Juma, Sonny Nyeko; Kagoya, Sumaya M.

Article

An assessment of electronic waste knowledge, attitude, intentions, and risk perception of sustainable electronic waste management from a developing country perspective

Reference: Juma, Sonny Nyeko/Kagoya, Sumaya M. (2022). An assessment of electronic waste knowledge, attitude, intentions, and risk perception of sustainable electronic waste management from a developing country perspective. In: Business management review 25 (2), S. 95 - 111.
https://journals.udsm.ac.tz/index.php/bmr/article/download/5509/4631.

Open Access article distributed in terms of the Creative Commons Attribution License [CC BY 4.0] http://creativecommons.org/licenses/by/4.0

Business Management Review
Volume 25, Issue No. 2
July – December, 2022

ISSN 0856 2253 (Print) & ISSN 2546-213X (Online)

www.journals.udsm.ac.tz/index.php/bmr
The Journal of the University of Dar es Salaam Business School

An Assessment of Electronic Waste Knowledge, Attitude, Intentions, and Risk Perception of Sustainable Electronic Waste Management from a Developing Country Perspective

Sonny Nyeko Juma
Senior Lecturer, Department of Computer Science and Engineering, Makerere University Business School, Kampala, Uganda

Sumaya M. Kagoya[1]
Lecturer, Department of Applied Computing and Information Technology, Makerere University Business School, Kampala, Uganda

To cite this article: Juma, S. N., & Kagoya, S. M. (2022). An Assessment of Electronic Waste Knowledge, Attitude, Intentions, and Risk Perception of Sustainable Electronic Waste Management from a Developing Country Perspective. *Business Management Review, 25*(2), 95 – 111.

Abstract
This study aimed at assessing E-waste knowledge, E-waste intentions, E-waste attitude, and E-waste risk perceptions regarding sustainable E-waste management practices among key government decision-makers using the Theory of Planned Behavior (TPB). Questionnaires were analyzed using Partial Least Squares-Structural Equation Modelling (PLS-SEM) multivariate statistical technique. Findings indicate that the sustainable E-waste management practice model, based on E-waste knowledge, E-waste intentions, E-waste attitude, and E-waste risk perceptions, explains 56.2% of the sustainable E-waste management practice variance. Additionally, E-waste attitude, knowledge, and intention significantly influence sustainable E-waste management practices. E-waste attitude demonstrates the most robust prediction of sustainable E-waste management practices from a government employee's perspective. Using the Theory of Planned Behavior (TPB) context, the study found E-waste attitude as the most crucial predictor of sustainability of E-waste management practices, followed by E-waste knowledge. Secondly, by applying the PLS-SEM approach, the study adds E-waste risk perception and E-waste knowledge as an extension of the Theory of Planned Behavior. Practically, valuable insights, and understandings encouraging environmental awareness and sustainable E-waste management among citizens plus recommendations are provided.

Keywords: E-waste, Theory of Planned Behavior, Reuse, Recycle, Reduce

---

[1] Corresponding Author: *skagoya@mubs.ac.ug*

Introduction

This study aims to assess the status of E-waste awareness, intentions, attitudes, and risk perceptions regarding sustainable E-waste management practices. The global trend of electrical-electronic waste (E-waste) generation is becoming one of the leading environmental and health concerns towards realizing sustainable development goals, considering its associated adverse health and probable eco-toxicological impacts (Panda, Panda & Pradhan, 2022). E-waste is a component destined for re-use, re-sale, salvage, or disposal and generated from information technology (IT) telecommunication equipment and consumer electrical/electronic products (Ngethe, 2021). The Global United Nations (UN) E-waste Monitor Report 2020 revealed 20-50 million tons of E-waste generation worldwide (Omondi, Ndiba & Koech, 2022), and are estimated to shoot beyond 74 million tons by 2030. The Uganda Communication Commission (UCC) had a projected yearly increase of 4,500 tons of E-waste from electronic-electrical equipment (EEE) users for 2018-2022 (O'Neill, 2019). In Uganda, the E-waste generated in 2019 and placed in the market was 32kilo tonnes (kt), whereas the E-waste documented and destined for collection and recycling in 2018 was at 0.18kt (Omondi, Ndiba & Koech, 2022). The third National Development Plan (NDP III 2020/21 – 2024/25) provides a roadmap for Uganda to improve and achieve efficient solid waste collection from 30% to 50% by 2024/2025 and address the potential human health and environmental repercussions (Zaheer, 2020; Skinner, 2018).

Improper management of E-waste is insecure for public health, the environment, and the atmosphere through the discharge of heavy metals (Abubakar et al., 2022; Mokarat et al., 2022). This has highlighted the necessity to study E-waste knowledge, E-waste attitudes and intentions, and risk perception of E-waste to ensure successful sustainable E-waste management amongst the consumers that generate it. Chakraborty et al. (2022) and Islam et al. (2021) reported that over 70% of environmentally harmful chemicals currently originate from E-waste, partly from heavy metals like cadmium, lead, mercury, and beryllium. Like the case in most developing countries, the huge population in Uganda is unaware of the adverse impact of surging E-waste generation due to the importation of EEE (Samarakoon et al., 2022). When the EEE are finally obsolete and incinerated or placed in landfills, they pose serious health risks and environmental challenges due to the harmful components they contain (Batoo et al., 2022; Murthy & Ramakrishna, 2022; Rautela et al., 2021; Jayaraman et al., 2019; Bhutta, Omar & Yang, 2011).

Globally, E-waste knowledge, attitude, intentions, and risk perception of E-waste are among the extensively researched areas, due to their impact on the sustainable management of E-waste (Fan et al., 2022). They emphasize that awareness of E-waste is realistically one of the significant ways to achieve long-term sustainable E-waste management (Almulhim, 2022; Tian et al., 2022). However, in Africa, several countries face the challenge of poor E-waste establishment, lack of E-waste knowledge and poor attitude towards E-waste (Almulhim, 2022; Tian et al., 2022). Attitude is a person's undesirable or optimistic evaluation of a particular behavior (Wang et al., 2022; Arkorful et al., 2022). Whereas knowledge is a situational and conditional aspect that controls environmentally friendly attitudes and behavior. Hossain, Al-Hamadani & Rahman (2015) opined that, understanding gaps in E-waste are essential at all organizational levels (Dhir et al., 2021; Islam et al., 2021). Despite much attention to conducting studies on E-waste management by developed countries, research in developing nations is inadequate (Jangre, Prasad & Patel, 2022). Moreover, the scanty studies based on the available literature ignore the influence of E-waste knowledge, attitude, intentions, and risk perception on E-waste management sustainability (Koshta, Patra & Singh, 2022; Thukral, Shree & Singhal, 2022). Thus, the study intends to fill gaps in a developing country context.

