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Factors That Influence the Safe Disposal Behavior of E-Waste by Electronics Consumers

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Abstract: This study investigated the factors that influence the safe disposal intention and behavior of consumers, considering the mobile phone as an example. Specific hypotheses linking the factors that influence safe disposal intention and behavior with the support of extant literature on theories of reasoned action and planned behavior were developed. A questionnaire was designed based on the following factors: awareness, convenience, subjective norms, producer interventions, and regulations that influence the intentions and behavior of consumers in the safe disposal of e-waste. The data was collected by conducting a cross-sectional survey in India. The collected data was analyzed for descriptive statistics and measurement properties and further tested the hypotheses using partial least squares-structural equations modeling (PLS-SEM). All the measures used in the study were found to have satisfactory reliability and validity testing. The findings of hypotheses testing suggest that the factors such as awareness (Std. coefficient = 0.109 with p value < 0.05 level), convenience (Std. coefficient = 0.341 with p value < 0.01 level), subjective norms (Std. coefficient = 0.242 with p value < 0.01 level), producer interventions (Std. coefficient = 0.228 with p value < 0.01 level), and regulations (Std. coefficient = 0.148 with p value < 0.01 level) were found to significantly impact safe disposal intentions. However, the direct effect of regulation on safe disposal behavior was found to be non-significant (Std. coefficient = 0.091). Therefore, the significant finding of our study is that without the intention of behaving in a certain manner, the direct regulations may not influence the consumers to behave as intended. Our study's results emphasize two areas that may trigger the consumer's intentions for safe disposal of e-waste. First, the social norms, and second, the importance of producer responsibility in creating the required reverse logistics infrastructure and clear communication to customers for the safe disposal of e-waste.

Keywords: e-waste; used mobile phone; theory of reasoned action; theory of planned behavior; waste disposal; consumer behavior; environmental behavior

1. Introduction

According to [1], 53.6 million metric tons of electronic waste (e-waste) was generated worldwide in 2019, mostly it was dumped or burned. It means that USD 57 billion worth of gold, silver, copper, platinum, and other high-value recoverable materials were simply dumped and burned, which could have been recovered and recycled. Not only was the opportunity to recover the material missed, health and environmental hazards were created by dumping and burning them because the e-waste also contains toxic materials such as mercury, cadmium, lead, etc. According to the report in [2], India generated 3.5 million tons of e-waste in 2019, and the country's formal e-waste recycling capacity of approximately 800,000 tons annually mostly remained underutilized. The informal sector handled 95% of the e-waste for recovery and recycling. According to [3], in Southern Asia, India is the only country that has e-waste legislation; e-waste (Management) Rules 2011, amended in 2016 and on 22 March 2018, states that the "Collection and channelization of e-waste under

Extended Producers Responsibility Act (EPRA) shall be in line with the targets prescribed in Schedule III of the Rules". Phase-wise collection targets for e-waste, which can be either in number or weight, shall be 30 percent of the quantity of waste generation as indicated in the EPR plan during the first two years of implementation of the Rules, followed by 40 percent during the third and fourth years, 50 percent during the fifth and sixth years, and 70 percent during the seventh year onwards. Still, Environmental Performance Index 2020 ranked India at 168 amongst 180 countries as reported by [4], the 12th rank from the bottom among 180 countries. E-waste is growing at a Compound Annual Growth Rate (CAGR) of about 30% in the country. With India being the world's second largest smart phone consumer, it has been estimated that mobile phones, tablets, and personal computers contribute to 82% of e-waste in the country (i.e., approximately 41 million tons), with the remaining items being other large household appliances. According to the report in [5], India had 502.2 million smartphone users as of December 2019. Considering that the average weight of a smartphone is 160 g, and consumers change their mobile phone every three to five years, it is estimated that by the end of the year 2022, there will be 144,000 tons of e-waste generated through mobile phones alone. Though global e-waste represents almost 5% of all municipal solid waste [6], the toxicity brought to the environment by this waste is high, representing almost 70% of our overall toxic waste [7].

