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Factors Influencing Consumers' Intentions to Participate in a Formal E-Waste Collection System: A Case Study of Onitsha, Nigeria

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Abstract: Due to the increasing amount of electronic waste (e-waste) generated in Nigeria, challenges such as consumer disposal behaviors have emerged. An understanding of consumers' intentions to participate in formal e-waste collections is key in increasing the level of participation in an e-waste collection scheme. The theory of planned behavior (TPB) creates an applicable platform for identifying the determinants of recycling intention. Based on the TPB, we develop a theoretical framework to study how influencing factors such as attitude, subjective norm, perceived behavioral control and environmental knowledge influence intentions to participate in formal e-waste collections. Additionally, we extend the research framework to examine whether the factors of infrastructure and economic incentive moderate the relationships between the influencing factors and intention. Using an empirical survey conducted in Onitsha with 384 usable questionnaire responses, we observe that attitude, subjective norm, and environmental knowledge directly influence consumers' intentions. Statistical results also show that only the factor of infrastructure moderates the relationship between two influencing factors (attitude and subjective norm) and intention. The resulting negative coefficients of regression for the interactions indicate that the introduction of infrastructure will result in a weaker influencing ability of attitude and subjective norm on intention. Thus, the implications of this study in motivating consumers' intentions suggest it would be beneficial for the government to provide functional and adequately managed infrastructure situated close to the community, such that it can be easily accessed by household consumers.

Keywords: e-waste; theory of planned behavior; influencing factors; moderating factors; intention

1. Introduction

The rapid technological changes and advancement in the electronics industry have led to the rapid rise of new and advanced products, which stimulates a constant consumption turnover and the disposal of old equipment, and this has tremendously increased the waste stream of obsolete electronic equipment globally [1]. According to the United Nations investigations, around 20 to 50 million tons of e-waste are generated on a global scale, an amount rising three times faster than the entire municipal solid waste stream thereby becoming one of the fastest rising waste streams around the world, and global generation is projected to rise by 16–28% annually [2,3].

Most developing countries, and especially Nigeria, face a rapidly increasing quantity of e-waste, both from domestic generation and import of obsolete or used electrical and electronic equipment (UEEE). It was reported that approximately 1.1 M tons of electrical and electronic equipment (EEE) become obsolete each year in Nigeria of which 75% is stored in homes, government institutions, industries and private offices, due to the uncertainty of how to handle or dispose of such items [4]. Most developing countries lack a functional structure for the sorting, storage, collection, and disposal of waste or the proper implementation of hazardous waste-related legislation [5]. In Nigeria, there is no formal collection system and practically no capacity for material recovery processes for e-waste. Thus, the processes of managing the huge e-waste stream is not clearly spelled out and practiced, as a result of which these items are recycled using crude methods and unwanted components become discarded in local dumps or surface water bodies [6,7]. Major factors influencing this trend are the low level of public awareness on e-waste toxicity and lack of legislation aimed at providing a collection or recovery system in the country. The rudimentary recycling of e-waste has caused considerable harm to the health of scavengers, workers with no personal protective equipment, and the surrounding environment. An adequate management system for formal e-waste recycling can drive the development of local economies and the reduction of poverty.

Today, as production, recovery, recycling and reuse of electronic products becomes an issue of concern among environmentalists and concerned stakeholders, it is becoming more imperative for governments to enact e-waste specific legislation and develop integrated e-waste management frameworks to increase the rate of collection, reuse, recycling and recovery of such wastes, to minimize disposal. More importantly, the role of consumers is key in the life-cycle of EEE, thus, a proper understanding of the consumers' e-waste disposal behavior and factors which will influence consumers' intentions to engage in green behavior is needed. In this light, several researchers have investigated consumers' intentions and behaviors towards recycling using the theoretical lens of the theory of planned behavior (TPB) [8–11]. In this paper, we seek to comprehend the factors that will influence consumers' intentions to participate in a formal e-waste collection system. Thus, we utilize the TPB to develop a theoretical framework to examine how influencing factors lead to formal collection participation intentions. In addition, we extend the framework to examine the moderation effect of infrastructure and economic incentives on the relationship between the influencing factors and intention.

The steps taken to conduct this study include a review of existing literature on the e-waste situation in Nigeria presented in Section 2. Section 3 presents the theoretical framework of this study. In Section 4, the methodology is elucidated, which includes the questionnaire development process, data collection methods and sampling distribution. Section 5 presents the data analysis and results. Section 6 presents the discussion of results and its implications, and Section 7 presents the conclusions.

2. Electrical and Electronic Waste in Nigeria

2.1. Electronic Waste Generation in Nigeria

A majority of electronic products used in Nigeria are imported, while there are only a few assembling companies. Nigeria, being the largest destination of illegal e-waste imports in Africa, is confronted with the challenges of large amounts of e-waste generation and several channels of e-waste sources [12]. As per a review by Schluep [4], in 2010, import insights demonstrated that the share between new and UEEE was around half/half, i.e., 600,000 of new EEE and 600,000 of UEEE imported into Nigeria. The study additionally uncovered that family units were the greatest buyers by a long shot with an installed base of 6,400,000 tons of big and small home appliances, while he number of units in use by institutional and corporate entities was evaluated at 400,000 tons [4]. In all, roughly 1.1 M tons of EEE become obsolete every year, of which just around 440,000 tons winds up as e-waste [4], the rest of the volume is either put away by the consumer, given away as gifts or sold to repair shops.

