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Article

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Suggested Citation: Michael, Lidwin Kenneth; Hungund, Sumukh S.; V., Sriram K. (2024) : Factors influencing the behavior in recycling of e-waste using integrated TPB and NAM model, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 11, Iss. 1, pp. 1-18, <https://doi.org/10.1080/23311975.2023.2295605>

This Version is available at:

<https://hdl.handle.net/10419/325940>

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To cite this article: Lidwin Kenneth Michael, Sumukh S. Hungund & Sriram K. V. (2024) Factors influencing the behavior in recycling of e-waste using integrated TPB and NAM model, Cogent Business & Management, 11:1, 2295605, DOI: [10.1080/23311975.2023.2295605](https://doi.org/10.1080/23311975.2023.2295605)

To link to this article: <https://doi.org/10.1080/23311975.2023.2295605>



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Factors influencing the behavior in recycling of e-waste using integrated TPB and NAM model

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ABSTRACT

The rapid advancement of technology across multiple sectors including education, the workplace, manufacturing, and household appliances, has resulted in a notable increase in the prevalence of electronic gadgets. Therefore, these devices, also known as e-waste, are discarded once they have reached the end of their useful life. The focus of the study is to identify and examine the factors that influence students' intentions toward the disposal of e-waste. The study adopts a quantitative approach with a cross-section study design to collect data from 415 participants selected through a purposive sampling method. The data was collected through an online survey. The study found that factors such as Environmental Knowledge, Public Awareness, Publicity, Convenience, Infrastructure, Willingness to Pay (WTP), Data security, and Personal norms positively influence students' intentions toward e-waste disposal behavior. This paper delineates the fundamental characteristics of e-waste management strategies that prioritize customer needs and presents a comprehensive framework for India. Policymakers must prioritize increasing customers' willingness to pay (WTP), offering support in advertising efforts, and ensuring robust data protection. Additionally, supporting education on environmental awareness is of utmost importance.

ARTICLE HISTORY

Received 4 September 2023
Revised 11 December 2023
Accepted 12 December 2023

KEYWORDS

E-waste; theory of planned behaviour; recycling intention; willingness to pay; awareness

REVIEWING EDITOR

Pablo Ruiz, Universidad de Castilla-La Mancha, Spain

SUBJECTS

Cognitive Psychology; Environmental Psychology; Testing, Measurement and Assessment; Social Psychology; Psychological Science

1. Introduction

Technological advances in education, household, workplace, industry, healthcare, etc. have created a greater demand for the use of electronic gadgets, appliances, and equipment (Kumar & Dixit, 2018; Rautela et al., 2021). Enterprises are actively driving advancements in the field of electronics engineering to cater to the diverse needs of consumers, encompassing various aspects of their daily routines. This is in response to the escalating prevalence of electronic devices (Ahirwar & Tripathi, 2021; Dwivedy & Mittal, 2013).

Due to the availability of new technologies and models, consumers frequently replace or throw away their old appliances and devices in favour of buying new ones. Electronic waste, or e-waste is the term used to describe these abandoned electrical or electronic devices (Nannaware & Kulkarni, 2018). The wasted material might be recycled, sold, reused again, recovered, or disposed of. But discarding them in an uncanny manner damages the environment. The electric vehicle batteries are also termed e-waste and pose a major danger to the environment after their end of life (Jiang et al., 2021).

E-waste is harmful to the environment and people's health if it is not properly treated (Hicks & Horning, 2006; Borthakur & Sinha, 2013). Globally, total e-waste generated in 2019 was 53.6 million metric tons, and only 17.4% of e-waste is recycled (Global e-waste, 2020). Globally, there will be 57.4 million metric tons of electronic garbage due to the average 7.6kg of waste produced by each person on earth (Agarwal et al., 2021). Unfortunately, India remains ill-equipped to handle recycling e-waste; in total, only over 1.5 tons of e-waste is recycled (Bandela, 2018). In India, the total e-waste produced in 2019 was 3.2

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million metric tons and only 1% of e-waste was formally recycled (Global e-waste, 2020). The amount of e-waste collected is going to increase in the years to come. The importance of the global climate crisis has led governments to formulate strategic policies aimed at reducing carbon emissions to address the severe impacts of climate change (Saleemdeen et al., 2021).

E-waste includes hazardous metals like lead other than aluminium, gold, palladium, copper, and platinum (Widmer et al., 2005; Xavier et al., 2021). Improper disposal of these metals or poor e-waste management harms health, the environment, and society (Z. Wang et al., 2016). Due to a lack of knowledge, many households do not dispose of small electronic goods, which calls for extensive public education efforts and governmental laws (Afroz et al., 2013; Kwatra et al., 2014). Kumar and Dixit (2018) opine that lack of knowledge and government laws are the primary causes of insufficient e-waste management systems. Furthermore, there is little awareness of the e-waste disposal technique (Nannaware & Kulkarni, 2018). At least three of the seventeen sustainable development goals (SDGs) might be greatly aided by effectively managing e-waste, which would also have a major positive environmental impact (Assembly, 2015).

Because of the lack of awareness, publicity, convenience, and other factors, a study is needed to better assess the level of awareness and e-waste disposal behavior. This study aims to identify the primary factors influencing the disposal behavior of e-waste among students and research scholars, utilizing the TPB-NAM model. The study incorporated various factors derived from Ajzen's Theory of Planned Behavior (TPB) and the Schwartz Norm Activation Model (NAM). The study sample consisted of individuals who had completed their undergraduate, postgraduate, or doctoral studies. To address the research gap, the following are the research questions that will assist our study:

1. What are the determinants of e-waste disposal intention?
2. Does the e-waste recycling intentions of youths' influence e-waste disposal behavior?

2. Theoretical background

The Theory of Planned Behavior (TPB) is utilized in this study due to the importance of psychological factors. The Theory of Planned Behavior (TPB) is a significant socio-psychological framework that explains social behavior (Ajzen, 1985; Fishbein & Ajzen, 1977). The TPB (Stern, 2000; Staats et al., 2003) assesses various environmental behaviors, including recycling, alternative transportation, energy consumption, water conservation, food choices, and ethical investing. TPB is widely accepted as the preferred framework for assessing the influences on recycling behavior (Tonglet et al., 2004; Z. Wang et al., 2011). Attitude (ATT) pertains to an individual's positive or negative evaluation of a specific behavior (De Groot & Steg, 2009). Subjective norms (SN) refer to the impact of social pressures on an individual's choice to participate in or refrain from a specific activity. PBC refers to perceived barriers associated with past personal experiences and expectations. Behavioral intention measures an individual's inclination to perform a particular action. Actions are the basic elements of behavior. Wu et al. (2017) proposed that there is a positive relationship between behavioral intention and ATT, SN, and PBC. Yuan et al. (2016) found that subjective norms (SN), attitude (ATT), and perceived behavioral control (PBC) were positively associated with increased participation in home garbage recycling.

