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The Effects of Environmental Values on Gen Z's E-Waste Recycling Intention

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Abstract: The rapid growth of electronic waste (e-waste) has become a pressing environmental concern, necessitating a deeper understanding of individuals' intentions toward responsible e-waste management. This study aims to explore the relationship between e-waste recycling intentions using the Theory of Planned Behavior (TPB) while considering the influence of environmental values. The research design employs a quantitative approach, utilizing a survey questionnaire to collect data from 115 Gen Z respondents. The findings show that perceived behavioral control, subjective norms and environmental values influence the intention to recycle e-waste while attitude was not impactful in influencing e-waste recycling intention. The findings will offer valuable insights for policymakers, environmental organizations, and practitioners seeking to promote sustainable e-waste practices. Ultimately, the study aims to foster a more comprehensive understanding of how individual attitudes can be leveraged to drive positive changes in e-waste management and contribute to a more sustainable future.

Keywords: *E-waste recycling, environmental values, Theory of Planned Behavior, perceived behavioral control.*

1. Introduction and Background

Waste from electrical and electronic equipment (WEEE) or also known as e-waste refers broadly to various types of products with circuity or electrical components with a power or battery supply (Step Initiative, 2014). The United Nations Institute for Training and Research, and the European member states recognize electrical and electronic equipment waste under six categories including temperature exchange equipment, screens and monitors, lamps, large equipment, small equipment and, small IT and Telecommunications equipment (Forti et al., 2020). In 2022, 50 million tons of e-waste recorded was recorded globally. Developed nations produce more e-waste than developing countries; however, Asia is expected to contribute significantly to the growing amounts of e-waste generated each year (Time, 2023). In Asia, 24.9 million tons of e-waste was generated in 2020, of which only 11.7% was documented and recycled through the proper channels. For this amount of e-waste, an estimated 60.8 million tons of carbon dioxide and greenhouse gases could be emitted into the atmosphere. It is also estimated that the raw material in e-waste could be worth up to USD 26.4 billion. China, India and Indonesia are expected to be the largest producers of e-waste in the coming decade (E-waste Monitor, 2020).

Locally, Malaysia is expected to produce 24.5 million units of e-waste by 2025 and the current most common e-waste item discarded by Malaysian consumers is the laptop (Department of Environment Malaysia, 2023; Business Today, 2023). The growing trend of usage of electric and electronic devices in consumer lifestyles is expected to increase the amount of e-waste which will be managed by governments around the globe through waste management systems. Proper e-waste management systems must be employed given that improper exposure to electric and electronic waste has been shown to cause a myriad of health issues including harmful effects on neurodevelopment (Huo et al., 2019) (, birth outcome Zhang et al., 2018), learning outcomes (Soetrisno et al. 2020), respiratory effects (Amoabeng et al. 2020), hearing loss (Xu et al., 2020) and cancer (Davis et al, 2019). Therefore, it is of growing importance to improve e-waste management systems and adjust consumer habits in discarding e-waste. Increasingly, e-waste management systems have increased in prominence on global and national agendas in line with sustainability goals. Policymakers must grasp the consumers' motivational precursors to e-waste recycling.

Given the importance of this issue, this study focuses on understanding Gen Z's (born between 1996 and 2010) (Pew Research Centre, 2020) intention to recycle e-waste. Previous studies indicate that motivational models used to study consumer behavior and intention in e-waste recycling stem from past studies in recycling (Tonglet et al., 2004). Current studies focusing on e-waste recycling intention have utilized the Norm Activation Theory (Nguyen, 2023), Behavioral Reasoning Theory (Dhir et al., 2021), Technology Acceptance Model (Ramzan et al., 2021), Valence Theory (Dhir et al., 2021) and most prominently, the Theory

of Planned Behavior (Wan et al., 2017; Wang et al., 2016). Drawing from Tonglet et al. (2004), further attention is required in the incorporation of additional variables to the Theory of Planned Behavior to further the understanding of the intention to recycle e-waste. Hence, this study will study the effects of Environmental Values on e-waste recycling Attitude and Intention. The effects of Environmental Values on attitudes should be investigated to examine the effects of altruistic values on pro-environmental behavior. Additionally, previous use of Environmental Values was only limited to understanding its effects on Perceived Behavior Control and requires the expansion of the model to include all variables in the Theory of Planned Behavior to obtain a deeper understanding of its influence as an intrinsic motivator (Ofori et al., 2022).