Studies conducted in various countries on consumer disposal behavior of electrical and electronics devices found that consumers tend to store End of Life (EoL) devices rather than discarding them safely [8,9]. Researchers have identified reasons for not safely disposing the devices, such as partly functional devices that are kept as spares to use whenever needed, psychological reasons (desirability), device is needed but no longer in fashion, and product failed and not functional [10,11]. Globally, several management interventions are ongoing, including a call for the adopting principles of circular economy, extended producer responsibility (EPR), recycling, and a Pro-Environment Behavior (PEB) in which individuals take protective actions toward the environment [12], which include responsibly engaging with outdoors or recycling household waste and adaptive responses to the impact of climate change, such as purchasing sustainable products (e.g., buying an electric vehicle or building an off-grid home) [13]. Shevchenko et al. [14] argue that consumers determine the demand for various products, use and maintain them, and decide whether to return products to the reuse/recycling system at products' end-of-life (EoL). The consumer has a special role in the operationalization of Extended Producer Responsibility (EPR) as a customer, user, and e-waste holder. Increasing consumer participation in e-waste collection schemes requires the identification of determinants that influence consumer recycling behavior [14]. Used mobiles collection and e-waste management primarily depends on the safe disposal intention and behavior of the consumers. Industry 4.0-based technologies support current circular economy practices by virtually and practically testing a waste from electrical and electronic equipment (WEEE) disassembly plant configuration through a set of dedicated simulation tools and a fully automatized manufacturing line [15]. A well-developed circular economy has the potential to generate jobs worldwide, possibly up to six million [16]. We believe that our findings contribute to identifying safe disposal intentions and behavior in electronics consumers to develop the schemes and policies to promote safe disposal behavior.

This paper is organized into five sections. The first section includes the introduction. The second section presents a literature review on e-waste disposal attitude that leads to safe disposal behavior. The third section presents the research framework and methodology, the fourth section presents findings and discussions, the fifth section provides data analysis and discussions, and finally, the study is concluded with direction for further studies.

2. Literature Review and Hypothesis Development

Previous researchers have presented various factors that can influence the behavior of consumers in contributing to reducing, reusing, and recycling e-waste. For example, Shevchenko et al. [14] argued that e-waste recycling depends on an individual's perceived

ease or difficulty in performing this behavior, which depends on an awareness and knowledge of e-waste recycling. The role of household awareness is underlined by [17], who believed that a well-informed and aware population can make better decisions related to the handling of e-waste [18]. Yasir et al. [19] identify deliberate behavioral attitudes, social norms, and behavioral manipulation for individual sustainable intentions as the way a character behaves and shows their desire. Intention is assumed to be a function of two basic determinants: attitude towards the behavior and subjective norm [20,21]. People's intentions are affected by their attitude towards recycling, perceived subjective norms, awareness, perceived behavioral control over recycling, and the convenience of recycling [22–24]. According to [25], planned behavior confirms that three principles determine a person's intention: (i) attitude, (ii) subjective norm, and (iii) perceived behavioral control.

2.1. Attitude

Attitude is a tendency or predisposition to feel and behave in a particular way toward some object. Contrary to the traditional understanding of attitude as a positive or negative evaluation of an object, the construct of attitude refers solely to the attitude towards the behavior [26]. Environmental attitude is defined as "the concern for the environment or caring about environmental issues [27], for example, [28] observed that people who have a positive outlook towards electric vehicles are ready to pay extra (up to USD 16,000) for green vehicles; recycling behaviors can be driven by recognition of the inherent value of the environment; [29,30] found that individual consumers and households can play a significant role in waste reduction and recycling by increasing individual awareness of waste issues and reinforcing attitudes that positively affect behaviors. Studies found that recycling awareness leads to various behaviors, such as a positive attitude towards recycling [31]. It is important to create awareness amongst consumers and collaboration between stakeholders to solve the e-waste problem [32].

The authors of [33] emphasize education and creating awareness to increase the demand for proper waste management. In this paper, the authors extended this model with the help of a small sample to show that, in Malaysia, environmental awareness has a positive impact on households' attitudes toward recycling. The paper by [32] underscores the importance of creating awareness amongst consumers and collaboration between stakeholders for solving the e-waste problem. According to [34], consumer awareness will help producers and authorities take the necessary steps to establish the "3 Rs" (reduce, reuse, and recycle) approach of waste disposal. The research by [35] concludes that consumer awareness and education and some factors are the causes of sustainable consumer behavior. Therefore, our first hypothesis is as follows.

