic characteristics like income, gender, or urban-rural domicile interact with psychological components to influence behavior.

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