This study is important because E-waste is associated with negative environmental pollution and human health impacts. Therefore, assessment of the status of E-waste knowledge, intentions, attitudes, and risk perceptions regarding sustainable E-waste management practices is crucial. The remainder of this paper is organized into five sections. Theoretical framework, hypotheses development, methodology used, analysis, and results. The paper closes with a discussion of the findings, limitations of the study, and recommendations for future studies.

Literature Review

Theoretical framework

Theory of Planned Behavior (TPB), an extension of the Theory of Reasoned Action (TRA), is employed in this research in the context of E-waste as it attempts to predict some behavior (Soomro et al., 2022). In addition to subjective norms and attitudes that predict interest, as emphasized by TRA, it is suggested that an individual's intention is due to those two behaviors (Nugroho et al., 2017). Furthermore, TPB stresses that behavior and perceived control behavior, are of paramount interest (Azjen, 2005). Ajzen (2005) considers perceived behavioral control as the individual's perception of his influences concerning particular behavior. Ajzen (2005) defines subjective norm as an individual's perception of the social pressure not to do or do specific behavior. Similarly, individuals are more likely to participate in a particular behavior, for instance, recycling and disposal, when their peers believe it's the right course of action (Arkorful et al., 2022).

Conversely, attitude is an individual's negative or positive evaluation of a particular behavior (Wang et al., 2022; Arkorful et al., 2022; Ajzen & Madden, 1986). Behavioral intention indicates a person's willingness to participate in a specific behavior presumed as an original determinant of behavior, whereas behavior considers a person's apparent action regarding an anticipated behavioral outcome (Ajzen, 2005). Thus, TPB can be employed to predict an individual's interest and behavior in indulging in E-waste management practices. As rightly put, someone's attitude to like the environment dramatically impacts the interest in engaging in a particular ecological behavior (Wang et al., 2022). Indeed, the TPB stresses that the specific individuals' behaviors are attributes to their intentions, predicted by three variables of subjective norm, attitude, and perceived behavioral control (Ajzen, 2005). Several waste-related studies (Pakpour et al., 2014) used TPB to predict and explain people's behavior in their context. However, other studies looked beyond intentions, an approach adopted in this study. Thus, the study utilized the TPB that focuses on attitude, subjective norm, and perceived behavioral control to predict and explain behavior and consider the influence of E-waste knowledge and risk perception. Thus, these are variable extensions of the TPB on sustainable E-waste management practices to comprehend the behavioral context of the study.

Hypotheses Development

Electronic Waste Knowledge and Sustainable Electronic Waste Management Practices

Knowledge refers to a sustainable competitive advantage that an individual should possess (Ge & Liu, 2022) in the context of E-waste. Otto et al. (2018) opined that knowledge is a situational and conditional aspect that controls environmentally friendly attitudes and behavior. Norazli et al. (2015) revealed that knowledge could increase arousal of interest to some satisfactory degree. Islam et al. (2021) pointed out that E-waste awareness with its harmfulness has a significant influence on recycling practices. Azodo (2019) clarified that, knowledge involving technical recycling and disposal could increase the individuals' motivation to indulge in that activity. Lavuri (2022) and Otto et al. (2018) found environmental knowledge to be an essential factor influencing a person's intention to participate in ecologically friendly behaviors. Likewise, Wang et al. (2022) argue that a person's perceived recycling knowledge and appropriate recycling materials availability also motivate recycling participation. Azodo (2019) revealed that inadequate knowledge associated with E-waste possibly poses a potential danger to the environment and human health, especially during the handling, re-using, or recycling of E-waste (Hossain et al., 2010). Information about reuse is critical. Yamamoto and Murakami (2022) revealed that information about reuse is a vital waste management practice that prolongs the lifespan of an electrical or electronic device. It also contributes to reducing E-waste volume, potential environmental impact per time, and possibly human health hazards. Rasheed et al. (2022) found that most of the public was ignorant about E-waste and recommended a vital necessity for spreading awareness and knowledge campaigns due to the mounting E-waste hazard. Prior studies have concluded that waste knowledge involving collection and separation is critical in explaining the behavior (Wang et al., 2022). Thus, the study hypothesizes that:

H1: Adequate knowledge of E-waste among decision-makers is positively and significantly associated with sustainable E-waste management practices.

Electronic Waste Attitude and Sustainable Electronic Waste Management Practices

Minimizing and controlling the associated adverse bearings on the environment and human health require management through a change in attitude. Attitude affects purchases of EEE. EEE cannot be ignored for as long as they are imported and in use. Lin (2013) revealed that attitudes impact pro-environment behavioral intentions. Liu et al. (2019) showed that consumers who replaced their personal computers or mobile phones did so with new products due to associated innovative features. Saritha et al., (2015) highlighted the boldness exhibited by consumers in India who have reserves for E-waste in stores or unattended to in their houses and ultimately disposed of in landfills. Also, customers ignore buying a new component of computer accessories but instead replace it with another innovative device (Rasheed et al., 2022). Thus, attitude towards a particular behavior shows that individual action assessment is under review from positive to negative. Consequently, attitude towards E-waste disposal/recycling is molded by the opinions that recycling or disposal is good for human health and the environment. A positive attitude towards recycling or disposal stands out amongst aspects shaping the intention to dispose of or recycle. Wang, Guo, & Wang, 2016 found attitude to be among the significant determinants impacting the residents' behavioral intentions towards E-waste disposal and recycling. Further, Thukral, Shree & Singhal (2022) stress that residents' attitudes and behavior towards formal collection and recycling of E-waste play a vital role in sustainable E-waste management practices. Therefore, this research hypothesizes that:

H2: A favorable E-waste attitude among decision-makers is positively associated with sustainable E-waste management practices.