Hypothesis 1 (H1). *Awareness is positively associated with the intention to safely dispose of mobile phone waste.*

2.2. Subjective Norms

According to the Theory of Reasoned Action model [36], "people's behavior is in the control of their own will". If others suggest behaving in a certain manner, and if they evaluate the suggested behavior as positive, it leads to an attitude, and if they think that others want them to behave in a certain way, it becomes a subjective norm. Subjective norms are perceptions of what others think of a particular behavior [25]. With a personal belief in which individuals depend on others' opinions or judgment on how they should or should not behave [37], an individual may forego a behavior if there is a belief that that behavior would be unacceptable, or they may decide to act in a way that would not be noticed. Many scholars found that a person will feel like performing a certain task if social pressure is behind it; [38,39] found that subjective norm has a significant effect on electric vehicle purchase decisions, with individuals admitting the role of perceived social expectations on their buying pattern. In a study of the influence of parents on their children's reuse and recycling of paper, researchers found both personal and subjective norms to be relevant [38], and a study by [40] confirmed that the subjective norms significantly influence

the intentions of young consumers in purchasing green products, organic personal care products, and visiting eco-friendly restaurants [41–43]. Boomsma et al. [44] found that subjective norms play a significant role in motivating consumers to recycle the products. Consumers are often influenced by their peers, families, societies, and the Government in making decisions. According to [45], proper infrastructure for safe recycling influences consumer choices. Therefore, our second hypothesis is as follows.

Hypothesis 2 (H2). *Subjective norms are positively associated with the intention to safely dispose of mobile phone waste.*

2.3. Perceived Behavioral Control (Regulations)

Perceived Behavioral Control (PBC) indicates people's perceptions of their abilities to perform a given behavior [46], and it is associated with perceived risk, where risk perception influences self-confidence in controlling one's behavior. Researchers observed the adoption intention of US households comprehensively and found that technology orientation and openness to change could lead to the feeling of better control and, hence, have a positive impact on respondents buying electric vehicles [47], and they argue that intrinsic and extrinsic motivations lead to different outcomes and, thus, are likely to have different effects on PBC [48]. Intrinsically motivated behaviors are produced and maintained because their enjoyment reinforces them [49]. Extrinsic motivation includes external regulation, which affects an individual's behavior through contingencies of reward or punishment, and self-regulation, which occurs when the external regulation has been partially internalized and is energized by such factors as desire for approval and avoidance of shame, contingent self-esteem, and ego-involvement. A study by [50] reported that PBC predicted pro-environmental behavioral intentions in their study of household waste recycling. The last element of the TPB model is the actual behavior, which, according to [25], can usually be predicted from the behavioral intention, and there may be no perfect correlation between intention and behavior [17]. Thus, the measure of the construct of behavior is necessary [46]. Moreover, Ajzen and Fishbein [26] insist that it is vital to define the target behavior precisely, even if the study is limited to investigating only the intentions.

The Government of India announced that "manufacturers are now also responsible for collecting e-waste generated during the manufacture of any electrical and electronic equipment and channelizing it for recycling or disposal" [51]. They also must obtain authorization from State Pollution Control Boards (SPCBs). Manufacturers are required to ensure that no damage is caused to the environment during the storage and transportation of e-waste. The Environment Ministry mandated industries to collect ten percent of e-waste through the Extended Producer Responsibility (as a producer intervention) plan. Therefore, our third hypothesis is as follows.

Hypothesis 3 (H3a). *Regulation is positively associated with the intention to safely dispose of mobile phone waste.*

Hypothesis 3 (H3b). *Regulation is positively associated with safe disposal behavior of mobile phone waste.*

2.4. Convenience

Recent research on e-waste disposal intention and behavior has attributed it to convenience in returning mobile phones [52]. A study in Malaysia by [53] found that, along with awareness, the convenience of the recycling infrastructure has a positive correlation with recycling intentions of the households. According to the paper, the Government of Bangladesh should establish recycling centers to encourage recycling activities. Sheoran et al. [35] conclude that ease of use, disposal methods, and available resources relate positively to sustainable consumer behavior. Saphores et al. [54] investigated the willingness to recycle e-waste at the drop-off center and found that convenience factors such as proximity to recycling centers and curb-side recycling programs increased eCycling.

Therefore, our fourth hypothesis is as follows.

Hypothesis 4 (H4). *Convenience is positively associated with the intention to safely dispose of mobile phone waste.*

2.5. Producer Intervention

The manufacturer's initiative to recycle mobile phones comes under the extended producer responsibility or producer intervention. Currently, India's major mobile phone producers have no pressure from the Government or consumers to recycle their produce, nor do they have any pressure to design and manufacture environmentally sustainable cellphones. However, some major players claim that they reuse extracted components and materials. Nokia states that, in 2017, through its voluntary programs, it sent around 2600 metric tons of old telecommunications equipment for materials recovery and reused approximately 68,000 units. It has also restricted the use of beryllium compounds. Apple claims to be "building iPhones that are less toxic but more durable. The tech giant also recently began using a 29-armed factory robot called Liam, which can disassemble an iPhone every 11 s and sort its high-quality components so they can be recycled" [55].

