Modeling the Young Adults E Waste Recycling Intentions an Extended Theory of Planned Behavior

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ARTICLE INFO	ABSTRACT
	Every year Pakistan generates around 390 thousand metric tonnes of e-waste. This e-waste growth is estimated to increase by 5 percent yearly. A huge challenge is to manage the e-waste in a sustainable and environment friendly way. In this context, e-waste recycling is considered as a win-win strategy for environment protection in developing countries. In order to promote and facilitate recycling, it is very essential to understand the socio-psychological factors affecting consumers' intention towards e-waste recycling. For this purpose, extended Theory of Planned Behavior (TPB) framework used to analyze socio-physiological factors impact on the young adult's intentions on adopting e-waste recycling. The cross-sectional data collected from 407 young adults from Faisalabad and employed a structural equation modeling to explore study objectives. The study findings show that subjective norms, perceived behavioral control, sense of duty, awareness of consequence, recycling habits positively influenced the young consumers' e-waste recycling behavior. Moreover, structural model results revealed that subjective norms had highest impact on the young consumers' e-waste recycling intentions. Therefore, these findings can be used by policy makers to devise some incentive policies and programs to motivate young adults to participate in e-waste recycling. Effective approaches should be developed to foster young adults' positive recycling habits, environmental benefits awareness and social norms realization, in order to increase their enthusiasm for participating in e-waste recycling activities. This study presented evidence about the effectiveness of extended Theory of Planned Behavior when appraising the young consumers' recycling intentions towards e-waste. From a practice point of view, this study conclusion surfaced a vital scientific basis for developing countries to encourage young adults to recycle e-waste for environmental protection.

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INTRODUCTION

Electronic waste, also referred to as Waste Electrical and Electronic Equipment (WEEE), is defined as electrical or electronic equipment that has reached the end of its life and is no longer required or wanted. This equipment includes a variety of items such as computers, mobile phones, televisions, and appliances, which contain both valuable and harmful materials that can be detrimental to the environment and human health if not disposed of properly (Seif et al. 2023; Quinto 2025). E-waste has emerged as one of the fastest-growing waste types worldwide, due to the rapid pace of technological innovation, increased consumption of electronic goods, reduced lifespans of electronic devices, and a lack of recycling facilities (Quinto 2025; WHO 2024). As per the Global E-waste Monitor 2024, the total generation of e-waste worldwide was estimated to be 62 million tonnes in 2022, and is expected to rise to 82 million tonnes by 2030, which indicates a substantial increase in the volume and toxicity of disposed electronic devices (Global E-waste Monitor 2024; WHO 2024). E-waste can be broadly categorized into information and communication technology (ICT) devices, large and small household appliances, consumer electronics, and other electrical accessories, with household appliances and ICT devices accounting for a substantial share of total e-waste generation worldwide (Seif et al. 2023; Quinto 2025).

E-waste is characterized by the presence of both valuable and toxic components. While it comprises valuable metals like copper, gold, and silver that can be recycled and reused, it also comprises toxic materials like lead, mercury, arsenic, cadmium, and brominated flame retardants, which are dangerous to the environment and human health (Forti et al., 2020; Parajuly et al., 2019). The improper disposal and recycling of e-waste can lead to the leakage of these toxic materials into the atmosphere, soil, and water, causing environmental pollution and health hazards like neurological disorders, respiratory ailments, and other health problems (Madkhali et al., 2023; Shittu et al., 2021). The increased consumption of electronics, reduced product lifetimes, poor recycling facilities, and the illegal transportation of e-waste across international boundaries have contributed to increased environmental exposure to

toxic substances, especially in developing countries (Borthakur & Govind, 2017; Dey et al., 2022). Developed countries tend to send their e-waste to developing countries because of the strict environmental laws and increased labor costs, where the e-waste is recycled in an unorganized manner without adequate safety precautions, posing serious environmental and occupational health risks to the workers and communities around them (Awasthi et al., 2019; Arya & Kumar, 2020). These issues are also interlinked with other environmental and sustainable urban issues, such as energy use patterns, landfill management, and domestic waste management in Pakistan (Zafar et al., 2025; Ghafoor et al., 2024; Nazeer et al., 2024).

Recent studies indicate that the informal recycling of e waste results in the release of a broad spectrum of toxic pollutants into the environment, such as heavy metals, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs), affecting the air, soil, and water in the vicinity of e waste recycling sites (Kumar et al., 2024; Huang et al., 2023). Research studies conducted in the main e waste recycling centers have indicated high levels of persistent organic pollutants (POPs) and heavy metals, which are of great concern to the environment and human health, especially among the most susceptible groups of people, including children and pregnant women (Huang et al., 2023; Abogunrin-Olafisoye & Adeyi, 2024). Informal recycling activities also make a significant contribution to airborne deposition of toxic metals such as lead, copper, manganese, and zinc, which have been linked to respiratory problems, neurological damage, and other harmful health impacts (Kazim et al., 2024). The results of these studies highlight the need for better e-waste management, recycling practices, and regulatory policies to safeguard the integrity of the environment and the health of communities affected by the informal processing of e-waste.