Electronic Waste Intentions and Sustainable Electronic Waste Management Practices

Within the TPB, the behavior determinants are the intentions to participate in that behavior representing a person's motivation. In the context of waste management, (recycling, or E-waste disposal) behavioral intention, as defined by (Yin, Gao & Xu, 2014), is the individuals' willingness and likelihood to recycle or dispose of E-waste in formal recycling and disposal zones in the future. Dhir et al., 2021) highlighted that region, education levels, and average income significantly impacts the customer's or consumer's behavior. Additionally, Thukral, Shree & Singhal (2022), Yin, Gao, and Xu (2014), in agreement, found that recycling costs and income levels were among the significant determinants impacting the residents' behavioral intentions toward E-waste disposal and recycling. The availability of E-waste information and eco-friendly awareness can motivate residents to engage in recycling and disposal activities (Dhir et al., 2021; Nguyen et al., 2021). In another study in Beijing, China, Meng et al. (2022) found that, besides economic benefits and residential conditions, the convenience of recycling amenities and recycling habits were important antecedents of residents' willingness and behavioral intentions toward E-waste disposal and recycling. Therefore, the study hypothesizes:

H3: Good E-waste intentions among decision-makers are positively associated with sustainable E-waste management practices.

Electronic Waste Risk Perception and Sustainable Electronic Waste Management Practices

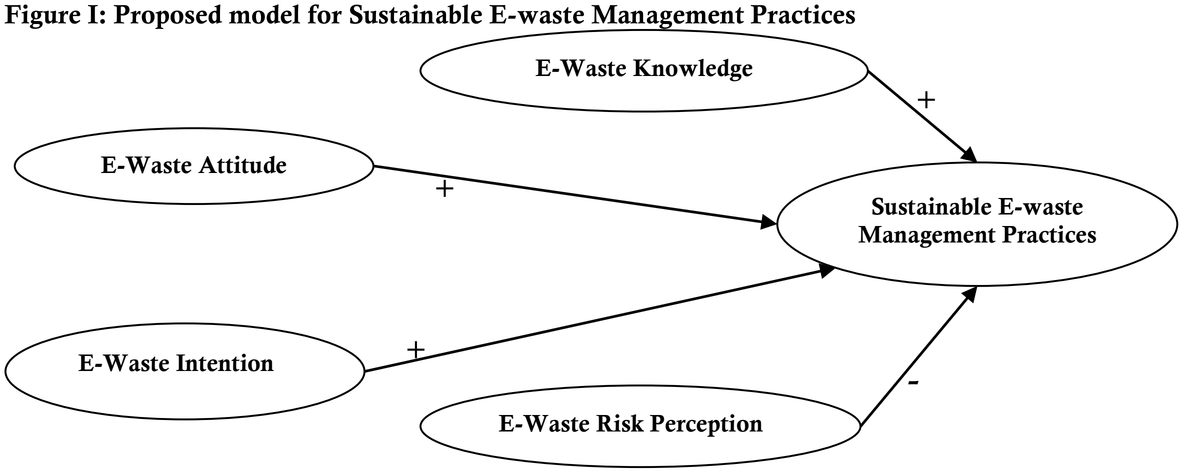
Burt (2001) defines risk as the probability or likelihood of an occurrence due to a particular exposure. Zhu & Yao (2018) assessed risk perception in four components: severity, susceptibility, response efficacy, and self-efficacy in a risk perception chain that influences risk behavior. Risk perception studies seek to enhance the understanding of a group's risk perception to help design risk communications and comprehend what knowledge workers might lack to protect themselves (Irfan et al., 2022). Such studies are particularly applicable in work-related settings where risk perceptions are bound to influence employees' safety behavior and are consequently expected to affect their actual risk (Irfan et al., 2022). Thus, the risk perception within the lay or ordinary population time and again has a slight link to their objective risk (Arezes & Miguel, 2008).

At the workplace, risk misperceptions might result in an individual's improper safety behavior or even potentially needless stress due to occupational risks (Jensen et al., 2021). In the context of E-waste, individuals are concerned about the loss of information and possible theft of EEE when taken to recycling centers (Almulhim, 2022). Ghosh et al. (2022) state that recycling E-waste aims to recover precious metals and safe disposal of harmful elements to avoid environmental and human health-related risks. Talwar et al. (2020) pinpoint that risk perception is a significant barrier to influencing behavior. Similarly, Kaur et al. (2020) found that risk perception is negatively associated with intentions to use mobile payment devices. Hence, the study hypothesizes:

H4: E-waste risk perceptions among decision-makers are positively related to sustainable E-waste management practices.

As indicated in Figure I below, the model adds two other components to the core constructs of the TPB, namely the influence of E-waste knowledge and risk perception, as extensions of the TPB on sustainable E-waste management practices. These will likely play an essential role in recycling behaviors.

Figure I: Proposed model for Sustainable E-waste Management Practices



Methodology

Data collection

The study employed the positivist approach. The positivist philosophy supports the study as a quantitative, scientific study based on deriving the truth (Alharahsheh & Pius, 2020). Data was collected through a cross-sectional survey of 456 government employees who were sampled conveniently from the ten (10) existing cities in Uganda including Kampala, the country's capital city. Government employees were targeted for the study because they are knowledgeable about government operations and the key decision makers on purchasing and usage of EEE in the country. Qu *et al.* (2022) found cross-sectional surveys robust for establishing relationship effects in information systems studies. Based on Krejcie & Morgan (1970), self-accounting entities comprised Ministries, Departments, and Agencies (MDAs), and 84 out of 109 were part of the study sample size. The study conveniently accessed the employees to cater for the standard operating procedures (SOPs) imposed due to the Covid-19 epidemic. 346 (75.9%) usable surveys were returned and considered satisfactory for further analysis.

Measures
A 7-point Likert scale from strongly disagree (1) to strongly agree (7) to collect data was used. To establish the validity of the questionnaire, the items in the instruments were discussed with the environmental experts to check for internal accuracy and relevancy, and based on the discussions; a consensus was reached on the items that were included in the final instrument to ensure that the instrument was valid. However, before data collection, the survey was appraised for linguistic correctness by three professionals. It improved on the new version of the questionnaire. The study constructs and subsequent dimension items were primarily drawn from the TPB model and existing literature to cater for the other extension variables, for example, E-waste knowledge and E-waste perception as displayed with references in Table 2.

Analysis and Results
Respondents Profiles
Table I reveals the respondents profiles. 160 (46.2%) and 186(54%) were female and male, respectively. 102(30%) and 100(29%) of respondents were between 31-40 years and 41-50 years, respectively. Respondents with undergraduate and postgraduate qualifications were 144 (41.6%) and 150 (43.4%), respectively.