2. Literature Review

Theory of Planned Behavior: The Theory of Planned Behavior (TPB) attempts to identify motivational factors that influence intention and behavior. The motivational factors indicate the extent of effort that will be exerted for the performance of behavior. Thus, the greater the intention, the higher the likelihood of performing the behavior. The Theory of Planned Behavior asserts that behaviors are shaped by the formation of intention. Intention is predicted by attitude, subjective norm and perceived behavioral control. An individual's perception of the favorability of a behavior is defined as attitude while subjective norm refers to the perceived social pressure to perform a behavior; and perceived behavioral control alludes to the ability of an individual to perform a behavior in the given context (Ajzen, 1991).

TPB has been used in the past to study pro-environmental behavior, including studies on e-waste recycling. Previous studies have employed the use of TPB with the Norm Activation model (Schwartz, 1977), the Value Belief Norm theory (Stern et al., 1999) and the Theory of Interpersonal Behavior (Triandis, 1977). TPB is viewed as an effective model to understand behavioral intention (Riebl et al., 2015; Timm and Deal, 2016). When TPB is used in studies focusing on pro-environmental behavior, studies were found to focus on additional variables such as moral norms, past behavior, self-identity and habit (Yuriev et al., 2020). Behavior performance is expected to be successful when the individual has the required opportunities and resources. Deterrence in behavior performance is caused by non-motivational factors such as time or money; which represents actual control over behavior.

Attitude: Attitude refers to the degree to which the behavior is evaluated or appraised to be favorable or unfavorable. Attitude includes experiential and instrumental dimensions (Ajzen, 2002). Utilitarian drives also motivate individuals toward the performance of behavior (Batra & Ahtola, 1991). Voss et al. (2003) suggested that the degree of utility of a product would influence consumption attitude or rather, in this context, the degree of utility of performing a behavior.

Attitude is defined as an evaluative response to a specific matter as either preferred or non-preferred. It is usually a predisposed emotional state concerning a particular object, issue or entity (Perloff, 2016). According to Ajzen (1991), attitude shapes the intention to perform a behavior. Past studies on pro-environmental behavior have provided evidence that attitude influences the intention to adopt green building technologies (Rajae et al., 2019) and also recycling intention (Wan et al., 2017). Therefore, this study examines the following hypothesis:
H_1: Attitude has a significant effect on Behavioral Intention.

Subjective Norm: Subjective norm is defined as the perceived social pressure to perform or not to perform the behavior (Ajzen, 1991). Subjective Norm describes social influence on behavior performance (White, Smith, Terry, Greenslade, & McKimmie, 2009). Significant others are seen to be able to influence an individual's behavioral intention (Ajzen, 1991). Individuals will be influenced by relevant other's beliefs on whether specific behavior should be performed (Fornara, Carrus, Passafaro, & Bonnes, 2011; White et al., 2009) as a form of external incentive or validation in decision-making (Comber & Thieme, 2013).

It is expected that the individual's willingness to meet the expectations of a reference group important to them would be a strong predictor of behavioral intention (Venkatesh & Davis, 2000). Previous research has shown that subjective norms can influence pro-environmental behavior intentions such as the intention to recycle agricultural waste (Jiang et al., 2018), recycle plastic waste (Khan et al., 2019), and e-waste (Wan et

al., 2017). Therefore, this study examines the following hypothesis:
H_2: Subjective Norm has a significant effect on Behavioral Intention.

Perceived Behavioral Control: Perceived behavior control refers to the perceived ease or difficulty in performing the behavior, given that it reflects experience and anticipates obstacles or impediments (Ajzen, 1991). Perceived control can be understood to be the effortlessness or difficulties in the performance of behavior (Tonglet et al., 2004). Thus, individuals who know how to recycle would be more likely to do so.

Past studies have shown that perceived behavioral control can affect the intention to perform behavior (Russell et al., 2017) in household recycling intention and electronic device reuse and repair intention (Kianpour et al., 2017) and even in pro-environmental behavior (Niaura, 2013). Knowing how to recycle through procedural steps has been found to influence recycling behavior (Rosenthal, 2018). Thus, recycling rates have been significantly influenced by perceived behavioral control (Kumar, 2019). However, previous observations have also suggested that perceived behavioral control did not affect recycling behavior (Zhang et al., 2019). Thus, this study examines the following hypothesis:
H_3: Perceived Behavioral Control has a significant effect on Behavioral Intention.