Schwartz (1977) introduced the Norm Activation Model (NAM), emphasizing the influence of personal morals on individual environmental behavior. The NAM investigates the impact of individuals' altruistic and moral values on their behavior, specifically their adherence to moral principles. NAM proposes that pro-environmental behavior consists of three primary components: awareness of consequences (AOC), ascription of responsibility (AR), and personal norms (PN) (Schwartz, 1977). AOC assesses an individual's ability to comprehend the consequences of their actions (Bamberg et al., 2007). According to Z. Wang et al. (2018), individuals with low personal norms are less likely to engage in recycling behaviors, whereas those with high personal norms are more inclined to recycle.

Existing research on the Theory of Planned Behavior (TPB) and the Norm Activation Model (NAM) have predominantly focused on the environmental factors. Several socio-psychology studies have

successfully combined the Theory of Planned Behavior (TPB) and the Norm Activation Model (NAM), which has made the environmental models more accurate (López-Mosquera & Sánchez, 2012; Ma et al., 2018). Park and Ha (2014) utilized the Theory of Planned Behavior (TPB) and Norm Activation Model (NAM) to predict the pro-environmental intentions of museum visitors. Rezaei et al. (2019) found that combining the TPB-NAM model improved the predictive accuracy of integrated pest management intention compared to using the TPB model alone. Fang et al. (2021) determined that the Theory of Planned Behavior (TPB) and Norm Activation Model (NAM) were successful in predicting recycling behaviors among residents of Taipei City.

Researchers from a variety of nations, including both developed and developing countries, frequently use the TPB-NAM model in their studies. Previous studies also discuss constructs of TPB such as attitude, subjective norm, perceived behavioral control, and intentions with respect to recycling e-waste among young individuals (Kumar, 2019; Ramzan et al., 2020; Shaharudin et al., 2020). The TPB-NAM model incorporates various constructs including Environmental Knowledge, Public Awareness, Willingness to Pay, Convenience to Dispose of e-waste, Infrastructure, Data Security, Publicity, and Personal Norms.

3. Hypothesis development

3.1. Environmental knowledge

Pandebesie et al. (2019) provide a definition of e-waste knowledge as the awareness of the presence of hazardous items that are stored inappropriately, hence posing environmental dangers and endangering human life. Nnorom et al. (2009) found insufficient knowledge about the toxic impacts of e-waste and its disposal among users of electronic and electrical products. Adequate knowledge of e-waste management is essential among consumers that will increase their intention to take part in the recycling of e-waste (Afroz et al., 2020; Arain et al., 2020; Borthakur & Govind, 2019). Echegaray and Hansstein (2017) found that knowledge is the main factor affecting the recycling of e-waste. According to the study conducted by Nduneseokwu et al. (2017), there is a significant relationship between consumers' intention to recycle e-waste and their level of environmental understanding. Therefore, based on the aforementioned study, it has been determined that Environmental Knowledge plays a key role in the process of recycling e-waste. As a result, the following hypothesis is proposed.

H1: Environmental Knowledge significantly influences youth's Disposal Intention.

3.2. Public awareness

Islam et al. (2016) state that the dissemination of environmental awareness is facilitated by means of education, which is deemed a crucial aspect in the realm of electronic waste management. Education should stress teaching individuals about their ethical responsibilities towards the environment, including environmental conservation, pro-environmental behavior, and the negative consequences of not following these responsibilities (Adu-Gyamfi et al., 2023). According to Garcés et al. (2002), in the specific context of Spain, it was determined that an increase in awareness would lead to higher levels of individual participation in garbage recycling. Saphores et al. (2006) and Ramzan et al. (2019) opined that teenagers or youth lack awareness of recycling e-waste. The awareness level of willingness to recycle or repair e-waste among the households was significantly low (Islam et al., 2020; Parveen et al., 2019). Afroz et al. (2013) and Islam et al. (2016) opined that most households knew about the impact of e-waste on the environment, but only a small percentage of the household recycled e-waste. Educational initiatives play a crucial role in promoting environmental consciousness and facilitating the proper management of electronic waste (Awasthi et al., 2016; Yin et al., 2014). Thi Thu Nguyen et al. (2019) found a significant relationship between awareness and residents' willingness to recycle e-waste. Therefore, we propose the following hypothesis:

H2: Public Awareness will significantly influence youth's Disposal Intention.

3.3. Convenience

Saphores et al. (2006) found that the convenience of drop-off e-waste at recycling centers is vital. Sidique et al. (2010) indicate that recyclers prefer to use more of the drop-off sites. Z. Wang et al. (2016) and Kumar (2019) found that recycling convenience has no significant effect on recycling behavior intention. A study by Thi Thu Nguyen et al. (2019) in Vietnam argued that recycling inconvenience significantly affected residents' behavioral intent. Z. Wang et al. (2011), Liu et al. (2019), and Arain et al. (2020) found that convenience for recycling facilities is one of the main determinants in the recycling of e-waste. Convenience is essential in disposing of e-waste through e-commerce sites (B. Wang et al., 2019; B. Zhang et al., 2019). According to Shaharudin et al. (2020), convenience will significantly influence youths' intentions to dispose of e-waste. Hence, the above study suggests that convenience is essential in recycling e-waste.

H3: Convenience to recycle e-waste will significantly influence youth's disposal intention

3.4. Willingness to pay

Kwatra et al. (2014) define willingness to pay as the additional payment made for the proper disposal and recycling of e-waste at a suitable recycling facility. Willingness to pay (WTP) is often used by the scholars along with the TPB model to analyse the renewable energy projects and waste management. Nketiah et al. (2022). According to Aadland and Caplan (2003), environmentally conscious young women with higher education levels, who are affiliated with environmental organizations, demonstrate a sense of accountability towards the environment and are willing to incur costs for curbside recycling of general waste. In developing countries, the willingness to pay for recycling e-waste remains low due to the practice of households disposing of e-waste in the informal sector in exchange for financial gains (Afroz et al., 2013; Dwivedy & Mittal, 2013; Islam et al., 2016). Shaikh et al. (2020) observed that individuals across various income levels demonstrated a willingness to financially support the implementation of an efficient e-waste management system. The studies mentioned suggest that Willingness to Pay is important in the context of e-waste recycling.