Table I: Respondents' profile

Variable	Description	Frequency (Percentage)
Gender	Male	186(54%)
	Female	160(46%)
Age	20 to 30 years	60(17.3%)
	31 to 40 years	102(30%)
	41 to 50 years	100(29%)
	51 to 60 years	54(16%)
	Above 60 years	30(9%)
Level of Education	Diploma	46(13.3%)
	Undergraduate Degree	144(41.6%)
	Postgraduate	150(43.4%)
	Ph.D.	6(1.7%)
Work experience	Below 5 years	186(54%)
	5 – 10 years	80(23%)
	11 – 20 years	51(15%)
	Above 21 years	29(8%)

Hypotheses Tests
The PLS-SEM was employed to test and assess the proposed sustainable E-waste management practices conceptual model. Compared to the covariance-based structural equation modeling, the PLS-SEM is merited for its optimum prediction accuracy (Hair *et al.,* 2020). Besides, it is a suitable data analysis technique because it takes care of normality tests.

The PLS-SEM is also appropriate for explanatory research (Danks *et al.,* 2020). PLS-SEM handles more complex models and is a robust technique against multicollinearity problems (Sarstedt *et al.,* 2020; Ringle *et al.,* 2020).

Construct Reliability

The composite reliability and the convergent validity calculate links amongst the indicators of the same constructs, thus certifying that the questionnaire items that measure the same constructs are highly connected. The internal reliability was weighed through the outcomes of Fornell's measure of CR and CA (Fornell & Larcker, 1981).

In Table II, the CR and CA factor loadings are above the threshold value of 0.7. That is, the factor loadings range from 0.738–0.945 (also shown in Table II), CA range from 0.849–0.924, and CR from 0.898–0.946, respectively, thus proving the appropriateness of all constructs set for data analysis. While the AVE constructs threshold should be above 0.5 (Ringle *et al.,* 2020). In this case, the AVE range between 0.698–0.816, proving that all constructs posted satisfactory convergent validity set for further analysis.

Table II: Adequate Loadings before PLS-SEM Analysis

Measurement items	Loadings	VIF	CA	CR	AVE
E-Waste Attitude			***0.89***	***0.92***	***0.698***
EWAT1: The e-waste stored at home should be dropped off for recycling.	0.834	2.509			
EWAT2: Dropping off my household e-waste for recycling is rewarding.	0.918	3.894			
EWAT3: I have a strong interest in the well-being of my community.	0.894	3.127			
EWAT4: Citizens should be concerned about proper e-waste management.	0.769	1.979			
EWAT5: I have a strong desire for the well-being of my neighbors.	0.749	1.734			
E-waste Intentions			***0.915***	***0.936***	***0.748***
EWI1: I intend to drop-off my e-waste at collection centers to create space in the house.	0.892	3.454			
EWI2: I am willing to participate in environmental programs by the government.	0.873	4.14			
EWI3: I intend to participate in a formal e-waste collection if I am satisfied with the collection measures by the government.	0.919	4.803			
EWI4: I intend to drop-off my e-waste if there are formal collection systems.	0.738	1.688			
EWI5: I am willing to engage in formal e-waste management methods.	0.89	2.897			
E-Waste Knowledge			***0.902***	***0.928***	***0.723***
EK11: I know that e-waste contains toxic & hazardous substances that are harmful to human health & deteriorates the Environment.	0.918	5.858			
EK12: E-waste can be a resource if properly managed.	0.915	6.021			
EK13: I know that e-wastes should be disposed separately from general household wastes.	0.814	2.132			
EK14: I know that proper management of e-waste reduces the use of landfills and emissions of greenhouse gasses.	0.84	2.443			
EK15: I know that recycling preserves natural resources for the benefit of present and future generations.	0.752	1.57			

E-Waste Risk Perception			***0.849***	***0.898***	***0.687***
EWRP1: I fear that upon the transfer of the electronic device for recycling, the collection center may misuse my stored information in the device.	0.815	1.967			
EWRP2: I fear that upon the transfer of electronic devices for recycling, the collection center that stored information could disappear or get lost.	0.79	1.545			
EWRP3: In my opinion, e-waste collection is often too complicated to be helpful.	0.843	2.175			
EWRP4: In my opinion, e-waste disposal is often too complicated to be helpful.	0.867	2.302			
Sustainable E-Waste Management Practices			***0.924***	***0.946***	***0.816***
SEWP1: I intend to resale my electronic devices.	0.926	4.233			
SEWP2: I am willing to influence people around me to dispose of their e-waste at formal facilities.	0.945	5.166			
SEWP3: I intend to recycle e-waste at drop-off points.	0.854	2.565			
SEWP4: I intend to reuse my electronic devices.	0.884	2.873			

Discriminant Validity

Campbell & Fiske (1959) emphasize that the discriminant validity assessment of the measured variables ensures that those around various constructs are unrelated. In other words, the questionnaire items measuring those constructs should not correlate. According to (Fornell & Larcker, 1981), a superior parameter to evaluate discriminant validity takes the AVE square root higher than the correlations amongst those constructs and other factors within the model. Thus, Table III displays all the AVE square root values along the diagonal as more significant than the correlations below the diagonal. Hence, the discriminant validity has been proved for the case below since it is significantly loaded.

Table III: Fornell-Larcker Criterion (Correlation matrix and AVE square root)

Constructs	E-waste Attitude	E-waste Intention	E-waste Knowledge	E-waste Risk Perception	Sustainable E-waste Management Practices
E-waste Attitude	**0.836**				
E-waste Intention	0.506	**0.865**			
E-waste Knowledge	0.105	0.468	**0.850**		
E-waste Risk Perception	0.360	0.525	0.498	**0.829**	
Sustainable E-waste Management Practices	0.643	0.584	0.420	0.453	**0.903**

Note: Diagonal bolded values are AVE square root.

Multicollinearity

When using PLS-SEM, the researchers check for collinearity concerns before conducting the structural model assessment (Ringle *et al.* (2020). Hair *et al.* (2020), in their rule of thumb in evaluating multicollinearity issues, allow for VIF values less than 10. However, Ringle *et al.* (2020) provide a five (5) as the maximum level of VIF. In our study, as shown in Table II above, the three values out of 23 are between 5.8 and 6.0. Therefore, based on the criteria by Hair *et al.* (2020), VIF<10 is also acceptable, an indicator the model is not contaminated with the common bias method.