Environmental Values: Values are seen as shaping an individual's self and personality and function as a force of motivation for behavior (Schwartz, 2012). Values can regulate people's intentions to perform a behavior. Values can predict the performance of pro-environmental behavior such as the use of electric vehicles (Han et al., 2017; He et al., 2018) and staying in green hotels (Verma et al., 2019) or using electric vehicles, as mentioned by Dhir et al. (2021). The consumers' values shape their actions. When selecting a specific behavior to perform, consumers consider the compatibility between the action with their values, previous experience, current beliefs and established needs (Saphores et al., 2012). Previous studies have observed the influence of values in determining the disposal of e-waste such as mobile phones (Ting et al., 2019).

Environmental values can be described as a moral obligation to engage or refrain from certain actions that will jeopardize the quality of the environment (Steg & Nordlund, 2019). Environmental values are expected to serve as a form of intrinsic motivation for environmentally friendly behavior (Ofori et al., 2021). Previous research indicates that environmental values do influence pro-environmental behavior such as recycling (Khalil et al., 2017; Zuo et al., 2017; Sorkun, 2018), using public transportation (Bamberg et al., 2002), reducing personal car use (Nordlund & Garvill, 2003), recycling e-waste (Zuo et al., 2017; Sorkun, 2018). Thus, this study examines the following hypothesis:
H_4: Environmental Values Control has a significant effect on Behavioral Intention.
H_5: Environmental Values have a significant effect on Attitude.

3. Research Methodology

For this study, 128 respondents answered the online questionnaire, but 115 respondents were retained due to straight-lining. Based on the minimum sample size obtained through G*Power a prior power estimation, the minimum sample size required for more than 0.80, effect size of 0.15 (Hager, 2006), with a 5% probability of error, to the power of $(1 - \beta) = 95\%$ and with four predictors is 89. Purposive sampling was employed where the respondents selected by the researcher were individuals who use electrical and electronic products. The age of the respondents was 20 – 24 years old representing the age of consumers recognized as Gen Z. Purposive sampling not only is efficient and cost-effective but also allows for typical representations of the population to be obtained, aligning to the objectives of this study.

The research questionnaire used included the instrument for the Theory of Planned Behavior (Wan et al., 2017) comprising 34 items and environmental Values containing 9 items. The 7-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree' was utilized for the instrument (Ofori et al., 2021). The respondent's demographic attributes were also collected. Twelve demographic items were also included in the questionnaire. Partial Least Squares Structural Equation Modelling analysis was employed using the SmartPLS4 software. This is primarily motivated by the research goal which is to identify the influence of key drivers in consumer technology acceptance and extend existing structural theory. This can be achieved in

PLS-SEM because it estimates coefficients or path model relationships that maximize the R^2 values of the endogenous constructs. PLS-SEM also estimates complex models with multiple construct and structural paths where causal predictive explanations are emphasized (Ramayah, Cheah, Chuah, Ting & Memon, 2018; Hair, Hult, Ringle & Sarstedt, 2016) in estimating statistical models.

4. Results

Demographic Profile: A total of 128 respondents took part in this study, however, 115 responses were retained due to straight-lining. All respondents were aged between 20 years old to 24 years old and identified as Bumiputra. The most common way respondents dispose of their e-waste was by re-selling followed by storing it at home, recycling it at the designated recycling point, recycling through a waste collection van/lorry service, giving it away, discarding it in the dumpster, recycling by sending it to government allocated recycling rubbish bin, recycle using recycling bins for electronic waste, recycle by sending to a government-run recycling center, recycle by sending to waste store, recycle by sending to waste collection in mall and other manners not mentioned in the questionnaire (Table 1).