H4: Willingness to Pay will significantly influence youth's Disposal Intention.

3.5. Infrastructure

Saphores et al. (2006) argue that the implementation of infrastructure management strategies will facilitate the accessibility of convenient e-waste disposal locations for a larger number of individuals. In China, Qu et al. (2013) found that though the collection level of e-waste has increased, there is no proper infrastructure for the suitable disposal of e-waste. In addition, numerous researchers feel infrastructure significantly impacts the resident's recycling behavior (Tonglet et al., 2004; D. Zhang et al., 2015). Hage et al. (2009) suggest that infrastructure for collecting waste makes it easier for households to recycle e-waste. In Nigeria, a study by Nduneseokwu et al. (2017) found that infrastructure negatively influences the intention to recycle e-waste. Borthakur and Govind (2017) discovered that insufficient infrastructure hindered the proper disposal of e-waste by individuals. This study highlights the significant role of infrastructure in the disposal of e-waste.

H5: Infrastructure will significantly influence youth's e-waste Disposal Intention

3.6. Publicity on recycling of e-waste

According to Z. Wang et al. (2016), publicity will raise awareness among the residents and make them willing to recycle e-waste. The dissemination of information plays a critical role in increasing knowledge regarding the need of household waste separation, as well as its environmental and health consequences. It also emphasizes the necessity for individuals to comprehend the advantages and techniques involved in engaging in this practice (Tang et al., 2023). Wan et al. (2014) opine that publicity should enhance

and support the recycling of e-waste. Due to the absence of environmental promotions and education in China, consumers' level of environmental awareness was limited (Yu et al., 2014). Z. Wang et al. (2018) suggest that publicity should be done regularly and focus should be more on reducing the environmental damage and making the consumer aware of the importance of recycling e-waste. According to Park et al. (2019), regular publicity will enhance the e-waste collection rates. Thus, we hypothesize that:

H6: Publicity positively influences youth's e-waste Disposal Intentions.

3.7. Data security

Individuals and corporations may choose not to engage in electronic goods recycling, even after the products have reached the end of their life cycle, due to concerns regarding the potential retention of sensitive information (Singh et al., 2020). Reusing some parts may lead to misuse of information, thereby leading to data theft (Singh et al., 2020). Liu et al. (2019) found that the most significant barrier to cell phone disposal was information theft, resulting in 30 percent of mobile phones being left at home. Existing research suggests that data security plays a crucial role in individuals' decision not to recycle their mobile phones (Araim et al., 2020; Singh et al., 2020). But, in contrast to study by L. Zhang et al. (2021), indicate that individuals' privacy concerns exhibit a direct and positive influence on their inclination to participate in formal recycling activities. Since not much research has been done in the above area, data security is considered a critical factor in recycling e-waste. The following hypothesis is set to analyse the study:

H7: Data Security significantly influences youth's e-waste Disposal Intention.

3.8. Personal norm

Nketiah et al. (2022) states that individuals with greater awareness of the consequences are more likely to develop strong personal ethics, which in turn affects their willingness to invest in a particular behavior. Personal Norms explain pro-environmental behavior (Thøgersen & Ölander, 2006), while the NAM model links pride and guilt to personal standards (Schwartz, 1977). In a context where personal norms represent moral obligation, social pressure may indirectly influence environmental action (Han et al., 2018). Onwezen et al. (2013) found that expected pride and guilt regulate behavior and personal norms.

H8: Personal Norms have a significant influence on e-waste Disposal Behaviour.

3.9. Disposal Intentions

Irvin and Stansbury (2004) say that the person's intentions play a significant role in how they act. If the intentions are more significant, the more likely the person's behavior will go in the direction of the intentions (J. Wang et al., 2023; D. Zhang et al., 2015). Some researchers suggest that the individual variables are integrated into TPB to improve the ability to predict their behavior (Tonglet et al., 2004; Echegaray & Hansstein, 2017; Thi Thu Nguyen et al., 2019). According to the findings of B. Zhang et al. (2019), university students exhibit a preference for utilizing online recycling platforms as a means of disposing their outdated electronic devices. This preference is contingent upon two key factors: a thorough comprehension of the importance of recycling behaviors and the availability of a satisfactory user experience on the platform. According to Delcea et al. (2020), it has been demonstrated that increasing consumers' intentions has a direct and favorable impact on their e-waste recycling behavior. As a result, the following hypothesis is proposed

H9: Disposal Intention significantly influences e-waste Disposal Behaviour

4. Methodology

The hypotheses stated in the preceding section were evaluated using a structured questionnaire and measurement methods to collect and analyse the responses to the survey.

4.1. Questionnaire design

Before administering the questionnaire to the study participants, the instrument was validated by subject experts. The instrument was administered to a panel consisting of three academicians and two industry experts. The questions for each construct were derived from prior research. A comprehensive review of the questionnaire was conducted, and minimal feedback by experts were provided to the researcher regarding areas requiring clarification.

The questionnaire comprised two sections: demographic information and e-waste behavior, which were guided by the existing literature. The first section of the survey asked participants about their level of education and other demographic details. The study's second section investigated the respondents' perceptions and practices related to e-waste recycling. The measuring items were constructed using a five-point Likert scale, ranging from 1 to 5. A score of 1 represents strong disagreement, while a score of 5 represents strong agreement. [Appendix A](#) contains the constructs and the questions.

4.2. Data collection

The study utilized a purposive sampling method. Purposive sampling is a type of non-random sampling used to select samples based on specific study objectives to address research inquiries. Participants in the study include men and women over the age of 17 who are presently enrolled in educational programs and who own or frequently use electronic devices including computers, tablets, smartphones, and other gadgets. The researchers used a questionnaire to collect data for this study. The questionnaire for the study was distributed via Google forms. The data collection was limited to the Manipal region of India, and 415 responses were collected for this study. A pilot data was collected from 50 respondents to assess the instrument's validity and reliability. These respondents' comments and ideas were utilized to improve the questionnaire's readability. Finally, the data gathering questionnaire was developed. Smart PLS was employed in this investigation. To achieve the recommended standards, 415 questionnaires were completed and processed. [Table 1](#) illustrates respondent distributions.