2.2. Electronic Waste Collection and Recycling in Nigeria

In Nigeria, collection and recycling activities are predominantly centered around the informal sector. There is a vast number of self-employed people engaged in the collection and recycling of e-waste. Some of them buy or pick up unusable e-waste discarded by importers and marketers while some others move from house-to-house to purchase e-waste from consumers which they, in turn, resell to recyclers and refurbishers [7]. These types of informal collection activity have been a great source of economic benefit to many unskilled workers across developing countries. Consequently, there are a huge number of electronic products in the possession of informal collectors which have no reuse value. They are usually recycled using crude or substandard methods, this is widely known as "backyard recycling". Such crude methods are non-environmentally friendly, thereby causing severe damage to human health and the environment [13]. These crude techniques include acid leaching for precious metals, unprotected melting of plastics, open burning to extract metals and direct dumping of hazardous residuals. These operations are usually undertaken with little or no personal protective equipment or pollution control measures. As a result, there have been several cases of adverse health effects and environmental degradations from the released toxins [14–16]. The major reasons for the predominant crude recycling practices include lack of legislation or weak enforcement of existing legislation and lack of environmental protection measures and recycling infrastructure [13].

The city of Onitsha's waste management system is overseen by the Anambra State Environmental Protection Agency. They suffer many challenges such as having weak institutional capacity, poor funding for environmental issues, and lack of equipment, resulting in inadequate disposal of solid and liquid waste [17]. There appears to be no distinction between domestic solid waste and e-waste during collection and disposals at dumpsites [18]. The agency is yet to implement a solid waste management plan for Onitsha. The city being famous for its large-scale economic and commercial activities has a constant import inflow of both new and UEEE which adds to the already existing e-waste stream [19]. There are no spelled-out procedures for managing e-waste streams in south eastern Nigeria including Onitsha, hence, there are no records of the quantities of e-waste constantly generated in Onitsha [18].

2.3. Laws and Regulations on E-Waste in Nigeria

The National Environmental Standard and Regulation Enforcement Agency (NESREA) is responsible for implementing all environmental laws, legislation, and guidelines including the oversight and control of e-waste [20]. According to NESREA [21], there exist five major regulatory instruments for e-waste control in Nigeria.

- Harmful Waste (special criminal provisions) Act, 1988 and updated in 2004. This act bans the conveying, depositing and disposal of hazardous waste [21].
- Environmental Impact Assessment Act, 2004. It guarantees that environmental considerations are made during planning to identify and minimize environmental impacts [21].
- National Environmental (sanitation and waste control) Regulations, 2009. It regulates the transportation, storage, and treatment of hazardous wastes into and within the country [21].
- In 2011, NESREA established a set of guidelines for importers as measures to checkmate the importation of end-of-life electrical/electronic products [21].
- National Environmental (electrical/electronic sector) Regulations, 2011. This regulation adopts a life cycle approach and incorporates all aspects of the electrical/electronic sector from manufacture to disposal, outlining stakeholder responsibilities [21].

In conclusion, only the EEE sector regulations have direct items about e-waste collection, however, it is not certain how the concerned parties should engage with their outlined responsibilities in e-waste collection. The existing system operates outside the guidance of regulations [22].

2.4. Challenges to Effective Electronic Waste Recycling and Management

The main challenges to effective recycling of electronic waste, as highlighted by previous studies [3,23–25], are:

- There are few environmental laws/regulations in place that encourage e-waste collection and recycling.
- There exists the problem of no and/or lax enforcement of existing legislation on the trans-boundary movement of e-waste resulting in a huge burden of e-waste imported from developed countries which are highly uncoordinated.
- There are no mandatory or voluntary take-back programs in place for e-waste.
- Consumers, collectors, and crude recyclers lack awareness and/or possess less knowledge of the toxicity of e-waste and the hazards posed by unsuitable recycling methods.
- There is a lack of funding towards financing advances in e-waste recycling.
- The multinational ICT companies pay little or no attention to e-waste management in the developing countries.
- There is the reluctance of individuals and companies to dispose of obsolete EEE or even pay for recycling, especially because of the economic value and emotional attachment placed on obsolete EEE.

3. Theoretical Framework

It has been argued that theories represent the keystone of knowledge production [26]. This study uses the theory of planned behavior (TPB) to investigate the influencing factors and moderating factors determining consumers' intention to engage in a disposal behavior towards a formal e-waste collection scheme. The TPB concept was proposed by Icek Ajzen in 1985 through his article "from intentions to actions: a theory of planned behavior". The theory was developed from the theory of reasoned action (TRA), which was proposed by Martin Fishbein together with Icek Ajzen in 1980 [27,28]. According to Ajzen [29], the TPB is a theoretical framework designed to predict and describe human behavior in specific contexts. The TPB emphasizes that the specific behaviors of individuals are a result of their intentions, and these behavioral intentions can be predicted by three predictor variables of attitude, subjective norm and perceived behavior control [27,29].