Structural model

As a way of determining the sustainable E-waste management practice model, the dependent variable (SEWP), and R-squared (R^2) value, are obtained from earlier PLS algorithm calculations, as illustrated in Table IV. Thus, the R^2 value is 0.562, indicating that 56.2% of the variation of sustainable E-waste management practice in the model is explained by exogenous latent variables (Sarstedt *et al.,* 2022). The study used the PLS-SEM bootstrapping technique to test the research hypotheses. This consequently resulted in the output of the t-Statistics of the parameters and standard errors represented in Table IV. For the hypothesis to be supported, the threshold value (t-Statistics) is 1.96 (Sarstedt *et al.,* 2020).

Table IV: Path Coefficient, R-Squared (R^2) Values & t-Statistics for E-waste Behavioural Intentions

			β	T	p	Decision
H1: EWK	⇨	SEWP	0.258	6.679	0.000	Supported
H2: EWA	⇨	SEWP	0.507	7.765	0.000	Supported
H3: EWI	⇨	SEWP	0.183	3.168	0.020	Supported
H4: EWRP	⇨	SEWP	0.046	1.116	0.265	Not Supported
R-Squared (R^2)						56.2%

Note: EW = e-Waste, SEWP = Sustainable E-Waste Practices.

As indicated in Table IV above, the associations between EWK and SEWP (t = 6.679, β = 0.258, P < 0.05), EWA and SEWP (t = 7.765, β = 0.507, P < 0.05), EWI and SEWP (t = 3.168, β = 0.002, P < 0.05), were significant. Thus, hypotheses H1, H2, and H3 were supported. Meanwhile, the relationships between EWRP and SEWP (t = 1.116, β = 0.265, P > 0.05), was not significant, thus H_4 not supported.

Discussion

The PLS-SEM analysis results point out that E-waste attitude, displaying an influence coefficient of 0.507, plays the most significant role in individual government employees' sustainable E-waste management practices. This outcome is consistent with prior research (Guna, Horvat & Podjed, 2022; Kochan et al., 2016). These scholars reported that attitude toward E-waste positively influenced their sustainable E-waste management practices. Moreover, they felt that, taking old electrical and electronic equipment (EEE) to recycling and disposal centers is appropriate for human health and the protection of the environment. Attitude plays a vital role in influencing electronic companies, electronic resellers, and electronic stores' decisions to implement take-back systems for old EEE. Hence, it is apprehensible that the E-waste attitude is among the essential aspects in affecting government employees' behavior. Therefore, working on government employees' attitudes about E-waste should be a high priority, necessitating clear and well-defined employee responsibility for sustainable E-waste management practices (Fadugba et al., 2022). Besides, the boldness and assertiveness of dropping off E-waste for collection and recycling, and the employees' concern for proper E-waste management, are mainly due to the understanding that such actions reduce the impact of environmental problems and protect human life (Dobre-Baron et al., 2022).

Regarding an association between E-waste knowledge and its influence on sustainable E-waste management practices, the study observes that the posted analysis results show a positive effect on workers' sustainable E-waste management practices. The E-waste knowledge path coefficient of 0.258 came in second place behind E-waste attitude, showing that knowledge of E-waste is the second most crucial factor to sustainable E-waste management practices among government employees. This is similar to previous studies (Almulhim, 2022; Kochan et al., 2016). Furthermore, Asif et al. (2022) found environmental knowledge to be an essential factor influencing a person's intention to participate in ecologically friendly behaviors. Likewise, Lansana (1993) argues that a person's perceived recycling knowledge and appropriate recycling materials availability also motivate recycling participation. Besides, Islam et al. (2021) found that waste knowledge involving collection and separation is critical in explaining the behavior. Knowing the impact of E-waste on human health and the environment, the collection sites, recycling, and disposal sites, contribute to sustainable E-waste management practices. Indeed, by knowing the dangerous E-waste impact on public health and the environment when treated inappropriately, workers can promote and grow awareness campaigns toward E-waste collection, recycling, and disposal (Modoi & Mihai, 2022; Wirtu & Tucho, 2022).

Several researchers such as (Alblooshi et al., 2022; Fan et al., 2022) suggest that, E-waste intentions positively influence sustainable E-waste management practices. Our study also found E-waste intentions, with a path coefficient of 0.183, play the least significant role in government employees' sustainable E-waste management practices. Government employees are open to communicating with peers about appropriate modes of old EEE disposals and demonstrated the willingness to drop off their E-waste to formal collection systems. Like in other studies, E-waste intentions contributed significantly to E-waste recycling (Fan et al., 2022; Laeequddin et al., 2022; Alblooshi et al., 2022; Wang et al., 2018; reuse (Bovea et al., 2017; Agrawal et al., 2015), and reduction (Koshta, Patra & Singh, 2022).

The results further revealed that E-waste risk perception does not statistically influence sustainable E-waste management practices. The path coefficient of E-waste risk perception and sustainable E-waste management practices was 0.046. Thus ($t = 1.116$, $\beta = 0.265$, $P > 0.05$), was not supported since the t-Statistics at 1.116 is less than the threshold of 1.96, meaning that the employees are not comfortable transferring their devices for recycling in fear of misuse. And that, the collection and disposal centers are perceived to be complicated and costly. This is consistent with (Wang et al., 2018), who asserted that high E-waste management costs reduced the wish of Chinese residents to recycle E-waste hence hindering the chances of participating in sustainable E-waste management practices (Almulhim, 2022).

Conclusion

In a nutshell, the results show that E-waste attitude, E-waste knowledge, and E-waste intention, in order of importance positively and significantly influence sustainable E-waste management practices. However, results show an insignificant relationship existing between E-waste risk perception and sustainable E-waste management practices. First, in the Theory of Planned Behavior (TPB) context, the study's contribution to the theory is that E-waste attitude is the most crucial predictor of sustainability of E-waste management practices, followed by E-waste knowledge. Secondly, by applying the PLS-SEM approach, the study adds E-waste risk perception and E-waste knowledge as an extension of the Theory of Planned Behavior.