4.3. Reliability of the scale

SmartPLS assesses the consistency of each construct using Cronbach's Alpha. To calculate the intra-correlation of each construct, the Composite Reliability measure is utilized. This measure assesses the degree of similarity among the elements within each construct (refer to [Table 2](#)). This study considers a composite reliability value greater than 0.7. The reliability of a measurement is positively associated with its value (Hair et al., 2016; Netemeyer et al., 2003). A composite reliability value of 0.95 or higher is considered undesirable. Each part has been slightly altered, indicating that it may be removed entirely. Furthermore, the Average Variance Extracted (AVE) is considered as a measure of the similarity and dissimilarity between the components of a construct. To establish validity in this scenario, a value exceeding 0.5 is necessary. Next, the external loadings of each component are analysed. The outer loadings demonstrate the contribution of the component to the construct. Hair et al. (2011) prefer a value greater than 0.5. The statistics indicate that scales exhibit a strong level of internal consistency.

Table 1. Sample distribution ($n=415$).

| Variable | Category | Total | Percentage |
|---------------|----------|-------|------------|
| Gender | Male | 244 | 58.79 |
| | Female | 171 | 41.21 |
| Age group | 18–25 | 219 | 90.36 |
| | 26–35 | 196 | 9.64 |
| Qualification | UG | 219 | 52.77 |
| | PG | 157 | 37.83 |
| | PhD | 39 | 9.40 |

[Table 1](#) indicates descriptive data that shows majority of respondents were male (58.79%), and were of age group 18–25 (90.36%) pursuing their undergraduate, postgraduate, and Ph.D. programs. It was also found that the majority of the respondents were pursuing their undergraduate program (52.77%)

Table 2. Description of the measurement items in the questionnaire.

| Variables | Indicators | Loading factors | Cronbach's alpha | Composite reliability | Average variance extracted (AVE) |
|------------------------------|------------|-----------------|------------------|-----------------------|----------------------------------|
| Disposal Behaviour (DB) | DB3 | 0.829 | 0.734 | 0.832 | 0.564 |
| | DB4 | 0.854 | | | |
| | DB5 | 0.788 | | | |
| Convenience (Conv) | CON1 | 0.776 | 0.607 | 0.782 | 0.501 |
| | CON2 | 0.791 | | | |
| | CON3 | 0.840 | | | |
| Data Security (DS) | DS1 | 0.592 | 0.669 | 0.801 | 0.504 |
| | DS2 | 0.703 | | | |
| | DS4 | 0.745 | | | |
| | DS5 | 0.784 | | | |
| Environmental Knowledge (EK) | EK2 | 0.720 | 0.780 | 0.850 | 0.532 |
| | EK3 | 0.785 | | | |
| | EK4 | 0.704 | | | |
| | EK5 | 0.693 | | | |
| | EK6 | 0.742 | | | |
| | INT1 | 0.791 | | | |
| INT2 | 0.760 | | | | |
| INT3 | 0.777 | | | | |
| INT4 | 0.760 | | | | |
| INT5 | 0.805 | | | | |
| Personal Norms (PN) | PN1 | 0.812 | 0.713 | 0.839 | 0.635 |
| | PN2 | 0.806 | | | |
| | PN3 | 0.773 | | | |
| Public Awareness (PA) | PA1 | 0.688 | 0.790 | 0.855 | 0.541 |
| | PA2 | 0.699 | | | |
| | PA3 | 0.722 | | | |
| | PA4 | 0.777 | | | |
| | PA5 | 0.786 | | | |
| Publicity (Pub) | PUB1 | 0.677 | 0.774 | 0.847 | 0.528 |
| | PUB2 | 0.638 | | | |
| | PUB4 | 0.823 | | | |
| | PUB5 | 0.769 | | | |
| | PUB6 | 0.710 | | | |
| | WTP1 | 0.762 | | | |
| WTP2 | 0.645 | | | | |
| WTP3 | 0.753 | | | | |
| WTP4 | 0.767 | | | | |
| Infrastructure (Infra) | INFR1 | 0.700 | 0.691 | 0.811 | 0.519 |
| | INFR2 | 0.719 | | | |
| | INFR3 | 0.653 | | | |
| | INFR4 | 0.802 | | | |

The components DB1, DB2, DS3, CON 4, CON 5, EK1, PUB 3, WTP5, and INFRA5 have been removed as their factor loadings were less than 0.5.

4.3.1. Methods and measures

Initially, all the components/items of the constructs were considered when gathering the responses. To mitigate bias, the items associated with the negative questions of the constructs were subjected to reverse scoring. The items that were negatively worded for the constructs are as follows: PA 3, WTP 2, WTP 5, CON 4, CON 5, DS 1, DS 3, PN 2, PN 3 and DB 4. The factor loadings for WTP 5, DS 3, CON 4, and CON 5 were found to be less than 0.5, leading to their exclusion from the analysis.

5. Data analysis

According to Fornell and Bookstein (1982), the PLS-SEM technique doesn't require any assumptions about the demographics or measurement scales. Because PLS allowed for the inclusion of reflective and formative indicators in the model, it was chosen above AMOS and LISREL (Fornell & Larcker, 1981). PLS-SEM is chosen for this study. The PLS-SEM is preferred over a covariance-based SEM due to the use of non-probability sampling methods, such as purposive sampling, in the data collection process. A CB-based SEM is appropriate when the data is obtained using a probability-based sampling technique and conforms to a normal distribution. A PLS-SEM is more appropriate for non-normal data sets (Hair et al., 2016). A two-part explanation of the PLS-SEM approach is given by Hair et al. (2016). The measuring model's validity and reliability are initially evaluated. The second part involves testing the structural model.

5.1. The measurement model

The measurement model is assessed, and the convergent and discriminant validity scores show construct validity (Hair et al., 2011). Convergent validity is achieved when the AVE exceeds 0.5 (Fornell & Larcker, 1981). The discriminant validity is then evaluated using the Fornell-Larcker criterion (Hair et al., 2011). First, the Fornell-Larcker criterion calculates latent construct correlations. Second, find the highest squared correlation. Step 1's maximum squared correlation must be less than each latent construct's AVE to meet the Fornell-Larcker criterion. To satisfy the cross-loading condition, an indicator's loading must be greater than the sum of its cross-loadings. Tables 3 and 4 summarise the results of the discriminant validity evaluation. We can conclude that discriminant validity has been proved based on the diagonal elements.

The Variance Inflation Factor (VIF) must be examined among constructs to identify if there is multi-collinearity in the data. Using the so-called inner VIF values in Table 5, we can see the correlations between latent variables. Hair et al. (2011) say VIF readings should be less than five. Multicollinearity should not be a concern because the numbers in Table 5 fall within the range.