The attitude leading to the behavior is a product of a proper understanding of the behavior in question. The subjective norm refers to pressures emanating from one's social circle which could be positive or negative. The perceived behavioral control is related to one's confidence towards the possibility of performing a certain behavior. In essence, if an individual perceives that the attitude and subjective norm relating to a particular behavior would be beneficial and has strong convictions of successfully executing the said behavior, the greater would be the motivations of the individual's intention to engage in the said behavior. Behavioral intention is a sign of an individual's willingness to engage in a particular behavior and it is presumed to be an original determinant of behavior, on the other hand, behavior is an individual's evident action with regards to an expected behavioral outcome [29].

The TPB has been applied in several precise behavior studies. Ghani et al. [10] applied the TPB to examine the influencing factors of participation in source separation of food waste. Taylor and Todd [9] utilized the TPB to establish a theoretical framework to examine municipal solid waste recycling behavior. Weigel et al. [30] integrated the TPB and innovation theory to investigate the predicting factors of information systems. In spite of the theoretical approach of the TPB in studying recycling behaviors, it is essential to focus more on discovering other factors which can be integrated into the TPB framework to encourage recycling behaviors [29]. In addition, many researchers agreed that there exist other factors which are not entirely covered by the TPB that predict environmental behaviors [11,31,32]. More so, recent studies using the TPB to predict environmental behaviors have incorporated moderating factors to contribute to the body of knowledge on TPB predicting capabilities and further understand the behavioral context [33–35]. This study, based on existing literature and the prevalent e-waste

management situation in Nigeria, incorporates the additional variables of environmental knowledge, and infrastructure and economic incentive, as influencing and moderating factors respectively.

The importance of perceived knowledge has been demonstrated in a number of studies. According to Aung and Arias [36], environmental knowledge was found to be a factor influencing individual intentions to engage in environmentally friendly behaviors. Similarly, Lansana [37] argues that an individual's recycling knowledge and the availability of appropriate recycling materials is an important factor motivating recycling participation. Previous researchers argue that situational factors such as economic incentive would influence the transformation from behavioral intention to environmental behavior [33,34,38]. The research by Wang et al. [38] revealed that economic benefits, convenience of recycling structures, housing conditions, and recycling habits were four determining factors of residents' willingness and behavior in e-waste recycling. Several studies found that providing adequate and appropriate infrastructure for waste collection systems and recycling is key to achieving a functional waste management system [11,39–41]. Also, Darby and Obara [23] emphasized on the influencing ability of a well-established local infrastructure in motivating consumers to engage in sustainable waste management behaviors.

As stated in Section 1, there is no formal collection scheme in Nigeria, as a result of which no formal disposal behavior exist. Hence, we adopt the variables that are consistent with our study. Consequently, behavior is not included as a studied variable as there is no obtainable relationship between consumers' intention and a formal disposal behavior. In summary, our theoretical framework contains seven constructs: attitude, subjective norms, perceived behavioral control and environmental knowledge as independent variables; infrastructure and economic incentive as moderating variables; and intention as the dependent variable. While several other studies have investigated the participation of consumers in recycling programs using the theoretical lens of the TPB, not many studies have examined the moderation effects of additional variables on the relationship between the influencing factors and behavioral intention. Hence, this study establishes a framework (see Figure 1) to integrate the TPB with external factors to examine the participation intentions of consumers.

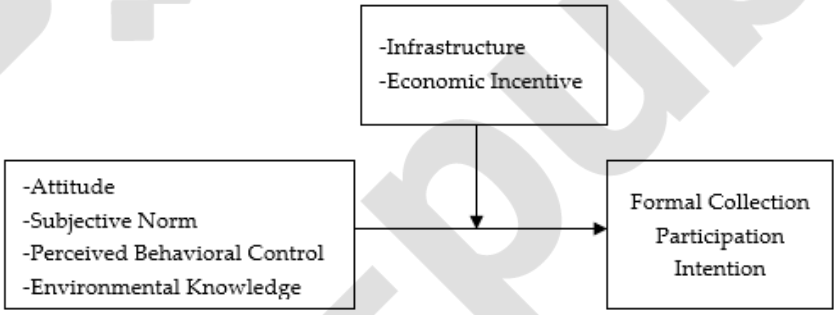

Figure 1. A theoretical framework for formal collection participation intention.

4. Research Methodology

4.1. Questionnaire Development

A self-report questionnaire was used for this study and was structured into three parts: the first part consists of respondents' socio-demographic information which included gender, age, education, and income. The second part consists of two questions soliciting current level of e-waste awareness and disposal behavior. The third part contains three main sections with a total of seven constructs: (1) items of influencing factors including attitude, subjective norms, perceived behavioral control and environmental knowledge; (2) items of moderating factors including economic incentives and infrastructure; and (3) items of intentions; altogether 27 items.

The questionnaire was developed based on existing literature, previous applications of the TPB [11,29,42], and information obtained from elicitation interviews with a sample of 20 Onitsha

residents and further revised according to Nigeria's current e-waste situation. Following this, a pilot study was conducted to test the content validity of the questionnaire. Fifteen consumers: five household fathers (breadwinners), five household mothers and five young adults, gave their comments and suggestions. The questionnaire was refined based on feedback from the consumers. To avoid potential misunderstanding, we included a brief explanation of the concept of e-waste and that of a formal collection system. The 27 questionnaire items required that respondents respond to the items on a five-point Likert scale ranging from 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 agree to 5 = strongly agree.