A complete grasp of government employees' sustainable E-waste management practices to support appropriate E-waste management initiatives is necessary to contribute to the study. Based on positions held, these employees can influence government policy by effectively implementing E-waste recycling, reuse, and reduction management systems. In other words, attitudes impact pro-environment employees' behavioral intentions toward E-waste disposal and recycling. To the extent that workers' attitudes and behavior towards formal collection and recycling of E-waste play a vital role in sustainable E-waste management practices. The same also applies to E-waste intentions that contributed significantly to E-waste recycling, where there is the employees' willingness and likelihood to recycle or dispose of, E-waste in formal recycling and disposal zones in the future. Recycling costs and income levels were among the significant determinants impacting the residents' behavioral intentions towards E-waste disposal and recycling. The study is particularly applicable in work-related settings where risk perceptions are bound to influence employees' safety behavior and are consequently expected to affect their actual risk. For instance, employees are concerned about the loss of information and possible theft of EEE when taken to recycling centers.

The current study recommends that government spearhead educational campaigns to step up the citizens' E-waste attitude and shape their beliefs and E-waste knowledge towards sustainable E-waste management practices. This effort can start with a clear E-waste public service code of conduct that promotes and fosters sustainable practices such as E-waste reuse, recycling, and reduction habits. The government also needs to prioritize establishing regional E-waste collection and recycling infrastructure but should not relax on E-waste risk perception-related concerns. Relying on government employees and quantitative analysis for the study was a limitation to the study. Future studies could be done in private organizations while employ a qualitative data analysis approach.

References

Afroz, R., Masud, M. M., Akhtar, R., & Duasa, J. B. (2012). Public environmental awareness and performance in Kuala Lumpur city, Malaysia: A case study on household electrical and electronic equipment. *Environment and Urbanization Asia*, *3*(2), 385-396.

Abubakar, A., Zangina, A. S., Maigari, A. I., Badamasi, M. M., Ishak, M. Y., Abdullahi, A. S., & Haruna, J. A. (2022). Pollution of heavy metal threat posed by e-waste burning and its assessment of human health risk. *Environmental Science and Pollution Research, 28*(1), 133-153.

Agrawal, S., Singh, R. K., & Murtaza, Q. (2015). A literature review and perspectives in reverse logistics. *Resources, Conservation and Recycling*, *97*(3), 76-92.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of experimental social psychology*, *22*(5), 453-474.

Ajzen, I. (2005). Laws of human behavior: Symmetry, compatibility, and attitude-behavior correspondence. *Multivariate research strategies*, *40*(3), 3-19.

Akhtar, R., Masud, M. M., & Afroz, R. (2014). Household perception and recycling behaviour on electronic waste management: A case study of Kuala-Lumpur, Malaysia. *Malaysian Journal of Science*, *33*(1), 32-41.

Alblooshi, B. G. K. M., Ahmad, S. Z., Hussain, M., & Singh, S. K. (2022). Sustainable management of electronic waste: Empirical evidences from a stakeholders' perspective. *Business Strategy and the Environment, 31*(3),40-59.

Alharahsheh, H. H., & Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2*(3), 39-43.

Almulhim, A. I. (2022). Household's awareness and participation in sustainable electronic waste management practices in Saudi Arabia. *Ain Shams Engineering Journal*, *13*(4), 101-117.

Andeobu, L., Wibowo, S., & Grandhi, S. (2021). An assessment of E-waste generation and environmental management of selected countries in Africa, Europe and North America: A systematic review. *Science of The Total Environment*, *792*(10), 148-167.

Arezes, P. M., & Miguel, A. S. (2008). Risk perception and safety behaviour: A study in an occupational environment. *Safety science, 46*(6), 900-907.

Arkorful, V. E., Hammond, A., Lugu, B. K., Basiru, I., Sunguh, K. K., & Charmaine-Kwade, P. (2022). Investigating the intention to use technology among medical students: An application of an extended model of the theory of planned behavior. *Journal of Public Affairs*, *22*(2), 2460- 2476.

Asif, M. H., Zhongfu, T., Irfan, M., & Işık, C. (2022). Do environmental knowledge and green trust matter for purchase intention of eco-friendly home appliances? An application of extended theory of planned behavior. *Environmental Science and Pollution Research*, *8*(3) 1-13.

Azodo, C. (2019). *Nothing wasted: A risk and investment analysis of waste-to-energy for the industrial and commercial clusters of Anambra State* (Unpublished Doctoral Dissertation, University of Ibadan).

Batoo, K. M., Pandiaraj, S., Muthuramamoorthy, M., Raslan, E. H., & Krishnamoorthy, S. (2022). Behavior-based swarm model using fuzzy controller for route planning and E-waste collection. *Environmental Science and Pollution Research*, *29*(14), 19940-19954.

Bhutta, M. K. S., Omar, A., & Yang, X. (2011). Electronic waste: a growing concern in today's environment. *Economics Research International*, *2011*(1),1-9

Borthakur, A., & Govind, M. (2017). Emerging trends in consumers' E-waste disposal behaviour and awareness: A worldwide overview with special focus on India. *Resources, Conservation and Recycling*, *117*(4), 102-113.

Bovea, M. D., Pérez-Belis, V., & Quemades-Beltrán, P. (2017). Attitude of the stakeholders involved in the repair and second-hand sale of small household electrical and