Recent studies indicate that electronic waste has emerged as one of the fastest-growing waste types globally, owing to rising consumption of electronic goods, technological advancements, and reduced lifespans of electronic products. As indicated in the Global E waste Monitor reports, the total global generation of electronic waste in 2019 was estimated to be 53.6 million metric tons, which increased to 62 million tons in 2022, and is projected to reach approximately 82 million tons by 2030 if the current trend continues. These trends highlight the pressing need for enhanced e-waste policy structures and recycling facilities to counter the environmental and health concerns posed by the growing waste stream (Forti et al., 2020; Liu et al., 2023; Jain et al., 2023). Recent global estimates show that the amount of electronic waste has increased significantly in terms of total amounts and per capita production. Based on global estimates of e waste, the total amount of e waste produced globally was estimated to be 53.6 million metric tons in 2019, with an average of 7.3 kg per capita, and this trend continued to increase in the coming years as the use of electronics continued to rise (Hariyani et al., 2025). Countries with high population and increasing use of electronics, such as Asia, showed the highest total amounts of e waste produced, estimated at 24.9 megatonnes in 2019, which was significantly higher than other continents. Although countries in developed continents like Europe and Oceania have shown higher per capita production, Asia leads in total amounts due to the high population and adoption rates of technology.

In the Asian context, for example, China, India, and other growing economies in the region make a substantial contribution to the overall e waste, while the recycling activities in these countries are often carried out without proper safety precautions (Ogunyemi et al., 2025). At the same time, the global transportation of e waste is a challenge that persists in the global community, as the disposal of toxic waste from developed countries continues to move into developing countries, which have limited capacities to enforce the rules, despite the existence of conventions such as the Basel Convention that regulate the global transportation of e waste (Basel Convention overview; challenges in implementation). Pakistan is one of the countries that have been largely impacted by this global phenomenon. Being one of the top importers of e-waste, the country is witnessing an increase in both the domestic production of e-waste and imports of used electronic items (Abid et al., 2019). Cities like Karachi, Lahore, Rawalpindi, Faisalabad, and Islamabad have also emerged as major hubs for the recycling of e-waste in an unorganized manner. Unorganized recycling techniques like disassembling by hand, burning, acid baths, and blow torches are very common without any safety precautions (Umair et al., 2015; Sajid et al., 2019).

Domestic generation of e-waste in Pakistan is also on the rise because of rising levels of income, urbanization, and technology use. The number of mobile phone users has already crossed 137 million in 2014, and sales of computers and electronic appliances have been steadily increasing (Iqbal et al., 2015). Estimates show that the generation of e-waste in Pakistan in 2014 was around 316 kilotons, and it is expected to rise with the expansion of the GDP (Breivik et al., 2014; Iqbal et al., 2015; Shahabuddin et al., 2023). Moreover, the import of second-hand or obsolete electronic appliances is also a major source of e-waste (Iqbal et al., 2015).

In light of the growing magnitude of e-waste and the hazards it poses to the environment and human health, there has been a rising need to understand public perceptions and behavioral intentions concerning recycling. In past research, economic and psychological theories have been employed to interpret recycling behavior (Wang et al., 2011; Song and Li, 2015; Yin et al., 2021). Of these, the Theory of Planned Behavior (TPB) (Ajzen, 1991) has been employed extensively to interpret pro-environmental intentions and behaviors (Jiang et al., 2019; Faisal et al., 2020).

TPB argues that attitudes, subjective norms, and perceived behavioral control are strong predictors of behavioral intentions. The theoretical construct offers a comprehensive and sound platform for exploring e-waste recycling behavior, especially in settings where the infrastructure is still in its nascent stages.

Given the increasing problem of e-waste in Pakistan and the absence of a proper recycling system, it is imperative to investigate the behavioral determinants that shape recycling intentions. By doing so, it is possible to gain important insights for policy-making, encourage responsible waste management practices, and ultimately contribute to the improvement of environmental and health outcomes. Hence, the objective of this research is to explore consumer-level cognition and awareness about e-waste recycling practices in the study area, identify the factors shaping the respondents' intentions to recycle e-waste, and make informed recommendations to facilitate policy-making and enhance the development of effective and sustainable e-waste recycling systems in Pakistan.

METHODOLOGY

Methodology is the techniques used to estimate the empirical findings based on the data collected. This study uses a quantitative research approach to analyze the determinants of the young adults' intention to recycle e-waste in Pakistan. The research aims to model the young adults' intention to recycle e-waste in Pakistan. Thus, the universe of the study includes the young adult consumers living in Pakistan. The young adults are considered a relevant and significant population to analyze the behavioral intention to recycle e-waste, as the usage of electronic devices among the youth is increasing and has the potential to contribute to sustainable consumption practices.

Data Collection, Sampling, and Analysis

The primary data was collected using a structured self-administered questionnaire prepared based on the relevant literature and the Theory of Planned Behavior. The questionnaire, which was prepared in English, consisted of two sections: demographic variables and important constructs regarding e-waste recycling intentions, such as attitude, subjective norms, perceived behavioral control, recycling habits, awareness of consequences, sense of duty, and intention to recycle. A total of 407 questionnaires were distributed to the respondents. Before the main survey, a pre-test was carried out among 35 respondents for a period of seven days to check for clarity and consistency, and necessary modifications were done to improve the validity and reliability of the instrument. After the data collection process, the responses were analyzed using SPSS and AMOS software. The reliability of the instrument was determined by Cronbach's Alpha to check the internal consistency, and Structural Equation Modeling (SEM) was used to test the proposed relationships and determine the direct and indirect effects of behavioral determinants on the intention to recycle e-waste.