4.2. Data Collection and Sampling Distribution

The survey was conducted in the metropolitan city of Onitsha in Anambra State. The city is famous for its large-scale economic and commercial activities, industries, education and river port. As of 2016, Onitsha boasts an estimated urban populace of 7,425,000 [43]. The city of Onitsha was selected for this study for the reason that it is a good representation of mega cities in Nigeria, not only in economic growth but also it has a mixture of the educated and uneducated populace as well as high- and low-income earners with increasing usage of electrical and electronic products. The sampling frame comprised of household consumers in relation to the aim of the study, which is to investigate the factors determining consumers' (individual) intentions to participate in formal e-waste collections, also in accordance with literature in Section 2 which highlights the household family units as the major consumers of electronic products.

The sample size for this study was determined using the formula by Cochran (1977) [44];

$$SS = (Zscore)^2 \times p \times (1 - p)/(margin\ of\ error)^2 \quad (1)$$

where SS is the sample size, $Zscore$ relates to the confidence level (95% confidence level selected), p is the standard deviation (0.5 to ensure a large sample), and *margin of error* relates to the confidence interval (+/−5%). Step one, we determine the sample size for infinite populations, given that $Zscore$ is 1.96 for a 95% confidence level; this results in a sample size of 384.16. Step two, we adjust the sample size to the specific population (7,425,000) of the sampled location, using the Cochran formula for the adjusted population size;

$$SSadjusted = (SS)/1 + [(SS - 1)/population] \quad (2)$$

This results in 384 sample size needed for the study.

The questionnaires were distributed through two channels. Firstly, we employed a simple random sampling method to distribute (hand-delivered) the questionnaires in the city. A total of 258 questionnaires were distributed in randomly selected residential areas on the basis of income level categories (high, middle and low), 86 questionnaires for each category. The high-income areas included Government reserved area (GRA), Federal housing, and Three-three; the middle-income areas included Fegge, Awada and Odoakpu; and the low-income areas included Okpoko, Otu Onitsha and Osuma. We visited households on a door-to-door basis to administer the questionnaires. The respondents were contacted in person by research assistants and asked to complete the self-report questionnaire. Altogether, we received a total of 193 valid responses (55 from high-income areas, 71 from middle-income areas and 67 from low-income areas), making it a response rate of 75%. Collecting questionnaires on the spot in residential areas can improve credibility and raise the response rate of the survey [38].

Secondly, in order to make our survey more representative, we uploaded the questionnaire as a web survey and sent the survey URL to 222 residents of the city whose email addresses and social media accounts (WhatsApp and Facebook) we had randomly obtained. These were collected from different segments of the city (market traders, high school teachers, university students and lecturers, bank and company staff and civil servants). In order to solicit a substantial response, the surveys were anonymous. We received a total of 191 valid responses (58 from emails, 73 from Facebook,

60 from WhatsApp), making it a response rate of 86%. Online data collection is advantageous in that it accesses a large and geographically distributed population, it is time and cost efficient with the absence of interview bias [45,46]. The potential for coverage problem was addressed as the survey employed two channels which covered 50% of the sample size for each of the sampling methods used (hand-delivered and web survey). Several other studies have successfully used web surveys to supplement hand-delivered surveys in investigating individuals' intentions and behaviors [34,47]. Since the questionnaires were distributed through two channels, we ensured that double entries were prevented. In the web survey sampling, participants email addresses and social media accounts were collected by the same researchers who had earlier administered the hand-delivered questionnaires and they collected only from people who had not already participated in the door-to-door survey. Likewise, after completing the hand-delivered questionnaire, participants were asked not to participate in the web survey. Totally, we collected 384 valid questionnaires from 480 respondents, making it a total response rate of 80%. An independent sample *t*-test was performed (based on the Levene's test for equality of variances and *t*-test for equality of means) to determine the differences between responses for key variables in the two survey channels [47,48]. The results did not show any statistically significant difference with all significant values at $p > 0.005$. Hence, we can merge the samples obtained through the two survey channels for analysis. The surveys were conducted from 20 November 2016 to 19 January 2017. Data collected were analyzed using the Statistical Package for Social Sciences (SPSS 24.0).

A total of 54% of the respondents were male and 46% were female. The people aged between 18 and 40 accounts for 56% of the respondents. Regarding education, 33% of the respondents held university/higher institution degrees. Finally, the majority of the sample fell in-between the middle-class income group, 10,000 Naira to 29,000 Naira (approximately $400 to $1000 respectively). The demographic composition of the sample is shown in Table 1. As presented in Table 2, a significant proportion of the sampled population either had no idea (49%) or low awareness (32%) of the concept of e-waste management. With regards the current e-waste disposal behavior, virtually the entire consumer population engage in informal non-environmentally friendly disposal behaviors, with the majority either disposing e-waste alongside household waste (57%), reselling to informal collectors (38%) or storing the e-waste at home (33%).

Table 1. Summary of respondent's demographic characteristics.