electronic equipment: Case study in Spain. *Journal of environmental management*, *196*(4), 91-99.
Burt, B. A. (2001). Definitions of risk. *Journal of dental education*, *65*(10), 1007-1008.
Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait multimethod matrix. *Psychological bulletin*, *56*(2), 81-105.
Chakraborty, S. C., Qamruzzaman, M., Zaman, M. W. U., Alam, M. M., Hossain, M. D., Pramanik, B. K., & Moni, M. A. (2022). Metals in e-waste: Occurrence, fate, impacts and remediation technologies. *Process Safety and Environmental Protection*, *162*(3), 230-252.
Danks, N. P., Sharma, P. N., & Sarstedt, M. (2020). Model selection uncertainty and multi-model inference in partial least squares structural equation modeling (PLS-SEM). *Journal of Business Research*, *113*(C), 13-24.
Dhir, A., Koshta, N., Goyal, R. K., Sakashita, M., & Almotairi, M. (2021). Behavioral reasoning theory (BRT) perspectives on E-waste recycling and management. *Journal of Cleaner Production*, *280*(12), 124-146.
Dhir, A., Malodia, S., Awan, U., Sakashita, M., & Kaur, P. (2021). Extended valence theory perspective on consumers'e-waste recycling intentions in Japan. *Journal of Cleaner Production*, *312*(8), 127-143.
Dobre-Baron, O., Nițescu, A., Niță, D., & Mitran, C. (2022). Romania's Perspectives on the Transition to the Circular Economy in an EU Context. *Sustainability*, *14*(9), 24-53.
Echegaray, F., & Hansstein, F. V. (2017). Assessing the intention-behavior gap in electronic waste recycling: the case of Brazil. *Journal of Cleaner Production*, *142*(4), 180-190.
Fadugba, O. G., Yusoff, M. S., Arogundade, S., Adam, N. H., Wang, L. K., & Wang, M. H. S. (2022). Sustainable Solid Waste Management. *Solid Waste Engineering and Management*, *2*(1), 1-12.
Fan, M., Khalique, A., Qalati, S. A., Gillal, F. G., & Gillal, R. G. (2022). Antecedents of sustainable e-waste disposal behavior: the moderating role of gender. *Environmental Science and Pollution Research*, *29*(14), 20878-20891.
Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, *18*(1), 39-50.
Ge, S., & Liu, X. (2022). The role of knowledge creation, absorption and acquisition in determining national competitive advantage. *Technovation*, *112*(10), 102-119.
Ghosh, B. K., Mekhilef, S., Ahmad, S., & Ghosh, S. K. (2022). A Review on Global Emissions by E-Products Based Waste: Technical Management for Reduced Effects and Achieving Sustainable Development Goals. *Sustainability*, *14*(7), 40-56.
Guna, J., Horvat, K. P., & Podjed, D. (2022). People-Centred Development of a Smart Waste Bin. *Sensors*, *22*(3), 128-138.
Hair Jr, J. F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS SEM using confirmatory composite analysis. *Journal of Business Research*, *109*(4), 101-110.
Hossain, M. S., Al-Hamadani, S. M., & Rahman, M. T. (2015). E-waste: a challenge for sustainable development. *Journal of Health and Pollution*, *5*(9), 3-11.

Irfan, M., Shahid, A. L., Ahmad, M., Iqbal, W., Elavarasan, R. M., Ren, S., & Hussain, A. (2022). Assessment of public intention to get vaccination against COVID-19: Evidence from a developing country. *Journal of Evaluation in Clinical Practice*, *28*(1), 63-73.

Islam, M. T., Huda, N., Baumber, A., Shumon, R., Zaman, A., Ali, F., & Sahajwalla, V. (2021). A global review of consumer behavior towards e-waste and implications for the circular economy. *Journal of Cleaner Production*, *316*(12), 128-147.

Jangre, J., Prasad, K., & Patel, D. (2022). Analysis of barriers in e-waste management in developing economy: An integrated multiple-criteria decision-making approach. *Environmental Science and Pollution Research*, *29*(48), 72294-72308.

Jayaraman, K., Vejayon, S., Raman, S., & Mostafiz, I. (2019). The proposed e-waste management model from the conviction of individual laptop disposal practices-An empirical study in Malaysia. *Journal of Cleaner Production*, *208*(5), 688-696.

Jensen, M., Combariza Bayona, D. A., & Sripada, K. (2021). Mercury Exposure among E-Waste Recycling Workers in Colombia: Perceptions of Safety, Risk, and Access to Health Information. *International Journal of Environmental Research and Public Health*, *18*(17), 9295.

Kaur, P., Dhir, A., Singh, N., Sahu, G., & Almotairi, M. (2020). An innovation resistance theory perspective on mobile payment solutions. *Journal of Retailing and Consumer Services*, *55*(3), 102-11

Kochan, C. G., Pourreza, S., Tran, H., & Prybutok, V. R. (2016). Determinants and logistics of e-waste recycling. *The International Journal of Logistics Management*, *27*(1), 52-70

Koshta, N., Patra, S., & Singh, S. P. (2022). Sharing economic responsibility: Assessing end user's willingness to support E-waste reverse logistics for circular economy. *Journal of Cleaner Production*, *332*(10), 130- 147.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Laeequddin, M., Kareem Abdul, W., Sahay, V., & Tiwari, A. K. (2022). Factors That Influence the Safe Disposal Behavior of E-Waste by Electronics Consumers. *Sustainability*, *14*(9), 4981.

Lavuri, R. (2022). Extending the theory of planned behavior: factors fostering millennials' intention to purchase eco-sustainable products in an emerging market. *Journal of Environmental Planning and Management*, *65*(8), 1507-1529.

Lin, S. P. (2013). The gap between global issues and personal behaviors: pro-environmental behaviors of citizens toward climate change in Kaohsiung, Taiwan. *Mitigation and Adaptation Strategies for Global Change*, *18*(6), 773-783.

Liu, J., Bai, H., Zhang, Q., Jing, Q., & Xu, H. (2019). Why are obsolete mobile phones difficult to recycle in China? *Resources, Conservation and Recycling*, *141*(5), 200-210.

Meng, Q., Liu, H., Zhang, H., Xu, S., Lichtfouse, E., & Yun, Y. (2022). Anaerobic digestion and recycling of kitchen waste: a review. *Environmental Chemistry Letters, 20*(3), 1-18.

Mokarat, M., Ruangsakunporn, A., Chaianunporn, T., Lomthaisong, K., Robson, M. G., & Keithmaleesatti, S. (2022). Heavy metal contamination and bioaccumulation in Khorat snail-eating turtles (Malayemys khoratensis) from an e-waste recycling activity site in Thailand. *Human and Ecological Risk Assessment: An International Journal*, *28*(1), 133-153.

Modoi, O. C., & Mihai, F. C. (2022). E-Waste and End-of-Life Vehicles Management and Circular Economy Initiatives in Romania. *Energies*, *15*(3), 11-20.

Murthy, V., & Ramakrishna, S. (2022). A review on global E-waste management: urban mining towards a sustainable future and circular economy. *Sustainability*, *14*(2), 647.

Ngethe, D. (2021). Influence Of Electronic Waste Management Systems in Kenya. A Critical Literature Review. *Journal of Environment*, *1*(1), 45-60.

Nguyen, H. T. T., Lee, C. H., & Hung, R. J. (2021). Willingness of end users to pay for e-waste recycling. *Global Journal of Environmental Science and Management*, *7*(1), 47-58.

Norazli, O., Roslina, M., Noor Ezlin, A. B., & Muhd Noor, M. Y. (2015). Developing an integrated electronic waste management approach in Malaysia. *Journal of Advanced Research in Business and Management Studies, 1*(1), 5–13.