Conceptual framework

A conceptual framework is a tool that illustrates the main variables of a research study and the relationships among them. It describes how the independent variables affect the dependent variable according to theory and logic. It assists the researcher in organizing his/her thoughts and in analyzing and interpreting the findings. It is normally depicted through a diagram or a model.
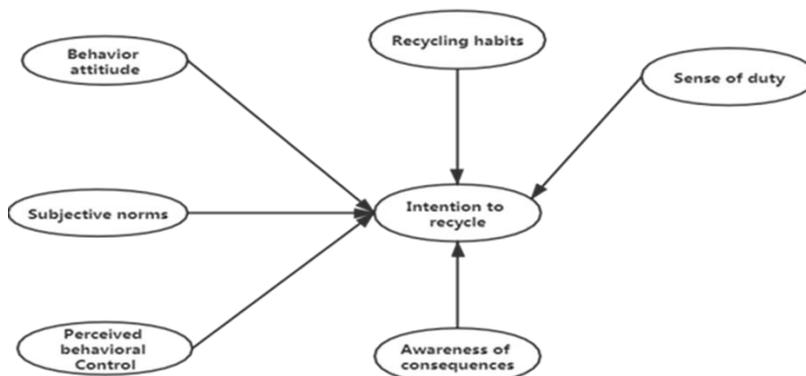

Figure 1: Conceptual Framework of Intention to Recycle

Figure 1 shows the conceptual framework that outlines the determinants of the intention of individuals to recycle e-waste. The conceptual framework argues that the intention to recycle is determined by cognitive, social, moral, and experiential components by incorporating the major components of the various behavioral theories, such as the Theory of Planned Behavior (TPB) and the norm activation theory. The dependent variable in the conceptual framework is the intention to recycle, which is the willingness or readiness of an individual to undertake the recycling behavior.

The model proposes six key constructs that are hypothesized to directly affect the recycling intention. Behavioral attitude is the individual's positive or negative judgment of recycling, such that when recycling is viewed as positive and responsible, the recycling intention is enhanced. Subjective norms refer to the perceived social pressure from

family, friends, workmates, or society, such that the greater the perceived norms, the more likely the recycling behavior will occur. Perceived behavioral control is the ease or difficulty of recycling, including ease of access to facilities, knowledge, and time, and greater perceived control increases confidence and intention. Awareness of consequences is the understanding of the effects of waste and recycling, and greater awareness reinforces the intention to recycle. Sense of duty is the moral obligation or personal responsibility to protect the environment, and greater recycling intentions are increased when people feel a sense of duty. Finally, recycling habits are prior behaviors, and established habits increase the intention to recycle by making recycling an automatic behavior.

In general, the framework proposed that recycling intention is influenced by a set of attitudinal, social, control, cognitive, moral, and behavioral factors. The direction of the arrows in the figure above illustrates the proposed direct effects of each construct on recycling intention. The proposed conceptual framework can be tested using Structural Equation Modeling (SEM) to assess the strength and significance of the proposed relationships, offering valuable information on the behavioral determinants of e-waste recycling.

RESULTS AND DISCUSSION

Analysis is the most important component of the study, which gives a detailed analysis of the variables used in the study. This section highlights the findings of the research to analyze the young adult's intention to recycle e-waste using an extended theory of planned behavior. There is an attempt to discuss, analyze, and interpret the relevant data to arrive at the relevant conclusions and make appropriate suggestions based on the findings of the study.

Descriptive Statistics

The socioeconomic attributes of the respondents were analyzed and presented using descriptive statistics in terms of frequency and percentage. The attributes include basic demographic data such as age, gender, educational attainment, family size, and monthly living expenses, which give a complete description of the consumer profile.

Table 1: Demographic and Household Characteristics of Respondents

Characteristics	Description	Frequency	Percentage (%)
Gender	Male	180	44.2
	Female	227	55.8
Age	Up to 20 years	89	21.8
	21-23	154	37.8
	24- 26	121	29.7
	27and above	43	10.6
Education Level	Undergraduate	184	45.2
	Postgraduate	223	54.8
Family Size	1-3 persons	68	16.7
	4-5 persons	135	33.1
	6-10 persons	189	46.4
	More than 10 persons	15	3.7
Monthly living expenses (Pkr)	1-5000	57	13.51
	5001- up to 10000	201	49.40
	10001-upto 15000	110	27.02
	More than 15000	39	9.60
Leftover Devices	No device	125	30.7
	1-2 devices	195	47.9
	3-4 devices	65	15.9
	More than 4 devices	22	5.4

The demographic and household characteristics of the respondents are presented in Table 1. The sample contained a slight majority of female respondents (55.8%) than male respondents (44.2%). The majority of the respondents

belonged to the age group 21-23 years (37.8%), followed by those belonging to the age group 24-26 years (29.7%), up to 20 years (21.8%), and 27 years and above (10.6%). With regard to education, the largest proportion was composed of postgraduate students (54.8%), followed by undergraduates (45.2%). The size of the family was mainly 6-10 members (46.4%), followed by 4-5 members (33.1%), 1-3 members (16.7%), and more than 10 members (3.7%). In relation to monthly living expenses, nearly half of the respondents (49.4%) had expenses between PKR 5,001 and 10,000, followed by 27.0% in the range of 10,001-15,000 PKR, 13.5% with expenses up to PKR 5,000, and 9.6% with expenses exceeding 15,000 PKR. In relation to the number of leftover electronic devices, the largest proportion of respondents had 1-2 devices (47.9%), followed by 30.7% who had no devices, 15.9% with 3-4 devices, and only 5.4% with more than four devices.