Demographic Attribute	Frequency, n	Percent, %
Gender		
Male	209	57%
Female	175	43%
Age		
18–30	111	29%
31–40	104	27%
41–50	91	24%
50>	78	20%
Education		
Primary School	69	18%
Secondary School	89	23%
Technical/Vocational Training	101	26%
University/Higher Institution	125	33%
Monthly Income		
<18,000 Naira	52	14%
18,100–49,000 Naira	65	17%
50,000–99,000 Naira	70	18%
100,000–299,000 Naira	119	31%
300,000–500,000 Naira	45	12%
500,000 Naira >	33	9%

Table 2. Questionnaire responses on current level of awareness and disposal behavior.

	Frequency, n	Percent, %
[a] Level of Awareness		
High awareness	73	19%
Low awareness	124	32%
No idea	187	49%
[b] Informal Disposal Behavior		
Ignore or do nothing/Store at home	82	33%
Dispose along with household waste	156	57%
Re-sell to informal collectors/Scavengers	95	38%
Abandon with technician/repairer	83	27%
Donate to family/friends/charity	50	18%
Open burning/incineration	39	7%

[a] How aware are you of the concept of e-waste management?; [b] How do you handle/dispose of your electronic waste?

5. Results

5.1. Factor Analysis

This study performed factor analysis to group the items into influencing factors, moderating factors and the factor of intention. A summary of the factor analysis results is presented in Table 3. We employed the principal component analysis method with a varimax rotation to extract the factors as proposed in the theoretical framework. The Kaiser–Meyer–Olkin (KMO) measure of sample competence and the eigenvalue test were also employed. A group of items is considered appropriate to further conduct factor analysis only when the value of KMO is over 0.70 [49]. The instrument reliability was analyzed by means of the Cronbach alpha method. And according to Tonglet et al. [11], a reliability coefficient is said to have achieved acceptable reliability when it is greater than 0.7.

Table 3. Component matrix for factor analysis of Intention.

	Items	Main Factor 1
Intention	I intend to drop-off my e-waste at collection centers to create space in the house.	0.828
	I am willing to participate in environmental programs by the government.	0.815
	I intend to participate in a formal e-waste collection if I am satisfied with the collection measures by the government.	0.761
	I intend to drop-off my e-waste if there are formal collection systems.	0.749
	I am willing to engage in formal e-waste management methods.	0.733

Extraction Method: Principal Component Analysis.

By conducting factor analysis for intention, the factor was extracted by the eigenvalue been greater than one, suggesting only one main factor. The factor of intention explained 62.91% of the variance. The items loading for intention is presented in Table 3. Factor analysis was also performed for the influencing and moderating factors alike, the eigenvalue number greater than one were set to be four and two respectively, which corresponds with four main influencing factors and two moderating factors as expected. However, three grouped items relating to perceived behavioral control (influencing factor) scored low (0.592) on the reliability test and as a result were deleted from the items of influencing factors. The resulting percentages of variance for the three main influencing factors were 22.60%, 21.01%, and 20.99% and overall, they explained 64.54% of all variance. Also, the percentages of variance for the two moderating factors were 39.48% and 28.25% and overall, they explained 67.74% of all

variance. The items loading for three influencing factors and two moderating factors are presented in Tables 4 and 5 respectively. The values for the respective reliability coefficients are presented in Table 6.

Table 4. Rotated component matrix for factor analysis of influencing factors.

Items		Main Factors		
		1	2	3
Environmental Knowledge	I know that recycling preserves natural resources for the benefit of present and future generations.	0.851	0.154	0.085
	I know that proper management of e-waste reduces the use of landfills and emissions of greenhouse gasses.	0.791	0.186	0.176
	I know that e-wastes should be disposed separately from general household wastes.	0.738	0.058	0.277
	E-waste can be a resource if properly managed.	0.603	0.084	0.396
	I know that e-waste contains toxic & hazardous substances that are harmful to human health & deteriorates the Environment.	0.543	0.099	0.260
Subjective Norm	My friends would influence me to participate in e-waste collections	0.075	0.877	0.223
	The community where I live would influence me to participate.	0.188	0.875	0.002
	My family would influence me to participate in e-waste collections.	−0.028	0.797	0.226
	Government regulations would influence me to participate.	0.342	0.654	0.053
Attitude	The e-waste stored at home should be dropped off for recycling.	0.165	0.130	0.819
	Dropping off my household e-waste for recycling is rewarding.	0.200	0.112	0.700
	I have a strong interest in the well-being of my community.	0.299	0.063	0.729
	Citizens should be concerned about proper e-waste management.	0.289	0.281	0.682

Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; Rotation Converged in 5 iterations.

Table 5. Rotated component matrix for factor analysis of moderating factors.

Items		Main Factors	
		1	2
Infrastructure	The collection centers have to be properly managed.	0.833	0.075
	I will drop-off my e-waste if the government provides adequate infrastructure.	0.826	0.069
	E-waste collection centers have to be situated close to the community.	0.767	0.154
	The collection centers ought to be a sustainable establishment.	0.622	−0.396
Economic Incentive	I am more likely to participate if collection schemes are linked with financial incentives.	−0.001	0.889
	Governments financial incentives will encourage me to drop off my e-waste at a collection center.	0.133	0.854

Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; Rotation Converged in 3 iterations.

Table 6. Factor analysis and Cronbach's alpha values.