There are many difficulties, mainly on account of the sizeable informal sector handling the e-waste, illegal imports, and weak regulatory capacity of the state [56,57] highlight that "companies will be successful in their activities related to sustainability when they have a broad situational view, engaging all stakeholders directly or indirectly". Policies such as producer intervention can be helpful, but the mere inclusion of extended responsibilities in waste management rules does not guarantee that it will work or result in a satisfactory response from the producers. Therefore, our fifth hypothesis is as follows.

Hypothesis 5 (H5). *Producer intervention is positively associated with the intention to safely dispose of mobile phone waste.*
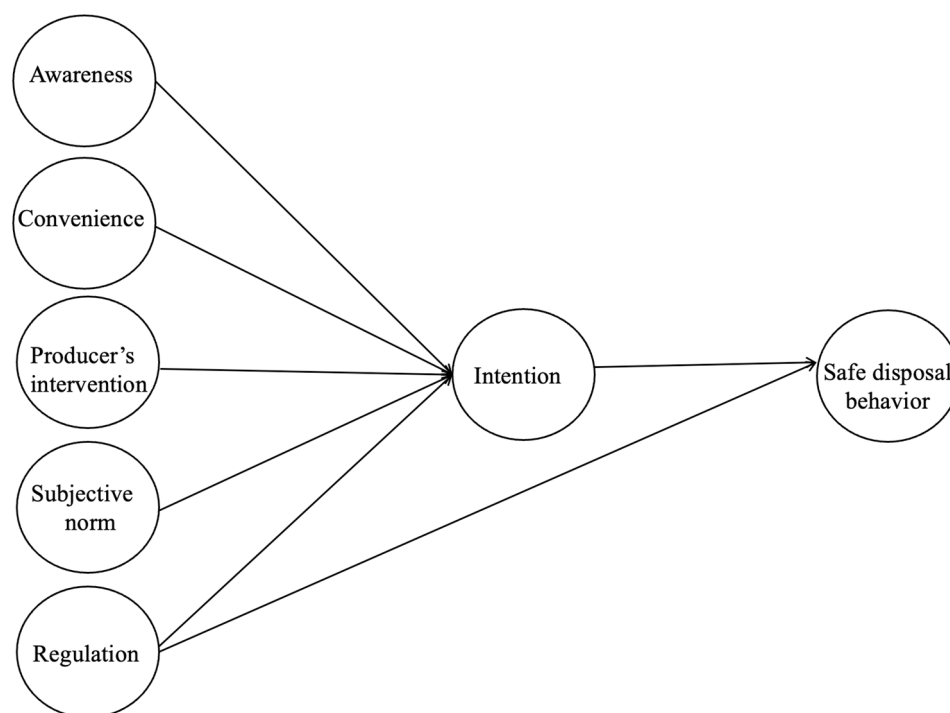
2.6. Intention

Product return intention, in this study, is the people's intention to return their mobile phones for recycling, refurbishing, or remanufacturing. According to Kochen et al. [58], the study shows that the consumers' intention has a relationship with the consumer behavior of returning the e-wastes. From a theoretical point of view, "it is intuitive, insightful to explain behavior, and parsimonious" [59]. An individual's recycling behavior is determined largely by their intention to recycle. Thus, to predict a specific behavior, such as recycling household waste regularly, we must assess equally specific beliefs, norms, and intentions to recycle household waste regularly. Residents of India refuse to deliver their obsolete electrical electronics equipment without financial incentive because e-waste is still considered a worthy commodity of commerce [9]. Therefore, our sixth hypothesis is as follows.

Hypothesis 6 (H6). *Intention to safely dispose of mobile phone waste is positively associated with safe disposal behavior.*

The relationship between the awareness, convenience, subjective norms, producer intervention, and regulations lead to the intention of people to safely dispose of the e-waste, and the government regulations directly lead to safe disposal behavior irrespective of the intention because of the penalty clauses or reward if any by the regulating authorities for disposal of the mobile phone waste. According to the Theory of Reasoned Action model [36], "people's behavior is in the control of their own will". If others suggest that people behave in a certain manner, and if they evaluate the suggested behavior as positive, it leads to the attitude of people thinking that others want them to behave in a certain way (it becomes a subjective norm/social norm). Both attitude and subjective norm may result in a higher intention (i.e., motivation to act) to behave as proposed in Figure 1.