PLS-SEM poses a further significant challenge in the form of the common method bias (CMB). Kock (2015) proposed that finding CMB requires a rigorous collinearity assessment technique. If even one VIF value exceeds 3.3, the CMB has an effect on the model (Hair et al., 2016; Kock, 2015) Results indicate VIF values in our model is less than 3.3. Hence our model is CMB-free.

Table 3. Discriminant validity test results.

| Variables | Item indicators | Correlations | | | | | | | | | |
|-----------|-----------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | | DB | Conv | DS | EK | Int | PN | PA | Pub | WTP | Infra |
| DB | 4 | 0.751 | | | | | | | | | |
| Conv | 4 | 0.316 | 0.708 | | | | | | | | |
| DS | 4 | 0.229 | 0.417 | 0.710 | | | | | | | |
| EK | 5 | 0.500 | 0.214 | 0.048 | 0.730 | | | | | | |
| Int | 5 | 0.662 | 0.342 | 0.236 | 0.547 | 0.779 | | | | | |
| PN | 3 | 0.596 | 0.281 | 0.216 | 0.569 | 0.651 | 0.797 | | | | |
| PA | 5 | 0.479 | 0.123 | 0.051 | 0.650 | 0.501 | 0.557 | 0.736 | | | |
| Pub | 5 | 0.433 | 0.315 | 0.212 | 0.482 | 0.500 | 0.461 | 0.375 | 0.726 | | |
| WTP | 4 | 0.441 | 0.312 | 0.168 | 0.572 | 0.558 | 0.508 | 0.494 | 0.398 | 0.734 | |
| Infra | 4 | 0.414 | 0.132 | -0.015 | 0.594 | 0.461 | 0.467 | 0.544 | 0.349 | 0.503 | 0.721 |

Note: Bold diagonals indicate the square root of AVE.

Table 4. Heterotrait–Monotrait ratio (HTMT).

| | DB | Conv | DS | EK | Int | PN | PA | Pub | WTP | Infra |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| DB | | | | | | | | | | |
| Conv | 0.472 | | | | | | | | | |
| DS | 0.334 | 0.641 | | | | | | | | |
| EK | 0.662 | 0.328 | 0.158 | | | | | | | |
| Int | 0.817 | 0.470 | 0.309 | 0.675 | | | | | | |
| PN | 0.783 | 0.430 | 0.302 | 0.760 | 0.841 | | | | | |
| PA | 0.602 | 0.165 | 0.102 | 0.815 | 0.597 | 0.723 | | | | |
| Pub | 0.569 | 0.454 | 0.295 | 0.622 | 0.612 | 0.622 | 0.467 | | | |
| WTP | 0.571 | 0.455 | 0.231 | 0.770 | 0.716 | 0.708 | 0.643 | 0.529 | | |
| Infra | 0.590 | 0.223 | 0.125 | 0.805 | 0.599 | 0.658 | 0.730 | 0.482 | 0.715 | |

Table 5. Inner VIF values.

| | Beh | Conv | DS | EA | INT | PN | PA | PUBs | WTP | Infra |
|-----------------------------------|-------|------|----|----|-------|----|----|------|-----|-------|
| Behavior | | | | | | | | | | |
| Convenience | | | | | 1.355 | | | | | |
| Data Security | | | | | 1.251 | | | | | |
| Environmental Knowledge | | | | | 2.373 | | | | | |
| Intention | 1.736 | | | | | | | | | |
| Personal Norms | 1.736 | | | | | | | | | |
| Public Awareness | | | | | 1.912 | | | | | |
| Publicity | | | | | 1.441 | | | | | |
| Willingness to pay infrastructure | | | | | 1.748 | | | | | |
| | | | | | 1.754 | | | | | |

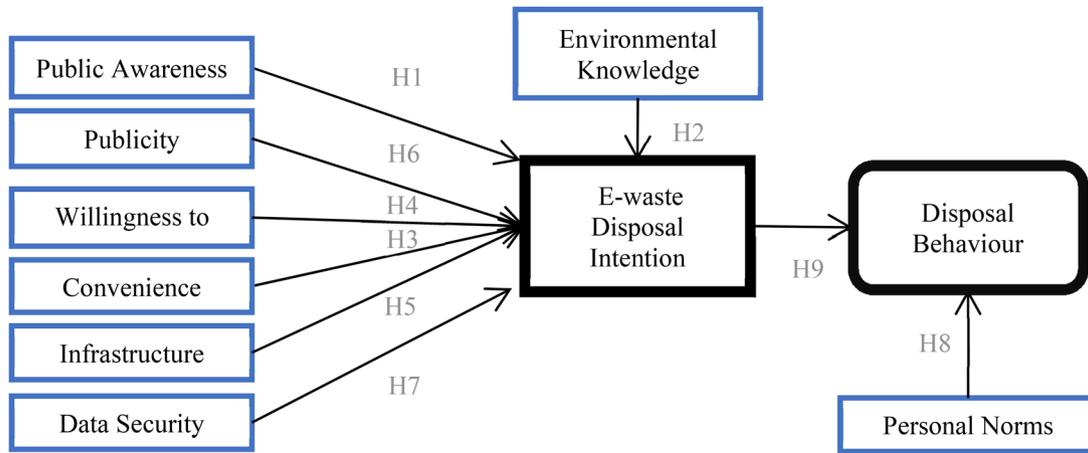


Figure 1. Integrated TPB-NAM Conceptual model showing the research hypothesis presented in the study.