Variables	KMO	Main Factors	No. of Items	Cronbach's Alpha	% of Variance	Mean	S.D
Influencing Factors	0.84	Attitude	4	0.801	22.60	4.281	0.641
		Subjective Norm	4	0.836	21.01	3.796	0.736
		Environmental Knowledge	5	0.820	20.99	4.202	0.593
					Total 64.54		
Moderating factors	0.78	Economic Incentive	2	0.751	39.48	3.719	0.950
		Infrastructure	4	0.750	28.25	4.158	0.609
					Total 67.74		
Intention	0.78	Intention	5	0.828	62.91	4.115	0.575

All factors: From 1 strongly disagree to 5 strongly agree.

5.2. Correlation Analysis

Pearson correlation measures the extent to which there exists a linear relationship between two or more variables [50]. According to Qu et al. [34], a moderation effect result means that the relationship between a dependent and independent variable can be strengthened or weakened by a moderating variable. Our theoretical framework assumes that the moderating factors of economic incentive and

infrastructure have a moderation effect on the relationship between the influencing factors (attitude, subjective norm, and environmental knowledge) and intention. To test this theoretical framework, a correlation analysis was performed amongst the influencing factors, the moderating factors, and intention as the first step. If there exists a significant correlation between an introduced variable with both the dependent and independent variable, then there is a probability that the introduced variable will have a moderation effect [51]. The results in Table 7 show that there exists a correlation between all influencing factors and moderating factors with intention, but not economic incentive, with attitude and environmental knowledge. The factor of economic incentive does not correlate with attitude and environmental knowledge, hence lacks the likelihood of having a moderation effect.

Table 7. Correlation analysis for moderating factors with influencing factors and intention.

	Attitude	Subjective Norm	Environmental Knowledge	Infrastructure	Economic Incentive	Intention
Attitude	1					
Subjective Norm	0.392 **	1				
Environmental Knowledge	0.578 **	0.353 **	1			
Infrastructure	0.500 **	0.311 **	0.528 **	1		
Economic Incentive	0.090	0.290 **	0.063	0.044	1	
Intention	0.502 **	0.420 **	0.507 **	0.728 **	0.174 **	1

** Correlation is significant at the 0.01 level (2-tailed).

5.3. Hierarchical Moderated Regression Analysis

To further explore the moderation effect of infrastructure and economic incentive on the relationship between the influencing factors and intention, we performed a hierarchical moderated regression analysis adopting the three-step variance partitioning method. According to Jaccard et al. [52], it is a suitably applicable method for testing moderation effects. Firstly, we entered the demographic variables into the first model. The second model included only the influencing factor. Then the influencing factor and the moderator was entered into the third model. Finally, the interaction variable was entered into the fourth model, which is a product of the influencing factor and the moderator. A moderation effect can be verified if the interaction input results in the variance increment of the dependent variable, individually indicated by the beta values or jointly indicated by the increment in the F-statistic values [53,54].

Multicollinearity in a multiple regression model occurs when two or more predictor variables are highly correlated and this can lead to misleading results in the model, in that, the variance of the coefficient estimates can be increased making it very sensitive and difficult to interpret [54]. However, multicollinearity can be prevented by centering the variables as done in previous studies [34,55]. Centering entails subtracting the mean value from an independent variable or moderating variable [56,57]. Also, we observed all values close to one indicating an acceptable variance inflation factor(s) for the entire regression analysis.

Table 8 presents the outcome of the hierarchical regression test to confirm the moderating effect of infrastructure on the relationship between attitude and intention. Individually, the significant negative beta value of infrastructure, −0.123 at $p < 0.001$, suggests that infrastructure moderates the relationship between attitude and intention. Additionally, the significant value of F change for step 3 (10.907 at $p < 0.001$) also shows the moderating effect of infrastructure.

Similarly, the outcome of the hierarchical regression test to confirm the moderating effect of infrastructure on the relationship between subjective norm and intention is presented in Table 9. Individually, the significant negative beta value of infrastructure, −0.088 at $p < 0.01$, suggests that infrastructure moderates the relationship between subjective norm and intention. Additionally, the significant value of F change for step 3 (6.518 at $p < 0.01$) also indicates the moderating effect of infrastructure. In both instances of the hierarchical regression test, the demographic variable of age and income has a significant effect on the dependent variable.

Table 8. Hierarchical regression with attitude and infrastructure.

Variable Entered		Dependent Variable			
		Step 1	**Step 2**	**Step 3**	**Step 4**
Demographic Variables	Gender	−0.040	−0.054	−0.035	−0.038
	Age	0.168 *	0.100	0.073 $^{+}$	0.087 *
	Education	0.094	0.063	0.024	0.035
	Income	−0.094	−0.124 **	−0.076 *	−0.072 *
Independent Variable	Attitude		0.495 ***	0.184 ***	0.148 ***
Moderator	Infrastructure			0.626 ***	0.671 ***
Interaction Variable	Attitude × Infrastructure				−0.123 ***
F for the Regression		3.364	28.498 ***	81.363 **	73.125 ***
F for the Step		3.364	124.657 ***	251.502 ***	10.907 ***
Adjusted R^2		0.012	0.281	0.607	0.635

Main table contains standardized coefficient Betas. $^{+}$ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 9. Hierarchical regression with subjective norm and infrastructure.