Figure 1. Relationship between factors impacting e-waste safe disposal intentions and behavior.

3. Methodology

3.1. Questionnaire Design

The questionnaire was designed based on the measures used in the previous studies on e-waste. Questionnaire items on intention, behavior, awareness, subjective norms, and convenience were taken from scales developed by [58,60,61], and items on regulation and producer intervention were taken from Kaur and Goel [45], as shown in Appendix A. Further, the items of the questionnaire were finalized in discussion with experts from the marketing and operations areas.

3.2. Pilot Study and Instrument Validation

A pilot questionnaire consisting of 38 items was administered online in an opportunity sample of 36 adults (18 to 56 years old), of which there were 16 women and 20 men. Reliability and validity tests were conducted using IBM SPSS. The results of Cronbach's alpha were in the range of 0.66 to 0.91, and the principal component factors ranged from 0.52 to 0.906. The items which affected the reliability and validity have been removed from the final questionnaire. A new questionnaire was developed, having 27 items as shown in Appendix A, and it was ready for administration. The questionnaire was divided into two sections. The first section's questions were based on the respondents' profiles such as gender, age, location, type of phone they are using, and availability of e-waste in their home, and the second part of the questionnaire consisted of the items of dependent variables and the independent variables measured on a Likert scale from one to five (1 = Strongly Disagree, 5 = Strongly Agree).

3.3. Data Collection

Primary data was collected in a Google form across the country from respondents of 15 years and above. Colleagues and students at management in the statute were asked to circulate a link to the questionnaire to their friends and family using Google Forms shared on various social media sites such as WhatsApp, Facebook, Twitter, LinkedIn, Quora. Mainly, the social media groups consisted of engineers, management graduates, and IT professionals. Considering the statistical technique, PLS-SEM, used to validate the hypotheses of our study, the following rule of "10 times the largest number of structural

paths directed at a particular construct in the structural model" [62] was applied to arrive at the minimum sample size required for the study. In our study, there are five structural paths directed at a latent construct of entrepreneurship intention that guided us to come up with a total sample size of no less than 50. Data were collected during the month of September 2020. We received 273 responses, out of which 248 were useful with complete information for data analysis. The sample size of 248 would be sufficient for the PLS-SEM analysis used in our study.

4. Analysis and Results

The data was analyzed for descriptive statistics, and we further tested the hypothesis using partial least squares-structural equations modeling (PLS-SEM).

Descriptive Statistics

Table 1 provides the details of sample characteristics. Most of the respondents are 20–30 years old (71.8%); 58.5% of respondents are male, and 41.5% are female; 51.1% of respondents are students. The responses are from the North, South, East, and West sides of the country. In total, 83.1% of respondents use Android phones, and 16.9% of people use iOS phones. A total of 72.18% responded saying that they have at least one discarded mobile phone with them.

Table 1. Sample characteristics.

Characteristics	Number	Percentage
Age Category		
20–30	178	71.77
31–40	22	8.87
41–50	15	6.05
51–60	20	8.06
60+	13	5.24
Gender		
Male	145	58.47
Female	103	41.53
Profession		
Student	127	51.21
Employed	93	37.50
Other	28	11.29
Region in India		
North	67	27.02
South	56	22.58
East	70	28.23
West	30	12.10
North East	25	10.08
Mobile phone operating system		
Android	206	83.06
iOS	42	16.94
Hold discarded e-waste at home		
Yes	179	72.18
No	69	27.82
Average no. years for change of mobile phone		3.56 years

The collected data was further used to check the measurement properties of the constructs used in the study and for validating the proposed model. We used partial least squares-structural equations modeling (PLS-SEM) with the help of SmartPLS 3.0 for this purpose. Table 2 provides factor loadings of the items with their respective construct and their cross loadings. Factor loadings express how well the respective item is related with the underlying factor, and cross loadings signify the level of the respective item's relationship with other underlying factors. All the items of the respective constructs shown in Table 2

load with their respective construct well, and their cross loading was low, which establishes convergent and discriminant validity of the measures used in the study. The items that were found to have factor loadings less than 0.50 and higher cross loadings were removed from further analysis.

Table 2. Factor loadings and cross loadings.