Table 1: Demographic Profile of the Respondents

Demographics	Frequency	Percent (%)
Age		
Below 20 years (from 18 years)	0	0
20 - 24 years	115	100.0
Gender		
Female	95	82.6
Male	20	17.4
Ethnicity		
Bumiputra	115	100.0
Ways of Disposing of E-waste		
Re-sell	75	
Recycle at designated recycling points (e.g., weekly community recycling initiative)	36	
Recycle using recycling bins for electronic waste	18	
Recycle by sending to waste store	11	
Recycle through waste collection van/lorry service	28	
Recycle by sending to waste collection in a mall	11	
Recycle by sending to government-run recycling centre	12	
Recycle by sending to government-allocated recycling rubbish bin	24	
Give away	27	
Store at home	30	
Discard in dumpster	25	
Others	3	

Measurement Model: The measurement properties were sufficient for Composite Reliability, Indicator Loading, Average Variance Extracted, Cross Loading, Fornell and Larcker's criterion and HTMT. Two items were dropped given the low item loading, below the value of 0.6 (Byrne, 2010) however, item EVAL2 was retained given that the threshold values for the measurement of internal consistency convergent reliability and discriminant validity were met (Table 2). The threshold of 0.70 (Hair, Hult, Ringle & Sarstedt., 2016; Henseler, Hubona & Ray, 2016) was achieved for all CR scores. Also, the Average Variance Extracted (AVE) for all constructs which were above 0.50 (Bagozzi & Yi, 1988; Fornell & Larcker, 1981; Hair et al., 2016) (Table 2).

Discriminant validity was indicated through examination of the cross-loading, Fornell and Larcker's criterion and HTMT. The cross loadings for each construct were observed to be the highest for their designated constructs thus indicating discriminant validity (Hair et al., 2016) (Refer to Table 3). For the Fornell & Larcker Criterion (Table 4), the square root of each construct's AVE was greater than all other correlations with any other construct (Hair et al., 2016). Using the stringent criteria, the HTMT scores are all below the threshold of 0.85 thus displaying discriminant validity (Kline, 2011) (Table 5).

Table 2: Factor Loadings, Convergent Validity and Composite Reliability

Construct	Items	Loadings	AVE	Cronbach Alpha	Composite Reliability (rho c)
Attitude	ATT1	0.830	0.538	0.794	0.851
	ATT2	0.716			
	ATT3	0.582 (item dropped)			
	ATT4	0.523			
	ATT5	0.802			
	ATT6	0.758			
Subjective Norm	SN1	0.746	0.565	0.847	0.886
	SN2	0.663			
	SN3	0.748			
	SN4	0.763			
	SN5	0.785			
	SN6	0.799			
Perceived Behavioral Control	PBC1	0.728	0.650	0.910	0.928
	PBC2	0.776			
	PBC3	0.821			
	PBC4	0.805			
	PBC5	0.871			
	PBC6	0.818			
	PBC7	0.818			
Environmental Values	EVAL1	0.625	0.557	0.883	0.908
	EVAL2	0.553			
	EVAL3	0.570 (item dropped)			
	EVAL4	0.665			
	EVAL5	0.844			
	EVAL6	0.849			
	EVAL7	0.826			
	EVAL8	0.805			
	EVAL9	0.746			
Behavioral Intention	BI1	0.811	0.701	0.786	0.875
	BI2	0.865			
	BI3	0.835			

Table 3: Cross Loadings

	ATT	BI	EVAL	PBC	SN
ATT1	**0.830**	0.255	0.347	0.310	0.363
ATT2	**0.716**	0.080	0.204	0.142	0.286
ATT4	**0.523**	0.040	0.138	0.127	0.229
ATT5	**0.802**	0.312	0.278	0.365	0.399
ATT6	**0.758**	0.224	0.126	0.355	0.330

BI1	0.290	**0.811**	0.378	0.610	0.535
BI2	0.233	**0.865**	0.254	0.666	0.528
BI3	0.199	**0.835**	0.430	0.467	0.495
EVAL1	0.183	0.260	**0.625**	0.126	0.076
EVAL2	0.209	0.193	**0.553**	0.080	0.135
EVAL4	0.340	0.318	**0.665**	0.233	0.232
EVAL5	0.321	0.338	**0.844**	0.217	0.313
EVAL6	0.242	0.377	**0.849**	0.196	0.252
EVAL7	0.200	0.337	**0.826**	0.182	0.209
EVAL8	0.211	0.313	**0.805**	0.151	0.203
EVAL9	0.195	0.328	**0.746**	0.173	0.197
PBC1	0.259	0.477	0.173	**0.728**	0.411
PBC2	0.332	0.541	0.185	**0.776**	0.432
PBC3	0.406	0.513	0.164	**0.821**	0.551
PBC4	0.351	0.473	0.142	**0.805**	0.523
PBC5	0.328	0.597	0.198	**0.871**	0.485
PBC6	0.217	0.652	0.256	**0.818**	0.511
PBC7	0.296	0.645	0.191	**0.818**	0.492
SN1	0.386	0.409	0.227	0.581	**0.746**
SN2	0.499	0.337	0.380	0.378	**0.663**
SN3	0.253	0.398	0.145	0.373	**0.748**
SN4	0.238	0.499	0.230	0.549	**0.763**
SN5	0.326	0.462	0.168	0.400	**0.785**
SN6	0.377	0.618	0.179	0.439	**0.799**