Variable Entered		Dependent Variable			
		Step 1	**Step 2**	**Step 3**	**Step 4**
Demographic Variables	Gender	−0.040	−0.057	−0.038	−0.045
	Age	0.168 **	0.104 *	0.062 $^{+}$	0.066 $^{+}$
	Education	0.094 *	0.030	0.000	0.002
	Income	−0.099 *	−0.098 $^{+}$	−0.065 $^{+}$	−0.058 $^{+}$
Independent variable	Subjective Norm		0.407 ***	0.212 ***	0.221 ***
Moderator	Infrastructure			0.655 ***	0.631 ***
Interaction variable	Subjective Norm × Infrastructure				−0.088 **
F for the regression		3.364	8.143 ***	86.248 ***	75.937 ***
F for the step		3.364	74.648 ***	44.546 ***	6.518 **
Adjusted R^2		0.012	0.173	0.611	0.628

Main table contains standardized coefficient Betas. $^{+}$ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The coefficient beta values for the interactions between subjective norm and economic incentive with intention (−0.051) and that between environmental knowledge and infrastructure with intention (−0.076) are not significant at $p < 0.10$ ($p = 0.541$) and $p < 0.10$ ($p = 0.220$) respectively. Hence, there is no existence of moderation effects. Consequently, the results tables will not be included.

6. Discussion

6.1. Results Discussion and Implications

The results of this study suggest that infrastructure is the significant moderating variable in the relationship between the influencing factors of the TPB and intention to participate in formal e-waste collection. The reliability tests revealed that perceived behavioral control (PBC) did not contribute to influencing a formal disposal intention, possibly due to the non-existence of formal collection systems in the country. This is also consistent with previous research on recycling which found that PBC did not provide a meaningful explanation of the variables of intentions and behavior [31,32]. Also, according to studies by Knussen et al. [58], the influencing abilities of PBC are weakened in the absence of recycling facilities, which results in low intentions to recycle. The findings also revealed that there exists no linear relationship between economic incentive and influencing factors of attitude and environmental knowledge. A possible explanation is the low level of awareness of the concept of e-waste management and solid waste management in general and also a lack of knowledge of the possible outcomes of a formal disposal exercise. As a result, the general populace is inexperienced in possible ways of pursuing sustainable environmentally-friendly behaviors. This is consistent with the study by Tonglet et al. [11] which found that the outcomes of recycling were meaningfully associated

with recycling intentions. The results from the moderation tests revealed that economic incentive and infrastructure did not have any moderating effects on the relationships between subjective norm and intention and environmental knowledge and intention respectively. Consistent with our results is the study by Xu et al. [33] which found that economic stimulus did not play a moderating role on the relationship between influencing factors and recycling intention. In as much as several other studies on recycling behavior have attested that economic incentives influence the intention to participate in recycling and are often effective in transforming an individual's intention into behavior [33,34,55], the situation in Nigeria as outlined in Section 2 provides no opportunities for residents to actually engage in any form of formal collection/recycling behavior, thus, it is a clearly different case from the situations in the studies mentioned above. Aung and Arias [36] found environmental knowledge to be a factor influencing individual intentions to engage in environmentally friendly behavior. Darby and Obara [23] also highlighted the usefulness of well-established facilities in motivating consumers to partake in more sustainable waste management behaviors. Clearly, both the necessary environmental knowledge and infrastructure needed is lacking in Nigeria. Consistent with existing literature, the prevalent level of e-waste awareness and disposal behavior of consumers as presented in Table 2 also highlights and corroborates the findings of our study.

Furthermore, our numerical results show that the factor of infrastructure moderates the relationship between attitude and intention and that between subjective norm and intention, which suggests that infrastructure could facilitate the transformation of attitude and subjective norms into intentions. Hence, to encourage consumers to participate in formal e-waste collections, the government should provide functional and adequately managed infrastructure situated close to the community, such that it can be easily accessed by household consumers. However, we observed that the coefficients of regression between the interaction variables (attitude × infrastructure and subjective norm × infrastructure) with intention are negative. This indicates that the introduction and availability of e-waste collection infrastructure will result in a weaker influencing capability of attitude and subjective norm on intention. This reveals that the establishment of adequate infrastructure can drive consumers' intentions to engage in formal collections even without being influenced by previous attitude or by the actions or opinions of family and neighbors. This shows that infrastructure plays a more significant role in improving consumers' intentions. A possible explanation could be the long absence (or lack of presence ever) of e-waste collection infrastructure in the country; in this case, consumers are not familiar which such attitudes and subjective norms that could drive them to engage in formal collection behaviors or even develop intentions. In as much as we cannot overrule the importance of attitude and subjective norm in influencing people's intentions to engage in recycling behaviors, however, in the case of Nigeria, the provision of infrastructure by the government will play a stronger role in improving consumers' intentions. These results seem to be consistent with other research which underscores the high importance of infrastructure/recycling facilities in establishing sustainable material recovery and management frameworks and developing consumers' intentions to recycle [10,11,34,58].

For both interactions, we found that the demographic variables of age and income also have effects on intention. However, the beta values for age and income and the dependent variable and their corresponding significant levels decreased upon entering the independent variables. This goes to show that differences exist among consumers of different age groups and income levels with respect to their intentions to participate in formal collections. All the findings of this study are pointing to the fact that a lot is needed to be done in the e-waste management sector by the government and relevant stakeholders. It is clear that the environmentally sound management of e-waste through a formal collection and disposal channel requires the conscious participation of the consumers, community and government regulators.