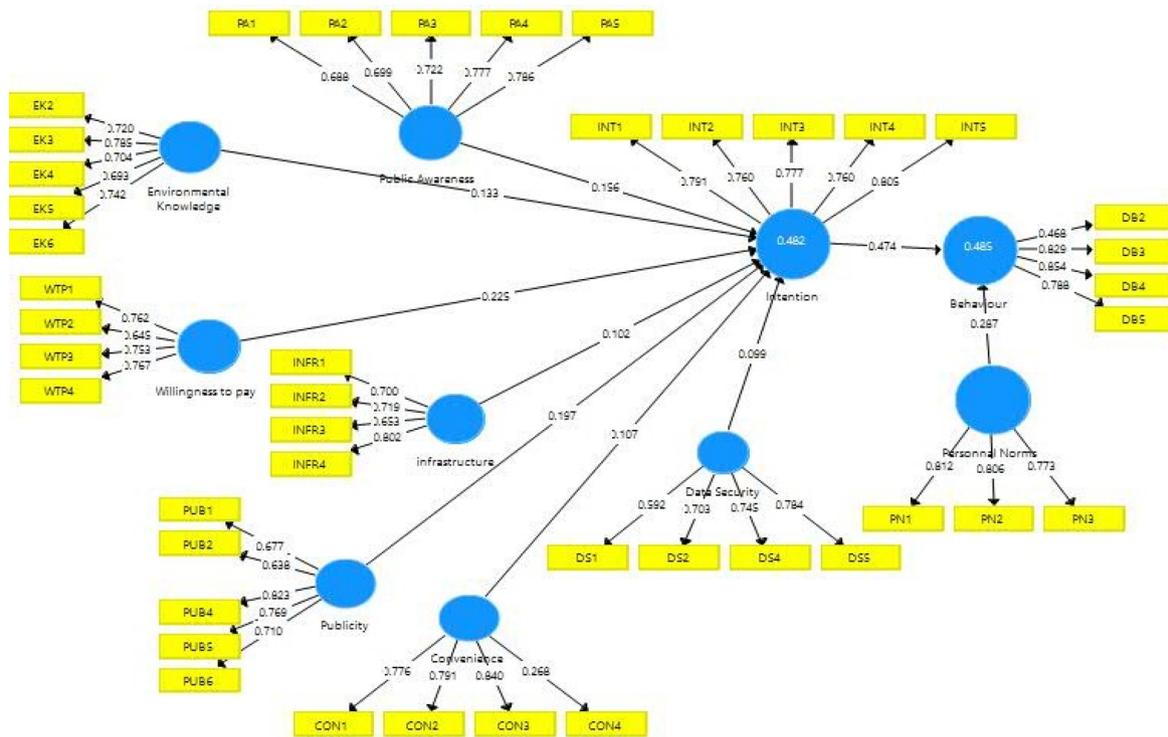


Figure 2. Outer model with factor loading value. The structural model in Figure 2 demonstrates strong predictive relevance, as indicated by a Q^2 value surpassing 0. The values exceed 0.350, suggesting a high level of robustness in the model (Alexander et al., 2012).

5.2. Testing of the structural equation model

Figure 1 depicts the evaluation of the conceptual model derived from the study through the utilization of Structural Equation Modeling (SEM) with the software SmartPLS. The results of the SEM analysis demonstrate the relationship between the statement items of the questionnaire and the latent variables.

The indicator is considered to have a significant positive effect when the T-statistic value exceeds 1.96 (Table 6). (Hair et al., 2010). Table 7 demonstrates that all indicators exhibit a significant and positive influence on the latent variables, as evidenced by their T-values exceeding 1.96. Latent variables are influenced to a greater extent by statements or indications that possess higher T-statistic values compared to those with lower T-statistic values.

Table 6. Predictive relevance using Q^2 and R^2 values.

| | Q^2_{predict} | R^2 | Effect |
|-----------|------------------------|-------|--------|
| Behavior | 0.414 | 0.485 | High |
| Intention | 0.448 | 0.482 | High |

Table 7. Path coefficients for the structural model.

| Hypothesis | Paths | Estimate (Beta) | t-Stat | Hypothesis result |
|------------|--------------------------------------|-----------------|----------|-------------------|
| H1 | Public Awareness -> Intention | 0.156 | 3.282** | Supported |
| H2 | Environmental Knowledge -> Intention | 0.133 | 2.112* | Supported |
| H3 | Willingness to pay -> Intention | 0.225 | 3.877*** | Supported |
| H4 | infrastructure -> Intention | 0.102 | 2.170* | Supported |
| H5 | Publicity -> Intention | 0.197 | 4.049*** | Supported |
| H6 | Convenience -> Intention | 0.107 | 2.483* | Supported |
| H7 | Data Security -> Intention | 0.099 | 2.259* | Supported |
| H8 | Personal Norms -> Behaviour | 0.287 | 5.816*** | Supported |
| H9 | Intention -> Behaviour | 0.474 | 9.436*** | Supported |

Note: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 8. Each variable's indirect, direct, and total effects on the e-waste behavior disposal system.

| Variables | Indirect effects | Direct effect | Total effects | p -Values |
|-------------------------|------------------|---------------|---------------|-------------|
| Convenience | 0.051 | 0.107 | 0.158* | 0.013 |
| Data Security | 0.047 | 0.099 | 0.146* | 0.024 |
| Environmental Knowledge | 0.063 | 0.133 | 0.196* | 0.035 |
| Intention | 0.474 | 0.000 | 0.474*** | 0.000 |
| Personal Norms | 0.287 | 0.000 | 0.287*** | 0.000 |
| Public Awareness | 0.074 | 0.156 | 0.230** | 0.001 |
| Publicity | 0.094 | 0.197 | 0.291*** | 0.000 |
| Willingness to pay | 0.107 | 0.225 | 0.331*** | 0.000 |
| infrastructure | 0.049 | 0.102 | 0.151* | 0.031 |

Note: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The path coefficients and results of the structural model demonstrate a positive influence on the constructs of the structural model. All nine hypotheses were supported. The study found significant effects of environmental knowledge, public awareness, willingness to pay, infrastructure, convenience, publicity, and data security on consumer intention to participate in e-waste collection programs. Specifically, the effects were as follows: H1: $\beta_1 = 0.156$, $p = 0.001$; H2: $\beta_2 = 0.133$, $p = 0.035$; H3: $\beta_3 = 0.225$, $p = 0.000$; H4: $\beta_4 = 0.102$, $p = 0.031$; H5: $\beta_5 = 0.197$, $p = 0.000$; H6: $\beta_6 = 0.107$, $p = 0.013$; H7: $\beta_7 = 0.099$, $p = 0.024$.

This means that H1, H2, H3, H4, H5, H6, and H7 are supported.

The effects of intention to recycle and personal norms on e-waste behaviour are (H8: $\beta_8 = 0.287$, $p = 0.000$), and (H9: $\beta_9 = 0.474$, $p = 0.000$), respectively. These values have a significant effect on e-waste disposal behavior. Therefore, H8 and H9 are supported. From Table 8, the H9 positively affects the intention to recycle behavior. Table 8 shows the direct, indirect, and total effects of each variable on consumer intention to participate in e-waste collection programs.