Item Measurement in the Extended TBP Model

The item responses were measured using a five-point Likert scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree. Table 2 shows the code, description (item statement), mean, and standard deviation of each item used in the questionnaire. The constructs used in the study were Behavioral Attitude (5 items), Subjective Norms (4 items), Perceived Behavioral Control (3 items), Recycling Habits (3 items), Awareness of Consequences (5 items), Sense of Duty (5 items), and Intention to Recycle (4 items), which were used to measure the respondents' intentions of e-waste recycling.

The findings show that the Behavioral Attitude had a strong positive impact on the intention to recycle e-waste among young people. For instance, the item "E-waste recycling is good" had the highest mean score among the items in the Behavioral Attitude dimension, which shows strong positive adoption behavior. The Sense of Duty (SOD) dimension had a high mean score, which shows the moral obligation of the respondents towards recycling practices. The Perceived Behavioral Control (PBC) dimension had the lowest mean score among all the dimensions.

In general, Table 2 above confirms the relevance of the constructs of the extended Theory of Planned Behavior (TPB) in explaining the intention of young adults to recycle e-waste. The descriptive statistics in the table offer insights into the relative strength of each determinant, while the results of the goodness-of-fit indices (as shown in Table 3 below) indicate that the measurement model of the extended TPB is reliable and ready for further structural analysis.

Table 2: Code, item statement, mean, and standard deviation of the constructs in the extended model of TPB

Code	Description	Mean	SD	Constructs
BA1	Recycling e-waste makes me feel very satisfied	3.74	1.039	Behavior attitude
BA2	Recycling e-waste contributes to society	3.89	.9801	
BA3	Recycling e-waste is everyone's responsibility	3.92	1.018	
BA4	E-waste recycling is good	3.96	1.003	
BA5	E-waste recycling is beneficial	3.94	1.011	
SN1	Most people who are important to me think I should engage in recycling E-waste	3.69	1.086	Subjective Norms
SN2	My friends/peer expect me to recycle	3.57	1.007	
SN3	Most people who are important to me would approve of me performing recycling of E-waste	3.63	1.025	
SN4	Experts expect me to recycle	3.60	1.078	
PBC1	I have the relevant resources, time, and opportunities to participate in e-waste reduction behaviors	3.45	1.084	Perceived Behavioral Control
PBC2	Whether to take action in e-waste reduction behaviors is entirely up to me	3.62	.982	
PBC3	Taking part in e-waste reduction behaviors is effortless	3.29	1.217	
RH1	I have not been doing recycling for a long time	3.51	1.012	Recycling Habits
RH2	I would need to change my current habit.	3.64	1.037	
RH3	I find my non-recycling very uncomfortable.	3.56	1.025	
AOC1	Recycling tablets/mobile phones/tablets improves the environment	3.75	.909	Awareness of Consequences
AOC2	Recycling tablets/mobile phones/tablets help to give back to society	3.87	.908	
AOC3	Recycling tablets/mobile phones/tablets is profitable	3.87	.959	
AOC4	Recycling tablets/mobile phones/tablets are environmentally friendly	3.83	.873	
AOC5	Recycling tablets/mobile phones/tablets provide good quality products to others at affordable prices	3.95	.976	

SOD1	I feel responsible for doing something about the level of waste generated by society today	3.72	.918	Sense of Duty
SOD2	I believe I am co-responsible for the reduction of waste generated by the society	3.90	.891	
SOD3	I feel responsible for doing something about the level of waste I generate	3.91	.896	
SOD4	My actions must support a sustainable environment	3.98	1.005	
SOD5	It is essential to do things that give back to society	3.85	1.050	
ITR1	I am interested in electronic waste recycling initiatives	3.73	1.071	Intention to recycle
ITR2	I will give my old devices and machines to recycling	3.71	1.052	
ITR3	I will encourage other members of the community to participate in the e-waste recycling programs.	3.88	1.024	
ITR4	I am keen to participate in environmental programs	3.83	1.044	

Measurement Model (MM) (reliability and validity test)

Results of the measurement model (MM) test for construct validity, reliability, and goodness-of-fit are summarized in Table 3. The model fits the data well as per conventional standards. The values of goodness-of-fit indices suggest that χ^2/df = 3.287, RMSEA = 0.076, CFI = 0.907, and NFI = 0.90, which clearly justify that the extended TPB model fits the data well. The values of factor loadings were above 0.5, and the signs were as expected, which justified construct validity. Moreover, the values of Composite Reliability (CR) were above 0.7, and Average Variance Extracted (AVE) values were above 0.5 for all constructs, which justified convergent validity. These findings collectively indicate that the measurement model is reliable and useful for testing structural relationships within the extended TPB model.

Table 3: Measurement of model fit of TPB Model

Goodness of fit measures	Recommendation value	Structural Model (Results)
$\chi2$ test statistics/df	>3.00	3.345
CFI (comparative fit index)	>0.90	0.907
NFI (normed fit index)	>0.90	0.90
RMSEA (root mean square error of approximation)	<0.08	0.76

Construct reliability and Validity Test

Table 4 shows the reliability and convergent validity statistics for all the constructs in the extended TPB model. Cronbach's Alpha (α), Composite Reliability (CR), and Average Variance Extracted (AVE) are the statistics used. The findings indicate that the constructs have adequate internal consistency reliability, with values for Cronbach's Alpha ranging from 0.76 to 0.91, which is above the acceptable level of 0.70. This suggests that the constructs are being accurately measured by their respective items. Additionally, the values for Composite Reliability (CR) range from 0.74 to 0.90, which is above the acceptable level of 0.70.