Constructs/Items	AW	CO	SN	PI	RE	RI	RB
Awareness (AW)							
AW1	**0.93**	0.28	0.16	0.20	−0.03	0.28	0.15
AW2	**0.94**	0.31	0.17	0.22	−0.03	0.29	0.22
AW3	**0.79**	0.21	0.13	0.21	0.05	0.24	0.14
Convenience (CO)							
CO1	0.20	**0.78**	0.32	0.25	0.10	0.45	0.31
CO2	0.18	**0.71**	0.33	0.16	0.12	0.37	0.25
CO3	0.27	**0.79**	0.35	0.18	0.07	0.41	0.20
CO4	0.15	**0.67**	0.26	0.13	0.08	0.36	0.29
CO5	0.28	**0.63**	0.28	0.16	0.12	0.39	0.30
Subjective norms (SN)							
SN1	0.16	0.34	**0.89**	0.43	0.44	0.48	0.39
SN2	0.18	0.36	**0.86**	0.33	0.34	0.45	0.32
SN3	0.03	0.37	**0.85**	0.39	0.36	0.51	0.32
SN4	0.20	0.35	**0.68**	0.44	0.30	0.48	0.39
Producer interventions (PI)							
PI1	0.25	0.25	0.45	**0.87**	0.16	0.47	0.48
PI2	0.16	0.20	0.42	**0.89**	0.20	0.39	0.56
PI3	0.14	0.15	0.33	**0.81**	0.27	0.33	0.51
PI4	0.23	0.25	0.47	**0.89**	0.32	0.49	0.60
Regulations (RE)							
RE1	−0.02	0.04	0.38	0.23	**0.85**	0.29	0.28
RE2	0.02	0.11	0.36	0.26	**0.84**	0.29	0.20
RE3	−0.03	0.18	0.35	0.20	**0.80**	0.33	0.17
Intention (INT)							
INT1	0.29	0.39	0.38	0.34	0.19	**0.76**	0.33
INT2	0.25	0.30	0.49	0.47	0.30	**0.72**	0.42
INT3	0.17	0.46	0.53	0.37	0.37	**0.80**	0.32
INT4	0.25	0.48	0.45	0.41	0.27	**0.78**	0.49
INT5	0.22	0.52	0.40	0.31	0.26	**0.79**	0.36
Safe disposal behavior (SDB)							
SDB1	0.14	0.26	0.38	0.55	0.23	0.41	**0.89**
SDB2	0.21	0.39	0.38	0.53	0.18	0.43	**0.84**
SDB3	0.14	0.32	0.37	0.52	0.26	0.47	**0.85**

Notes: Values in bold signify factor loadings converged to its respective construct and higher than its cross loadings.

All the measures were subjected to further discriminant and convergent validity tests, as shown in Table 3. The average variance extracted (AVE) of all the constructs used in the study exceeded the minimum cut-off of 0.50 establishing satisfactory convergent validity [62]. As per Fornell and Larcker's criterion, the square root of AVEs of the respective construct is also found to be higher than that construct's correlation with other constructs included in the study, which establishes satisfactory discriminant validity of the measures of all the constructs [62]. The reliability of all the measures is also presented in Table 3. The Cronbach Alpha and composite reliability of all the measures used in the study exceeded the minimum threshold limit of 0.70, thus establishing satisfactory reliability.

Once the measurement properties of all the constructs are confirmed, hypotheses testing of all proposed structural relationships is conducted. The results of the hypotheses testing are presented in Table 4. In PLS-SEM, the structural model is assessed for explanatory power, predictive relevance, and predictive power [57]. R^2 value signifies the explanatory power. R^2 is a measure used to explain to what extent the proportion of variance in the dependent variable is explained by the independent variable(s) used in the

model. The descriptive of the model with the dependent variable "recycling intentions" was 0.532, which means that 53.2% of the variance in the dependent variable "safe disposal intentions" is explained by the independent variables used in the study. This is adequate explanatory power.

Table 3. Reliability, convergent, and discriminant validity.

Constructs	Cronbach Alpha	Composite Reliability	AVE	Inter-Construct Correlations						
				AW	CO	SN	PI	RE	INT	SDB
Awareness (AW)	0.87	0.92	0.79	**0.89**						
Convenience (CO)	0.76	0.84	0.52	0.30	**0.72**					
Subjective norms (SN)	0.89	0.92	0.75	0.17	0.43	**0.82**				
Producer interventions (PI)	0.84	0.89	0.68	0.23	0.25	0.49	**0.87**			
Regulations (RE)	0.78	0.87	0.69	−0.01	0.13	0.44	0.28	**0.83**		
Safe disposal intentions (INT)	0.83	0.88	0.60	0.30	0.56	0.59	0.50	0.36	**0.77**	
Safe disposal behavior (SDB)	0.83	0.90	0.75	0.19	0.38	0.43	0.62	0.26	0.50	**0.86**

AVE: average variance extracted; values in bold are square root of AVE of the corresponding construct.