6. Theoretical implications, practical implications and discussion

TPB suggests a positive relationship between recycling intention and various independent variables, including Environmental Knowledge, Public Awareness, Publicity, Convenience, Infrastructure, Willingness to Pay (WTP), Data security with recycling intention, and personal norms with the recycling behavior of electronic waste (E-waste). In accordance with the prior studies, our research yielded similar findings. Several studies conducted in India have neglected to take data security into consideration. This study can contribute valuable insights for future empirical research on environmentally conscious behaviors. This study integrates the Theory of Planned Behavior (TPB) with the Norm Activation Model (NAM) to examine the influence of personal norm on individuals' recycling practices, specifically focusing on

electronics. This study demonstrates that attitudes and subjective norms are the primary determinants of recycling behavior. This study's findings may complement those of other studies and emphasize the need for increased attention to environmental issues. The R^2 values for recycling intention and recycling behavior in this study were 0.482 and 0.485, respectively. The independent variables (Environmental Knowledge, Public Awareness, Publicity, Convenience, Infrastructure, Willingness to Pay (WTP), Data security) explained 48.2% and 48.5% of the total variability on the dependent variables (recycling intention and recycling behavior).

The study findings offer policy recommendations and practical implications for regulatory authorities and practitioners. The suggestions seek to promote the adoption of e-waste collection platforms, raise awareness among young consumers about proper e-waste recycling, and engage multiple stakeholders in sustainable e-waste management practices. Colleges can enhance environmental awareness and promote sustainable e-waste management through the provision of environmental management education to young adults. This education can promote the growth of sustainable recycling practices in the future. The government and recycling companies can use these channels to enhance the recycling rate by promoting information about service providers. Young consumers can play a significant role in promoting sustainable e-waste management by encouraging the formal sectors to collect and appropriately treat e-waste. To enhance security and prevent data theft, it is crucial for the government to enact legislation or regulations that require the secure erasure of private information from collected electronic waste. Enhancing data security can be achieved through the implementation of measures such as documenting the complete dismantling process or issuing a guarantee document. Additionally, it is crucial for local governments and recycling companies to cooperate in order to establish effective public-private partnerships. Government subsidies can be used to support the creation of e-waste collection platforms, alongside individuals' willingness to pay (WTP). Manufacturers can address the issue of e-waste disposal in landfills and promote consumer awareness of environmentally friendly products by utilizing recyclable or recovered materials in their production, packaging, and shipping processes. Furthermore, they can offer explicit guidelines regarding the appropriate procedures for returning, recycling, or disposing of electronic products after they have become no longer functional.

Study results found that Environmental Knowledge had a favorable influence on the disposal intention of e-waste. The results from the study corroborated with the findings of Kwatra et al. (2014); Echegaray and Hansstein (2017); Borthakur and Govind (2019); Afroz et al. (2020); and Arain et al. (2020). This indicated that the young people on campus were aware of the environmental concerns that would result if e-waste is disposed of improperly, which in turn influenced their decision to dispose of their e-waste.

Concerning public awareness results indicated that the youths/research scholars knew about the harmful effects of e-waste on humans and the mother earth. The findings of the study were in contrast with the results of Saphores et al. (2006) and Ramzan et al. (2019) on youths, but the study results supported the studies by Awasthi et al. (2016) and Thi Thu Nguyen et al. (2019).

Furthermore, the findings demonstrated that convenience had a favourable influence on to disposal of e-waste. The conclusions of the study were found to be in concurrence with previous studies by B. Zhang et al. (2019), B. Wang et al. (2019), and Shaharudin et al. (2020). This is because most respondents said they recycled their electronic waste because it was easy, especially in terms of time, space, and distance. The e-waste disposal station is on Campus, and many people who used it said it was easy and saved them time.

When considering the factor Willingness to Pay (WTP), not many in the general youth crowd come forward to opt for the facility. WTP is sensitive as many Indians have to think twice before deciding on paying for e-waste, which is disposed of freely along with the normal household waste in most places. WTP usually should be backed up with proper facilities for recycling e-waste. The nearest recycling facility is almost 400 km from where the study was conducted. The youths in the campus are usually funded by their parents and WTP upfront or later on won't pinch their pockets. Both willingness to pay and infrastructure had a positive influence on the recycling of e-waste and are supported by the studies by Kwatra et al. (2014), Shaikh et al. (2020), and Saphores et al. (2006).

Furthermore, it was understood that publicity on e-waste would increase awareness towards the disposal of e-waste. Many youths/research scholars found that the proper content related to e-waste recycling should be implemented, which will make them cautious. The study findings had contrasting results

compared to previous studies (Z. Wang et al., 2016, 2018). The findings of this study on publicity have a significant influence on disposal intentions of e-waste.

Data security or information leakage is only concerning laptops, desktops, mobile phones, and tabs. The reason for not disposing or storing e-waste at home is due to fear of information leakage. Recent studies by Singh et al. (2020) and Arain et al. (2020) found data security to be a critical factor in not disposing of the e-waste. The previous studies found that they were unsure of backing up the data or lacked trust in their recyclers. But the finding of this study had data security influencing the disposal intention of e-waste, which contradicted the results of the previous studies.

The personal norms in this study were found to have a significant influence on disposal behaviour of e-waste. It was also supported by previous studies conducted on the general population (Park & Ha, 2014; Z. Wang et al., 2018; B. Wang et al., 2019).

Lastly, the study found that the inclination to discard e-waste had a notable impact on the adherence to proper disposal practices. The results indicate that young adults, college students, and researchers at a college campus have a desire to dispose of electronic waste and that this desire will eventually impact their behavior in terms of proper disposal. A study by Ari and Yilmaz (2016) found that the disposal behaviors of Turkish homemakers significantly influenced their intentions to recover electronic waste. The present study's results align with previous research (Delcea et al., 2020; Echegaray & Hansstein, 2017), which demonstrated a noteworthy relationship between intentions to dispose of e-waste and actual e-waste disposal behavior. The study was conducted in a comprehensive setup that included various facilities such as an institute website portal with information on e-waste, established collection centres, and information on informal e-waste disposal. The youth participants demonstrated their disposal behavior by adhering to the institute's instructions.

7. Limitations and future research

Since the study was conducted on campus with all the required facilities, youths adhered to the institutions instructions and followed all the norms. One of the important points identified in this research was the e-waste collection centres were situated only within the Campus. The general public or respondents have to dispose of it with the normal garbage, which is then sent to the informal sector for recycling. The nearest e-waste recycling facility is situated almost close to 400kms from the campus.

Future research should concentrate on demographic groups to confirm the influence of the factors on the intention to dispose of e-waste as well as the influence on their behaviors. As a result, whether the findings will change if the study is conducted on different demographic groups must be assessed. Using the integrated TPB-NAM model to search for other factors may also help consumers understand e-waste disposal in India.