Turning to the convergent validity, it can be seen that the majority of the constructs have AVE values above the recommended level of 0.50, namely Behavioral Attitude (0.63), Subjective Norms (0.64), Recycling Habits (0.58), Perceived Behavioral Control (0.61), Awareness of Consequences (0.64), and Intention to Recycle (0.60). However, it can be noted that the AVE value of Sense of Duty (0.36) is lower than the recommended level, although its Cronbach's Alpha and CR values are still acceptable. Based on the findings, it can be concluded that the majority of the constructs in the extended TPB model have high levels of reliability and convergent validity, thus confirming the appropriateness of the measurement model for further structural analysis.

Table 4: Reliability and Convergent Validity of Constructs

Construct	Cronbach's α	AVE	CR
BA	0.90	0.63	0.89
SOD	0.76	0.36	0.74
SN	0.88	0.64	0.87
RH	0.82	0.58	0.80
PBC	0.81	0.61	0.82

AOC	0.91	0.64	0.90
ITR	0.91	0.60	0.86

Correlations of the Constructs

Table 5 below shows the Pearson correlation coefficients between the constructs in the extended TPB model. It is evident that all constructs have positive correlations, which means that high scores on one dimension are associated with high scores on other dimensions. BA is positively correlated with SN (r = 0.48*), PBC (r = 0.33*), Recycling Habits (RH, r = 0.36*), Awareness of Consequences (AOC, r = 0.47*), Sense of Duty (SOD, r = 0.54*), and Intention to Recycle (ITR, r = 0.50*). Likewise, SN has strong positive correlations with all other constructs, especially ITR (r = 0.80*).

These findings indicate that each of the independent variables attitudes, social norms, perceived control, habits, awareness, and moral responsibility is positively related to the intention to recycle e-waste. The presence of asterisks in the table indicates that the results are statistically significant at the conventional significance levels of 1%, 5%, or 10%, thereby ensuring that the observed relationships are not chance events.

Table 5: Pearson Correlations among Constructs of the Extended TPB Model

Pearson Correlations	BA	SN	PBC	RH	AOC	SOD	ITR
BA	1						
SN	0.48*	1					
PBC	0.33*	0.70*	1				
RH	0.36*	0.68*	0.66*	1			
AOC	0.47*	0.64*	0.58*	0.66*	1		
SOD	0.54*	0.44*	0.34*	0.39*	0.51*	1	
ITR	0.50*	0.80*	0.71*	0.72*	0.76*	0.52*	1

Note: ***, **, * significant at, 1% 5% and 10%.

Result of the Structural Model (SM)

Table 6 shows the results of the structural model analysis, depicting the relationships between different independent constructs and the dependent variable, intention to recycle (ITR). The standardized path coefficients help to identify the strength and direction of these associations, while the standard errors (S.E.) provide information on the accuracy of these estimates. For BA → ITR, the negative coefficient of -0.012 is not significant, which implies that behavioral attitude is not a significant predictor of recycling intention in this study, and thus H1 is not supported. However, for SOD → ITR, the positive coefficient of 0.12 is significant at the 5% significance level, which suggests that an individual's moral obligation has a positive influence on recycling intention, and thus H2 is supported. Subjective norms (SN → ITR) have a strong positive coefficient of 0.36, which is significant at the 1% significance level, indicating that social pressure has a strong positive effect on recycling intention, thus supporting H3. Recycling habits (RH → ITR) have a coefficient of 0.16, which is significant at the 10% significance level, indicating that past habits of recycling have a positive effect on recycling intention, thus supporting H4. Likewise, perceived behavioral control (PBC → ITR) has a coefficient of 0.15, which is significant at the 1% significance level, indicating that people's perception of the ease of recycling behavior has a strong positive effect on recycling intention, thus supporting H5.

Awareness of consequences (AOC → ITR) shows a coefficient of 0.34, which is significant at 1%, indicating that awareness of the environmental and social consequences of e-waste is a strong predictor of recycling intention, thereby supporting H6. In summary, the structural model indicates that moral, social, experiential, and cognitive beliefs have a significant positive effect on recycling intentions, while behavioral attitude by itself does not have a significant direct effect on recycling intentions in this study.

Table 6: Results of the structural model (SM)

Structural relations	Standardized path coefficient	S.E.	Hypothesis	Result
BA---> ITR	-0.012	0.039	H_1	Not Supported
SOD --->ITR	0.12**	0.06	H_2	supported
SN --->ITR	0.36***	0.053	H_3	Supported