Nugroho, A. P., Hidayat, A., & Kusuma, H. (2017). The influence of religiosity and self-efficacy on the saving behavior of the Islamic banks. *Banks and Bank Systems (open-access)*, *12*(3), 35-47.

Okoye, A., & Odoh, C. (2014). Assessment of the level of awareness of E-Waste management and concern for the environment amongst the populace in Onitsha, Southeastern Nigeria. *Journal of Environmental Protection, 1*(2), 120–134.

Omondi, E. A., Ndiba, P. K., & Koech, G. C. (2022). Complexity of E-Waste and its Management Challenges in Developing Countries–A Review. *Management*, *22*(8),1-30.

O'Neill, K. (2019). *Waste*. John Wiley & Sons.

Otto, H. E., & Mandorli, F. (2018). A framework for negative knowledge to support hybrid geometric modeling education for product engineering. *Journal of Computational Design and Engineering*, *5*(1), 80-93.

Panda, B., Panda, G. K., & Pradhan, A. (2022). E-Waste Management. In *IoT-Based Smart Waste Management for Environmental Sustainability* (pp. 1-18). CRC Press.

Pakpour, A. H., Zeidi, I. M., Emamjomeh, M. M., Asefzadeh, S., & Pearson, H. (2014). Household waste behaviours among a community sample in Iran: An application of the theory of planned behaviour. *Waste management*, *34*(6), 980-986.

Qu, Y., Lv, Y., Ji, S., Ding, L., Zhao, F., Zhu, Y., & Shi, X. (2022). Effect of exposures to mixtures of lead and various metals on hypertension, pre-hypertension, and blood pressure: A cross-sectional study from the China National Human Biomonitoring. *Environmental Pollution*, *299*(11), 64-88.

Ramzan, S., Liu, C., Munir, H., & Xu, Y. (2019). Assessing young consumers' awareness and participation in sustainable e-waste management practices: a survey study in Northwest China. *Environmental Science and Pollution Research*, *26*(19), 20003-20013.

Rasheed, R., Rizwan, A., Javed, H., Sharif, F., Yasar, A., Tabinda, A. B., & Su, Y. (2022). Analysis of environmental sustainability of e-waste in developing countries, a case study from Pakistan. *Environmental Science and Pollution Research*, *29*(24), 36721-36739.

Rautela, R., Arya, S., Vishwakarma, S., Lee, J., Kim, K. H., & Kumar, S. (2021). E-waste management and its effects on the environment and human health. *Science of The Total Environment*, *773*(14), 145-163.

Ringle, C. M., Sarstedt, M., Mitchell, R., & Gudergan, S. P. (2020). Partial least squares structural equation modeling in HRM research. *The International Journal of Human Resource Management*, *31*(12), 1617-1643.

Samarakoon, S., Munro, P., Zalengera, C., & Kearnes, M. (2022). The afterlives of off-grid solar: The dynamics of repair and e-waste in Malawi. *Environmental Innovation and Societal Transitions*, *42*(3), 317-330.

Sarstedt, M., Hair, J. F., Pick, M., Liengaard, B. D., Radomir, L., & Ringle, C. M. (2022). Progress in partial least squares structural equation modeling use in marketing research in the last decade. *Psychology & Marketing*, *39*(5), 1035-1064.

Sarstedt, M., Hair Jr, J. F., Nitzl, C., Ringle, C. M., & Howard, M. C. (2020). Beyond a tandem analysis of SEM and PROCESS: Use of PLS-SEM for mediation analyses! *International Journal of Market Research*, *62*(3), 288-299.

Skinner, C. (2018). *Digital human: The fourth revolution of humanity includes everyone*. John Wiley & Sons.

Soomro, Y. A., Hameed, I., Bhutto, M. Y., Waris, I., Baeshen, Y., & Al Batati, B. (2022). What Influences Consumers to Recycle Solid Waste? An Application of the Extended Theory of Planned Behavior in the Kingdom of Saudi Arabia. *Sustainability*, *14*(2), 99-118.

Talwar, S., Dhir, A., Kaur, P., & Mäntymäki, M. (2020). Barriers toward purchasing from online travel agencies. *International Journal of Hospitality Management*, *89*(10), 1-11.

Tian, T., Liu, G., Yasemi, H., & Liu, Y. (2022). Managing e-waste from a closed-loop lifecycle perspective: China's challenges and fund policy redesign. *Environmental Science and Pollution Research 29*(1), 1-12.

Tiep, H. S., Kin, T. D. Y., Ahmed, E. M., & Teck, L. C. (2015). E-waste management practices of households in Melaka. *International Journal of Environmental Science and Development*, *6*(11), 81-97.

Thukral, S., Shree, D., & Singhal, S. (2022). Consumer behaviour towards storage, disposal and recycling of e-waste: systematic review and future research prospects. *Benchmarking: An International Journal*, Advanced Online Publication.

Wang, L., Fu, C. F., Wong, P. P., & Zhang, Q. (2022). The impact of tourists' perceptions of space-launch tourism: An extension of the theory of planned behavior approach. *Journal of China Tourism Research*, *18*(3), 549-568.

Wang, Z., Guo, D., Wang, X., Zhang, B., & Wang, B. (2018). How does information publicity influence residents' behaviour intentions around e-waste recycling? *Resources, Conservation and Recycling*, *133*(6) 1-9.

Wang, Z., Zhang, B., Yin, J., & Zhang, X. (2011). Willingness and behavior towards e-waste recycling for residents in Beijing city, China. *Journal of Cleaner Production*, *19*(9), 977-984.

Wirtu, Y. D., & Tucho, G. T. (2022). E-waste: Growing environmental and health problems and its management alternatives in developing countries. *Environmental Reviews, 11*(1), 11-29.

Xu, Y., Yeh, C. H., Yang, S., & Gupta, B. (2020). Risk-based performance evaluation of improvement strategies for sustainable e-waste management. *Resources, Conservation and Recycling*, *155*(10), 46-64.

Yamamoto, H., & Murakami, S. (2022). Which consumer psychological factors influence the lifetime of consumer electronic products? A case study of personal computers in Japan. *Waste Management*, *144*, 233-245.

Zaheer, A. (2020). Sustainability And resilience in megacities through energy diversification, land fragmentation and fiscal mechanisms. *Sustainable Cities and Society*, *53*(10),18-41.

Zhu, W., & Yao, N. (2018). Public risk perception and intention to take actions on city smog in China. *Human and Ecological Risk Assessment: An International Journal, 41*(3),1531-1546.