8. Conclusion

This study aims to predict the impact of different factors on individuals' intentions and behaviors regarding e-waste recycling. This study is essential due to the significant quantities of electronic waste generated annually and the potential impact of determinant factors on decision variables. The study focuses on a number of the elements that have been previously identified in the literature as important factors influencing recycling electronic waste intention and decisions. This study investigated and presented an integrated TPB-NAM model to determine the important factors of young adult's/students/research scholars' e-waste recycling behavior. We presumed students and research scholars have good knowledge about the environment and climate change that is taking place. The findings revealed that the main elements impacting e-waste recycling intentions are environmental knowledge, public awareness, willingness to pay, infrastructure, convenience, publicity, and data security. The intentions to recycle e-waste and personal norms also positively influenced the disposal behavior of e-waste. The empirical results from the study considered 'intentions' to be a major predictor of e-waste disposal behaviour of students/young youths followed by personal norms, advertising, and publicity. Based on the findings, policymakers have a deeper understanding of the phenomenon of recycling electronic trash and the fundamental

factors that contribute to it, and are in a better position to develop better policies for maintaining an appropriate e-waste management system.

Although the recent academic literature on the TPB model's predictive ability is polarised, the favourable findings from this research indicate that the integrated TPB-NAM model is likely to continue to be used in psychological and sociological research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix A

Table A1. Constructs with their items and questions.

| Constructs | Items | Questions | Ref. | Items reversed | Items deleted |
|--|--------|---|---|----------------|---------------|
| Public Awareness | PA1 | I am often concerned about environmental issues | Z. Wang et al., 2016 Thi Thu Nguyen et al., 2019 | No | No |
| | PA2 | I think everyone should contribute to environmental protection | | No | No |
| | PA3 | It's wrong to dispose electronic waste and regular waste together | | Yes | No |
| | PA4 | Disposing e-waste in a proper manner is my responsibility. | | No | No |
| | PA5 | I feel very satisfied when recycling e-waste. | | No | No |
| Environmental Knowledge | EK1 | When I buy electrical and electronic equipment I consider the harmful effects towards the environment. | Islam et al., 2016 Afroz et al., 2013 Ndunesokwu et al., 2017 | No | No |
| | EK2 | I know that recycling preserves natural resources for the benefit of present and future generations. | | No | No |
| | EK3 | Recycling my old electrical or electronic appliances is good for the environment. | | No | No |
| | EK4 | I know that e-waste is rich in recyclable components. | | No | No |
| | EK5 | Recycling my old electronic appliances is good for my health and my family's health. | | No | No |
| | EK6 | E-waste can be a resource if properly managed. | | No | No |
| Willingness to Pay | WTP1 | I am willing to share a part of recycling cost, only if there is recycling facility/collection center nearby | Kwatra et al., 2014 Shaikh et al., 2020 | No | No |
| | WTP2 | Willing to share a part of recycling cost, is not consumer's responsibility alone | | Yes | No |
| | WTP3 | Willingness to take responsibility for recycling of E-waste | | No | No |
| | WTP4 | Willingness to pay a charge for disposal of e-waste | | No | No |
| | WTP5 | I want the government to pay for the disposal and recycling of e-waste | | Yes | Yes |
| Infrastructure | Infra1 | The e-waste collection centers have to be properly managed. | Ndunesokwu et al., 2017 | No | No |
| | Infra2 | I will drop-off my e-waste if the government provides adequate infrastructure. | | No | No |
| | Infra3 | E-waste collection centers have to be situated close to the community/residential area. | | No | No |
| | Infra4 | The collection centers ought to be a sustainable establishment. | | No | No |
| | Infra5 | There are many e-waste collection facilities near my house. | | No | No |
| Advertising and Promotions - Publicity | Pub1 | Publicity will help me to know that, e-waste is the reason to pollute the environment or endanger human health. | Z. Wang et al., 2018 | No | No |
| | Pub2 | Publicity will help me to know there are still many recyclable components available in e-waste | | No | No |
| | Pub3 | I think the relevant information about e-waste recycling publicity is important. | | No | No |
| | Pub4 | Because of publicity I know the shortcomings of the informal e-waste disposal. | | No | No |
| | Pub5 | Publicity will help me to know what household e-waste can be recycled. | | No | No |
| Convenience | Conv1 | Because of publicity, I know where to dispose my household e-waste for recycling. | Sidique et al. (2010), Saphores et al. (2012) | No | No |
| | Conv2 | It is easy for me to go to an E-waste recycling centre | | No | No |
| | Conv3 | It is easy for me to find information on E-waste recycling | | No | No |
| | Conv4 | I have no convenient transport to send E-waste to the collection point. | | Yes | Yes |
| | Conv5 | I think surrounding E-waste recycling channels are incomplete. | | Yes | Yes |
| Data Security | D51 | I don't know how to back-up my data before disposing. | Liu et al., 2019, | Yes | No |
| | D52 | I believe the data from my mobile/laptop/desktop won't be breached/leaked. | | No | No |
| | D53 | I am concerned about my data theft. | | Yes | Yes |
| | D54 | I believe after the disposal of my mobile/Laptop/ Desktop my recycler will destroy the available data. | | No | No |
| | D55 | I trust my recycler | | No | No |
| Personal Norms | PN1 | I would feel proud if I actively recycled my household e-waste. | Z. Wang et al., 2018 | No | No |
| | PN2 | I would feel guilty if I did not recycle my household e-waste. | | No | No |
| | PN3 | Not separating waste would violate my moral principles | | Yes | No |
| Intention | Int1 | In the future when dealing with e-waste, I would like to try to contact the factory or professional recycling agencies. | Y. Zhang et al., 2020 | No | No |
| | Int2 | When I buy electronic products in the future, I tend to choose products that promise to be recycled or disposed of in a proper manner | | No | No |
| | Int3 | I intend to put extra effort into recycling E-waste | | No | No |
| | Int4 | In the future, I intend to recycle my e-waste by formal channels. | | No | No |
| | Int5 | In the future, I will actively participate in e-waste recycling and tell surrounding people about the recovery experience. | | No | No |
| Disposal | DB1 | I keep e-waste stored at home | Borthakur & Govind, 2019 | No | No |
| | DB2 | I prefer to exchange dead/used electronic waste at the store when buying a new one | | No | No |
| | DB3 | I will ensure that I dispose e-waste properly in the future | | No | No |
| | DB4 | I would feel guilty if I did not recycle my household e-waste | | Yes | No |
| | DB5 | When I buy electronic products in the future, I tend to choose products that promise to be recycled | | No | No |