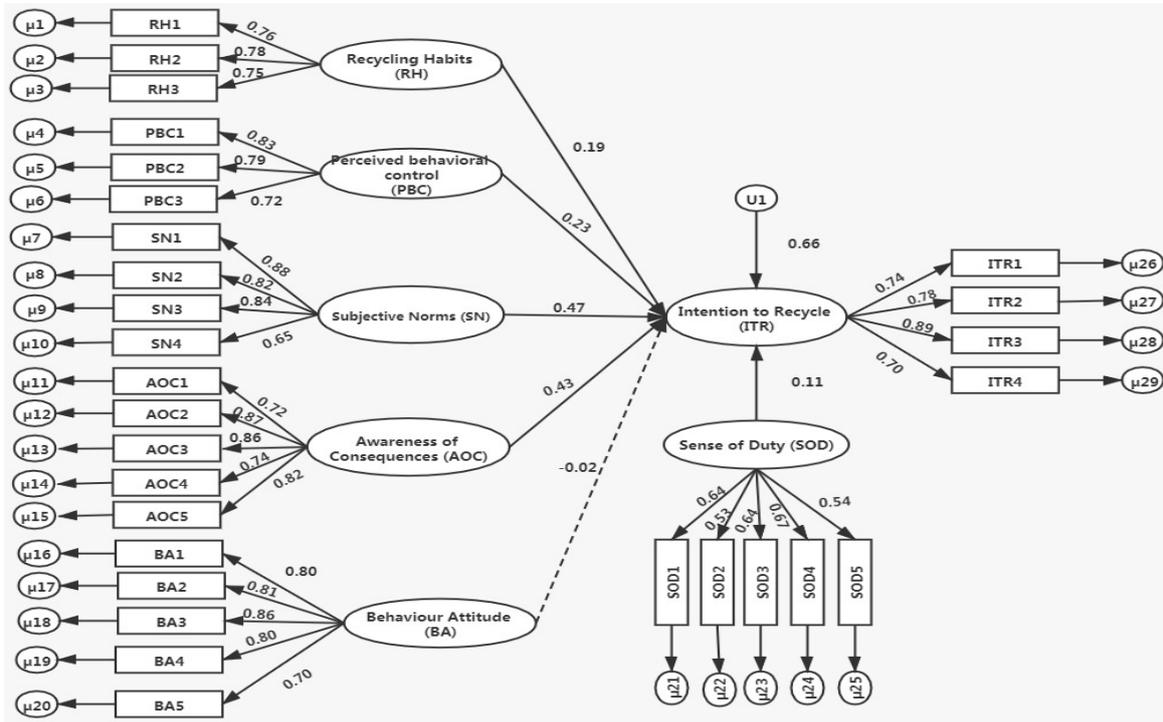| RH --->ITR	0.16*	0.055	H₄	Supported
PBC --->ITR	0.15***	0.04	H₅	Supported
AOC --->ITR	0.34***	0.046	H₆	Supported

Note: ***, **, * significant at, 1% 5% and 10%

Figure 2: Path Analysis of constructs

Figure 2 above shows the Structural Equation Model (SEM) that depicts both the measurement and structural links between the variables of the study and their influence on Intention to Recycle (ITR). The SEM combines the use of six latent variables: Recycling Habits (RH), Perceived Behavioral Control (PBC), Subjective Norms (SN), Awareness of Consequences (AOC), Behavior Attitude (BA), and Sense of Duty (SOD) to predict the recycling intentions of individuals.

The measurement model indicates acceptable indicator reliability for most of the constructs. The Recycling Habits construct is measured using three strong indicators with loadings of 0.75 to 0.78. Perceived Behavioral Control has high factor loadings of 0.72 to 0.83, which indicates that the observed variables are good representations of the construct. The Subjective Norms construct has strong factor loadings of 0.65 to 0.88, which indicate acceptable convergent validity despite having one relatively low loading. Awareness of Consequences has a good representation by five indicators with loadings of 0.71 to 0.87. Behaviour Attitude also has good representation by indicators with loadings of 0.70 to 0.86. On the other hand, Sense of Duty has moderate representation by indicators with loadings of 0.53 to 0.67. The dependent variable, Intention to Recycle, is represented by four indicators with good loadings of 0.70 to 0.89, confirming that the latent variable is well-represented by its indicators.

The structural model shows that the included predictors account for 66% of the variance in Intention to Recycle (R^2 = 0.66), which is a good indication of their explanatory power. Of the predictors, Subjective Norms has the strongest positive influence on recycling intention (β = 0.47). Awareness of Consequences is also positively influential (β = 0.43), implying that people who are aware of the consequences of waste are more likely to form recycling intentions. Perceived Behavioural Control is moderately positively influential (β = 0.23), implying that people who are able to recycle are more likely to form recycling intentions. Recycling Habits is also positively influential (β = 0.19), implying that past behaviour is an important factor in recycling intentions. Sense of Duty is positively influential (β = 0.11), implying that people who feel a sense of duty are more likely to form recycling intentions. However, Behaviour Attitude has a negligible and slightly negative influence (β = −0.02), implying that attitude is not a significant predictor of intention in this model.

Percentage response of respondents in each scale

The frequency distribution of the ratings given by the respondents to the key constructs measured on a five-point Likert scale is shown in Table 7. The results show that for Behavioral Attitude (BA1-BA5), the majority of respondents gave higher ratings (4-5), ranging from 38.1% to 44% for option 4 and 25.3% to 32.9% for option 5, indicating a positive attitude towards recycling, although a few respondents disagreed (1-2). For Subjective Norms (SN1-SN4), the majority of respondents gave ratings of 4 (40-45%) and 5 (15-23%), indicating that social pressure has a moderate to strong influence on recycling intentions. For Perceived Behavioral Control (PBC1-PBC3), the respondents mostly chose the mid-to-high scale options, reflecting a moderate level of perceived control over recycling behavior, although some variation was found in PBC3, where 22.9% chose option 2. Recycling Habits (RH1-RH3) responses were mostly in the 3-4 scale (27-44%), reflecting a moderate level of past behavior in recycling activities. Awareness of Consequences (AOC1-AOC5) had high levels of agreement with high scale options (4-5) ranging from 43.7% to 52.1% for 4 and 20.9% to 30.7% for 5, reflecting that the respondents were aware of the environmental and social consequences of e-waste. Similarly, Sense of Duty (SOD1-SOD5) had high ratings, with 4-5 options ranging between 43% and 49.9%, reflecting a strong sense of moral duty to recycle. Lastly, Intention to Recycle (ITR1-ITR4) was also focused in the higher ratings, with options 4 and 5 having a range of 41.5% to 48.2% and 20.9% to 28.7%, respectively, indicating a generally high level of recycling intention among respondents. Taken together, the data on the distribution of responses to the constructs in Table 7 generally indicate that moral, social, and cognitive considerations are well-appreciated by the respondents and are likely to influence their intention to recycle, while behavioral attitude exhibits moderate variability.