Table 4. Results of hypotheses testing (structural model).

Dependent Variable: Safe Disposal Intentions				Dependent Variable: Safe Disposal Behavior			
Independent Variables	Std. Coefficients	t-Value	Hypothesis Supported?	Independent Variables	Std. Coefficients	t-Value	Hypothesis Supported?
H1: Awareness	0.109	2.103 **	Yes				
H2: Subjective norms	0.242	3.223 *	Yes				
H3a Regulations	0.148	2.876 *	Yes	H3b: Regulations	0.091	1.352	No
H4: Convenience	0.341	4.985 *	Yes				
H5: Producer interventions	0.228	3.185 *	Yes				
				H6: Safe disposal intentions	0.471	7.529 *	Yes
R² Value		0.532				0.261	
Q² Value		0.306				0.189	

* *p* value < 0.01 level; ** *p* value < 0.05 level.

Further, being with two independent variables, the model with the dependent variable "safe disposal behavior" produced an R^2 value of 0.261, which can also be considered satisfactory. Regarding predictive relevance, through the blindfolding approach in Smart-PLS, the Q^2 value is drawn, which is supposed to exceed zero for a satisfactory predictive relevance [63]. Q^2 value is important in assessing the relevance of prediction as "it checks if the data points of indicators in the reflective measurement model of the endogenous construct can be predicted accurately" [63]. The Q^2 value of the model with the dependent variable "recycling intentions" (Q^2 value = 0.261) and the model with the dependent variable "recycling behavior" (Q^2 value = 0.189) exceeded the value of zero, establishing satisfactory predictive relevance.

The predictive power of the effect of each independent variable on the dependent variable is assessed by the significance of the standardized coefficients. In SmartPLS, the *t*-value of the standardized coefficients and their *p* values are drawn from a bootstrapping procedure. The bootstrapping procedure was used with a subsample of 5000. The standardized coefficients of all the independent variables proposed to impact the dependent variable "intentions for safe disposal" were found to be significant (Std. coefficient for Awareness = 0.109 with *p* value < 0.05 level; Std. coefficient for Convenience = 0.341 with *p* value < 0.01 level; Std. coefficient for Subjective norms = 0.242 with *p* value < 0.01 level; Std. coefficient for Producer interventions = 0.228 with *p* value < 0.01 level; Std. coefficient for Regulations = 0.148 with *p* value < 0.01 level). Thus, hypotheses H1, H2 to H3a, H4, and H5 of our study are supported.

Furthermore, the effect of safe disposal intentions on safe disposal behavior was found to be significant (Std. coefficient = 7.529 with *p*-value <0.01 level). Thus, hypothesis H6 of our study is supported. The effect of the independent variable, regulations, on safe disposal behavior, was non-significant (Std. coefficient = 0.091); therefore, hypothesis H3b of our study is not supported.

5. Discussion on Results

This study investigated the factors that influence safe disposal intentions and behavior of mobile phone waste in the context of a developing country, India. This study comprehensively included all the factors specific to the Indian context by applying the theory of planned behavior and theory of reasoned action. Broadly, the findings suggest that all the factors included in the study are significant, except the direct effect of regulation on safe disposal behavior. We found a positive significant effect of awareness on safe disposal intentions of mobile phone waste. It means that the more people are aware of the consequences of mobile phone waste, then the greater the people's intent to safely dispose of e-waste. After conducting a study on e-waste in African countries, [59] suggested including e-waste awareness in educational curriculums to make the young generation aware about the harmful effects. To increase the safe disposal attitude, the Government, the Electrical and Electronics Equipment (EEE) manufacturers, and educational institutions can play a major role in raising consumers' awareness through advertisements and organizing awareness campaigns for both the consumers and the unorganized e-waste recyclers. The communication of e-waste management information would increase in household participation towards e-waste management.

We found a positive significant effect of convenience on safe disposal intentions of mobile phone waste in agreement with previous findings. For example, "a site or a drop-off location closer to the consumers will help in conveniently disposing their EoL mobile phones" [35,53,54], whose authors concluded stating "safe disposal centers and facilities will positively impact people's intentions". Proper infrastructure, collection boxes, incentive schemes, proximity and convenience, and e-waste management system for safe recycling influences consumer choices [45,52,64]. Using contingent ranking analysis, [58] showed that people's environmental beliefs are statistically significant and play an important role in their willingness to pay for recycling convenience.