6.2. Recommendations for Improving Factors Influencing Consumer's Intentions

Consumers' participation may be improved through campaigns that emphasize individuals' obligations to practice environmentally friendly sorting and separation of household wastes and other

household waste reduction behaviors. It is imperative for the government to embark on mass awareness campaigns aimed at improving consumer's environmental consciousness and values. Such campaigns should emphasize the positive aspects of participation in a formal e-waste collection system (attitude), the social dimensions and importance of community involvement (subjective norms), the ability of individuals to participate (perceived behavioral control), e-waste toxicity, possible risks of improper dumping and backyard recycling, and advantages of formal recycling (environmental knowledge).

Environmental education should be inculcated in school curriculums starting from primary school up to the university level, all geared towards the development of environmental values which promote conservation of resources, sustainable consumption, and environmental preservation, which will in turn continuously motivate consumers to engage in recycling behaviors. It is also noteworthy to consider the age of consumers when designing the campaign and educational materials and the subsequent channel of dissemination, as the findings of our study revealed that age has a significant effect on participation intentions. The use of mass media will be very instrumental in reaching the older population who often pay close attention to television and radio programs. The informal collection and recycling sector should not be left out in the awareness campaign and education. A high level of environmental consciousness amongst the informal collection sector will be an advantage towards reducing informal disposals and crude recycling.

6.3. Recommendations for Developing an E-Waste Collection Infrastructure

An essential requirement for an efficient and effective formal e-waste collection system is the availability of adequate infrastructure. To curtail the indiscriminate disposal and scavenging of e-waste, in the interim, there is need for the introduction of take-back programs to serve as a feed base for the vast majority of informal collectors, which can also sustain the economic benefits of their activities. Kang and Schoenung [59] highlighted the key elements of an all-inclusive e-waste recycling scheme, which includes: take-back systems, categorization of waste, adequate material recycling, and disposal methods. Hence, developing applicable collection infrastructure is a major challenge the government must rise to, in order to consolidate increased environmental values amongst the consumers resulting from the education and awareness campaign. It is vital for government to adopt an all-inclusive approach, involving all stakeholders concerned and the general public. There needs to be collaboration in developing an all-encompassing collection/management system, functioning within an enabling organized system and capable of employing a sustainable system financing. This approach should commence from the initial stages of any proposed e-waste management approach and should endure through the implementation stage, in order to guarantee the acceptance and implementation of all innovation by the concerned parties.

In addition, there is a need for the introduction of legislation dealing specifically with a management system to consolidate on the infrastructure and system that will be established. Stricter measures such as enforced legislation should be put in place to checkmate e-waste disposals at the generation sources, domestic and imports. Already existing laws such as the National Environmental (electrical/electronic sector) Regulations which incorporate all aspects of the sector from manufacture to disposal and outlines stakeholder responsibilities should be fully enforced, involving all parties concerned and making clear the roles they are to play.

7. Conclusions

The findings of our study proffer suggestions for the promotion of intentions to participate in formal e-waste collections and necessary awareness campaigns in Nigeria. Collection is a central phase in gathering and diverting the e-waste streams to the desirable recycling facilities. Consumers' active participation in e-waste collection and recycling is vital in upholding an established e-waste management scheme. Hence a thorough understanding of consumers' intentions to participate in formal e-waste collection is essential. The TPB provides such a cognitive psychological model. Using the theoretical lens of the TPB to design and conduct surveys, we found very useful insights into

the factors which influence consumers' intentions to participate in formal e-waste collection schemes. Our findings suggest that attitude, subjective norms and environmental knowledge are the major influencing factors in developing intentions to engage in formal collections, whereas infrastructure moderates the relationship between attitude and subjective norms with intentions. Our regression results indicate that infrastructure could facilitate the transformation of attitude and subjective norms into intentions, and further suggests that the availability of e-waste collection infrastructure will likely result in a weaker influencing capability of attitude and subjective norm on intention, provided that there exists a functional and adequately managed infrastructure situated close to the community, such that it can be easily accessed by household consumers.

A major contribution of the methods employed by this study is that it highlights the potential factors that would influence consumers to participate in a formal e-waste collection scheme. This information can then be used to develop and implement formal e-waste collection schemes which are user friendly, and, in addition, can serve as a guide for developing campaign initiatives which promotes participation in such schemes. In conclusion, a formal e-waste collection system has to be developed and updated according to each countries' situation and culture, with the participation and support of all the stakeholders. Nonetheless, it is possible and necessary to learn from the experiences of the developed countries and to adopt what is suitable.

Our study examined the influences on intention to participate in a formal collection system in one metropolitan city in Nigeria, and so our findings may not be entirely applicable to other cities and cultures. In as much as the TPB has proven in this study and several other studies to be successful in the prediction of recycling intentions and behaviors, some researchers argue that case-specific variables be integrated into the TPB to increase its predicting capabilities [11,28,31,32]. In this light, Barr [60] suggested a theoretical framework that facilitates the prediction of behavioral intention and behavior by broad factors such as situational factors, psychological factors, and eco-friendly values. Such an adjustable framework supports the integration or exclusion of variables depending on the case study situation, as is the case of Nigeria where very little has been done in the e-waste management sector. Thus, this should be considered in future studies.

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