Table 7: Percentage response of respondents in each scale

Code	1	2	3	4	5
BA1	2.9%	10.1%	22.4%	39.3%	25.3%
BA2	2.9%	5.4%	20.1%	42.8%	28.7%
BA3	2.7%	6.9%	19.4%	38.1%	32.9%
BA4	2.7%	7.4%	14%	43.2%	32.7%
BA5	3.2%	6.9%	14.3%	44%	31.7%
SN1	4.4%	11.5%	17.9%	42.8%	23.3%
SN2	4.7%	8.6%	27.3%	43.7%	15.7%
SN3	3.9%	10.6%	22.1%	45%	18.4%
SN4	5.9%	8.4%	25.8%	40%	19.9%
PBC1	5.4%	12.5%	31%	33.7%	17.4%
PBC2	3.7%	7.6%	29%	42%	17.7%
PBC3	7.4%	22.9%	22.4%	28.7%	18.7%
RH1	4.9%	10.3%	27.5%	43.7%	13.5%
RH2	3.9%	10.8%	22.4%	43.5%	19.4%
RH3	4.7%	9.6%	27.5%	41.8%	16.5%
AOC1	2.2%	4.7%	28.5%	43.7%	20.9%
AOC2	3.7%	2.2%	19.9%	52.1%	22.1%
AOC3	4.2%	2.2%	21.4%	46.7%	25.6%
AOC4	2.2%	2.7%	26.5%	46.9%	21.6%
AOC5	3.4%	4.2%	17.0%	44.7%	30.7%
SOD1	1.7%	7.6%	26.8%	44.7%	19.2%
SOD2	0.7%	6.4%	21.4%	45%	26.5%
SOD3	2.5%	3.7%	18.9%	49.9%	25.1%
SOD4	4.9%	1.7%	16.7%	43.7%	32.9%

SOD5	5.2%	4.7%	18.7%	43%	28.5%
ITR1	4.9%	8.6%	18.9%	43.5%	24.1%
ITR2	5.4%	7.9%	17.7%	48.2%	20.9%
ITR3	4.4%	5.2%	16.7%	45%	28.7%
ITR4	4.2%	6.6%	19.7%	41.5%	28%

Discussion

This research work used the extended Theory of Planned Behavior (TPB) to investigate the determinants of e-waste recycling intentions among young people in Faisalabad. The results strongly support the applicability of the TPB framework in explaining the recycling intentions, with the structural model accounting for 66% of the variance in the intention to recycle (R^2 = 0.66). This is a high explanatory power, which suggests that cognitive, social, and moral influences are important determinants of pro-environmental behavioral intentions, as suggested by previous TPB-based environmental research (Ajzen, 1991; Bamberg & Möser, 2007; Chen & Tung, 2014). The extended TPB framework has been well-established in environmental research and has been shown to be effective in explaining pro-environmental behavioral intentions by including additional moral and awareness-related variables (Chen & Tung, 2014).

The findings showed that subjective norms were the most important predictor of recycling intention ($β$ = 0.36, $p < 0.01$). This result implies that social influence, such as peer, family, and expert pressure, is a key factor in encouraging young people to participate in e-waste recycling. The high correlation coefficient between subjective norms and intention (r = 0.80) further supports the importance of social pressure in influencing environmentally responsible behavior. This result is in line with previous research that found young people are highly susceptible to social pressure and peer behavior when making environmental decisions (Park & Ha, 2014; Wang et al., 2016; Chen & Tung, 2014). In collectivist countries like Pakistan, social norms tend to have a more important role in shaping behavior than individual attitudes because people in collectivist cultures tend to conform their behavior to social norms and values.

Consequence awareness also had a strong positive and significant effect on recycling intention ($β$ = 0.34, $p < 0.01$). This result shows that people who are more aware of the consequences of e-waste are more likely to form recycling intentions. The descriptive statistics also support this result, as the mean values for the awareness-related items were high, especially for the item "Recycling devices provides environmental benefits" (M = 3.95). This result is in line with Jain et al. (2023), who emphasized that awareness about the environmental consequences of e-waste is a crucial step in promoting recycling behavior. Awareness increases people's knowledge about the environmental consequences of pollution, depletion of natural resources, and health risks, and therefore, people are motivated to behave pro-environmentally.

Perceived behavioral control also positively influenced recycling intention ($β$ = 0.15, $p < 0.01$), indicating that people who perceive the ability, resources, and opportunities to recycle are more likely to intend to recycle. However, the relatively lower mean scores of the perceived behavioral control items suggest that some people perceive barriers such as the absence of facilities, time, and access to recycling systems. This result is in line with Chen and Tung (2010), who found that the absence of recycling facilities and infrastructure has a significant effect on reducing individuals' recycling intentions. The study highlighted that even if people have positive attitudes toward recycling, perceived barriers such as in convenience and a lack of access to recycling services could limit behavioral intentions.