Table 4: Fornell & Larcker Criterion

	ATT	BI	EVAL	PBC	SN
ATT	**0.734**				
BI	0.290	**0.837**			
EVAL	0.326	0.420	**0.746**		
PBC	0.383	0.700	0.236	**0.806**	
SN	0.450	0.622	0.282	0.603	**0.752**

Table 5: HTMT

	ATT	BI	EVAL	PBC	SN
ATT					
BI	0.316				
EVAL	0.346	0.503			
PBC	0.419	0.809	0.252		
SN	0.545	0.737	0.330	0.686	

Structural Model: To assess the lateral collinearity, the Variance Inflator Factor (VIF) was examined. All values were below the threshold value of 3.3 and thus, the model does not possess collinearity issues (Table 6).

Table 6: VIF

	ATT	BI
ATT		1.353
BI		
EVAL	1.000	1.151
PBC		1.615
SN		1.745

The results of hypotheses testing are presented in Table 7 where the following hypotheses were found to be significant: Subjective Norm (H_2) (ß = 0.301, p <0.01), Perceived Behavioral Control (H_3) (ß = 0.505, p <0.01) and Environmental Values (H_4) (ß = 0.256, p <0.01) had a significant effect on Behavioral Intention. Environmental Values (H_5) (ß = 0.326, p <0.01) also had a significant effect on Attitude. Finally, Attitude (H_1) (ß = -0.122, p <0.01) did not have a significant effect on Behavioral Intention.

According to Cohen (1988), the effect size (f^2) can be interpreted as having a substantial effect size (0.35), medium effect size (0.15) and small effect size (0.02). Perceived Behavioral Control (0.407) has a large effect size. Although, Environmental Values (0.147) and Subjective Norms (0.134) were observed to be close to having a medium effect size they did not achieve the threshold requirement of 0.15. Lastly, Attitude (0.029) has a small effect size.

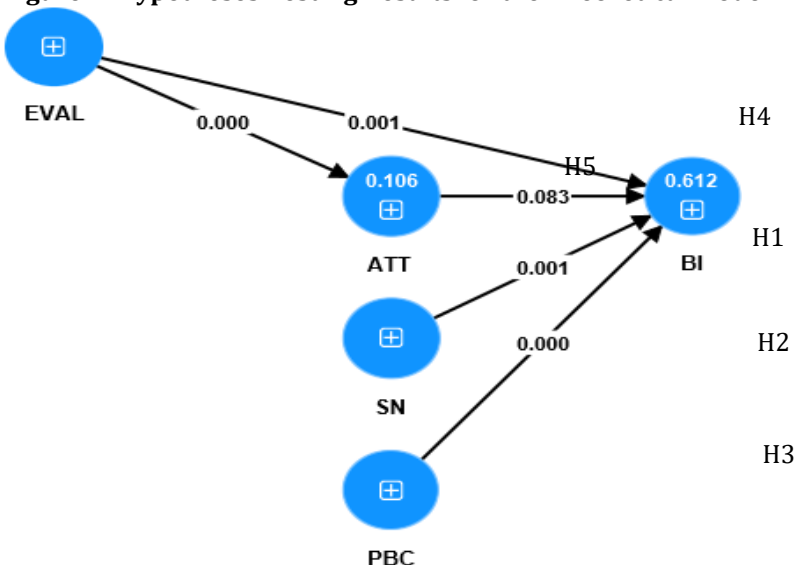
Using Cohen's (1988) interpretation of the Coefficient of Determination (R^2), in influence of the constructs can be interpreted as substantial (0.26), moderate (0.13) or weak (0.02). Behavioral Intention (0.612) shares 61.2% of the variance with Attitude, Subjective Norm, Perceived Behavioral Control and Environmental Values, signifying a large effect. The variance in Attitude (0.106) indicates a moderate effect (Refer to Table 7).

For Stone-Geisser's Q^2 value, a value higher than 0 is considered to have predictive relevance for the endogenous constructs (Hair et al., 2016; Geisser, 1974). Given the Q^2 scores in Table 7, the constructs in the model exhibit predictive relevance.

Table 7: Hypotheses Testing

	Hypothesis	Beta	SE	t-value	LL	UL	f^2	R^2	Q^2	Findings
H_1	ATT → BI	-0.122	0.071	1.732	-0.275	0.000	0.029			Not Supported
H_2	SN → BI	0.301	0.095	3.179	0.114	0.481	0.134			Supported
H_3	PBC → BI	0.505	0.085	5.955	0.331	0.658	0.407	0.612	0.552	Supported
H_4	EVAL → BI	0.256	0.080	3.207	0.099	0.411	0.147			Supported
H_5	EVAL → ATT	0.326	0.082	3.978	0.081	0.440	0.119	0.106	0.043	Supported

Figure 1: Hypotheses Testing Results for the Theoretical Model



5. Conclusion and Discussion

The results indicate that Perceived Behavioral Control has the largest effect on Behavioral Intention. Previous literature asserts these findings as well (Ofori et al., 2021). This indicates that most respondents have the individual capacity to recycle their e-waste. The confidence to perform a behavior narrows the gap between intention and behavior (Rosenthal, 2018) increasing the likelihood of follow-through to behavior performance. Thus, policymakers should consider the importance of offering the public a system for recycling e-waste that enables citizens to perform e-waste recycling easily. Convenient avenues for e-waste recycling would aid rather than hinder the chances of residents being interested in recycling e-waste whether or not they care about the health environment or not.

Subjective Norm is observed to be an important indicator of the intention to recycle e-waste among Gen Z. Congruent to the findings by Wan et al. (2017); Subjective Norm has a significant effect on Behavioral Intention while Attitude does not. Literature suggests that as the influence of Subjective Norms increases, the influence of Attitude decreases (Huffman et al., 2014). In this study, Attitude was not found to be a significant predictor of Behavioral Intention. This suggests that while Gen Z might not fully perceive e-waste recycling to be favorable for them, they continue to possess the intention to recycle e-waste. Huffman et al. (2014) assert the importance of social groups in shaping the behavior of communities even when the individual is not aware of the benefits of recycling.

Environmental Values influence Behavioral Intention and Attitude in a significant manner. As observed through the effect sizes for H_4 and H_5, it is evident that Environmental Values do influence the formation of the intention to recycle e-waste. Internal environmental values can be observed in this study to shape Gen Z's formation of attitude and intention, leading to the performance of e-waste recycling behavior. This is further supported by data from the respondents, where more than half of the respondents do actively sell their used e-waste and a smaller proportion of respondents discard their e-waste directly into the dumpster without any type of recycling.

Managerial Implications and Recommendations

This study focuses on the influence of Environmental Values on the Attitude construct in TPB and the intention to recycle e-waste. However, future studies should consider investigating the effects of Environmental Values on beliefs using the full Theory of Planned Behavior model. One of the limitations of this study is the use of university students only as the sample. Thus, it is recommended that the study be carried out on other age groups to ascertain the importance of the indicators in the intention to recycle e-

waste.

The findings suggest that Gen Z possesses the intention to recycle e-waste when they are confident that they are able to perform the behavior and when their social group perceives e-waste recycling to be favorable. Government agencies interested in promoting e-waste recycling behavior to Gen Z should focus on ensuring that e-waste recycling facilities are within easy reach of Gen Z. E-waste recycling agencies should consider making e-waste drop-off bins, centers and collection points that are within an acceptable radius of distance from Gen Z's congregation spots. Additionally, engaging opinion leaders perceived to be important to Gen Z could also help influence their perception of recycling e-waste.

Conclusion

This study seeks to establish the influence of environmental values on attitudes and e-waste recycling intention for Gen Z. The influence of environmental values is evident on attitude and behavioral intention indicating that pro-environmental values can shape the attitudes and intentions of Gen Z. However, from this study, it can be seen that perceived behavioral control and subjective norms had a stronger role to play in shaping the intention to recycle e-waste. Therefore, while pro-environmental values do affect attitude, the roles of perceived behavioral control and subjective norm should not be discounted as significant motivators of e-waste recycling behavior.

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