Habits of recycling also had a positive influence on recycling intention ($β$ = 0.16, $p < 0.10$), suggesting that people who have had previous experiences with recycling are more likely to form future recycling intentions. This lends further support to the notion that habits can enhance the consistency of behavior over time. The positive relationship between recycling habits and intention (r = 0.72) also lends further support to this notion. Previous research has also suggested that past behavior and habits play an important role in shaping future pro-environmental intentions and behaviors (Ouellette and Wood, 1998; Thøgersen, 2000; Knussen et al., 2004). Habit formation helps to decrease the cognitive effort associated with a particular behavior and helps to ensure consistent environmental behavior.

Sense of duty was positively and significantly related to recycling intention ($β$ = 0.12, $p < 0.05$), indicating that moral obligation is a factor in taking responsibility for the environment. The participants showed high levels of agreement with statements concerning personal responsibility for protecting the environment, indicating the presence of moral motivation. This result is consistent with the extended TPB model, which recognizes the significance of moral norms and personal responsibility in the formation of pro-environmental intentions (Chen & Tung, 2014). Moral obligation enhances people's internal motivation to take environmentally responsible action, going beyond the social pressure of the external environment.

Notably, the behavioral attitude measure did not show a significant influence on recycling intention ($\beta = -0.012$, NS), although the respondents showed a positive attitude towards recycling. This result indicates that, although young adults are aware of the benefits of recycling, having a positive attitude may not be a sufficient factor to influence behavioral intention without the presence of supportive social influence, awareness, and facilitating conditions. This is consistent with previous studies that found that attitude was not a strong predictor when structural factors or social factors played a relatively more dominant role (Nigbur et al., 2010; Chen & Tung, 2010).

The descriptive analysis also revealed that a majority of the respondents had unused electronic devices, with 47.9% of the respondents having 1-2 devices and 21.3% having three or more devices. This is an indication of a great potential for e-waste generation among the young generation. Jain et al. (2023) noted that the increased usage of electronic devices among the young generation has contributed to the current e-waste problem. Despite the great potential for e-waste generation, the perceived behavioral barriers and the lack of proper recycling systems may affect the actual recycling behavior.

However, the results confirm that the extended TPB model is effective in predicting the intentions of young adults to recycle e-waste. Social influence and environmental awareness were identified as the most important predictors, followed by perceived behavioral control, recycling behavior, and moral obligation. The results are in line with Chen and Tung (2014), who showed that the extended TPB variables can significantly improve the prediction of pro-environmental intentions. The findings of this study have important implications for policies that aim to encourage the recycling of e-waste. Increasing environmental awareness, improving social norms through education, and making recycling facilities more accessible would be effective in encouraging the recycling of e-waste. Educational institutions can play an important role in inculcating a recycling culture among students.

CONCLUSION AND POLICY IMPLICATIONS

This paper investigated the factors influencing the recycling intentions of young adults towards e-waste using an extended Theory of Planned Behavior framework. The results showed that subjective norms were the strongest predictor of recycling intention, which emphasizes the important role of social factors in influencing pro-environmental behavior. Recycling habits, perceived behavioral control, sense of duty, and awareness of consequences were also found to have a positive and significant influence on recycling intention, which suggests that both social and moral factors, as well as ease of action, play an important role in influencing the recycling intentions of young adults towards e-waste. Conversely, the behavioral attitude did not demonstrate a significant positive impact on recycling intention, implying that favorable attitudes are not sufficient to facilitate behavioral intentions in the absence of supportive social and structural factors. In conclusion, the extended TPB model was successful in predicting e-waste recycling intentions among young adults, highlighting the significance of social norms, environmental awareness, moral obligations, and facilitating factors. These results offer valuable insights for stakeholders aiming to promote sustainable e-waste management practices and encourage responsible recycling behavior among young people.

From the results of this study, the following are some key policy implications that can be derived to encourage recycling behavior of e-waste among young adults. First, raising environmental awareness is important to improve recycling intentions. Environmental awareness campaigns, seminars, and educational programs should be conducted by government agencies, educational institutions, and environmental groups to raise awareness among young consumers about the environmental and health hazards posed by the improper disposal of e-waste. Raising awareness about environmental hazards can greatly improve recycling intentions. Second, enhancing recycling infrastructure and accessibility is important to improve perceived behavioral control. The government should set up convenient e-waste recycling centers, especially in universities, colleges, and residential areas. Easy accessibility of recycling facilities will eliminate perceived barriers and encourage young adults to participate in recycling activities. Third, social influence must be leveraged as a means to induce recycling practices. Social campaigns, online drives, and community-based environmental initiatives can be used to instill positive social norms regarding recycling. Youth-based environmental movements and community leader engagement can be used to enhance social support for recycling practices. Fourth, recycling practices must be induced through institutional means to develop sustainable behavior. Educational institutions must implement recycling programs, such as e-waste collection drives and environmental clubs, to instill regular recycling practices among students. Habit formation is an important aspect of developing consistent environmental behavior. Fifth, there is a need for the formulation and implementation of e-waste management policies and regulations. The promotion of formal e-waste recycling programs and public-private partnerships can be useful in improving the infrastructure of e-waste management. This will ensure that e-waste is not disposed of in an informal manner, thus reducing environmental pollution. Lastly, the inclusion of environmental education in academic programs can be helpful in instilling a sense of environmental responsibility in young adults. Environmental values and moral responsibility should be developed at a young age to ensure the development of pro-environmental behavior.

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