Krueger et al. [65] propose that the theory of planned behavior is entirely based on these three social and personal factors: personal attitudes toward sustainability (perceived desirability), subjective norms (perceived social norms), and perceived behavioral manipulation (perceived feasibility). In our study, subjective norm was found to be positively associated with the intention to safely dispose of mobile phone waste in line with previous studies; for example, peer pressure, pressure from family, friends, and society influences people's decisions in returning their phones for safe disposal, as found by [58]. A study conducted in China [66], found that subjective norms of the residents significantly impact their recycling behavior intentions of e-waste. Ylä-Mella et al. [67] found that social norms influence individual attitudes which further impact pro-environmental purchase intentions. A possible explanation for this can be that people follow the environmental norms in their community, peer pressure, peer group behavior, and society and are socially conscious. Since the social norms significantly influence consumers' behavior in safe disposal, the community leaders, educational institutions, and Self-Help Groups can influence the safe disposal behavior and organize the collection centers.

Producer intervention was found to be positively associated with the intention to safely dispose of e-waste. This finding implies that any intervention by the mobile phone producers as a part of extended producer responsibility will influence people's decision in returning the products. Hence, producers/manufacturers should have schemes to collect back the phones and give clear instructions to the consumers for safe disposal. For example, *The Gazette of India* [68] describes the extended producer responsibility and consumer and bulk consumer responsibilities towards the safe disposal of e-waste. The

rule, known as E-waste management rules (2016), states that producers are responsible for providing contact details such as address, e-mail address, toll-free phone numbers, or help line numbers to consumer(s) or bulk consumer(s) through their website and product user documentation so as to facilitate the return of end-of-life electrical and electronics equipment and create awareness through media, publications, advertisements, etc. Our study found that regulation was positively associated with the intention to safely dispose of mobile phone waste. However, regulation's direct effect on safe disposal behavior is not supported. Andeobu et al. [69] argue that e-waste regulations in both developing and emerging economies should include the EPR and EEE manufacturing regulations to produce simple, lightweight products, intended for reuse rather than obsolescence so that component materials can become resources for future new products, thus lessening the demand for raw materials. Similarly, Appolloni et al. [70] argue that the loss of economic opportunities is unsustainable, unless waste is transformed into a resource. In their study, they highlighted that the sustainable objective may not be achieved if there is a lack of attention to social risks. This implies that regulations on the safe disposal of e-waste do not lead people to dispose of the waste safely.

Similarly, e-waste management rule (2016) states that consumers or bulk consumers of electrical and electronic equipment listed in schedule I shall ensure that e-waste generated by them is channelized through collection centers or dealers. Additionally, it states that consumers of electrical and electronic equipment listed in schedule I shall ensure that end-of-life electrical and electronic equipment are not mixed with e-waste containing radioactive material. Our study confirms that the intention to safely dispose of e-waste is positively associated with safe disposal behavior. In fact, people's intention to safely dispose of mobile phones will lead them to safe disposal behavior. This result is consistent with the TRA and TPB literature discussed in the earlier sections. The implications of this findings are that without the intention of behaving in certain manner, the direct regulations may not influence the consumers to engage in safe disposal behavior.

6. Limitations and Direction for Further Work

This study attempted to comprehensively examine the factors that influence safe disposal intentions and behavior related to mobile phone waste among electronic consumers in a developing country, India. The study consists of several limitations. The findings of the study are limited to the Indian context and due care needs to be exercised when they are applied in other contexts. The study is limited only to mobile phone waste. Even though the study included all possible factors that could contribute to safe disposal intentions and behavior, there could be other factors not included in the study that might possibly impact safe disposal intentions and behavior for mobile phone waste. The R^2 value of the model with the dependent variable "safe disposal intentions" is 0.53 which means only 53% of the variance in safe disposal intentions was explained by the factors included in the study, which still suggests the possibility of other factors. Regarding the model with safe disposal behavior as the dependent variable, the R^2 value is 0.261 which also suggests the inclusion of other factors in understanding safe disposal behavior of mobile phone waste. The future research could examine specific variables of the Indian context to understand the safe disposal intentions and behavior of mobile phone wastes. For example, future studies could investigate the effects of various kinds of costs involved in the safe disposal of mobile phone waste. Since about 95% of e-waste is handled by the unorganized sector in India, future research could examine their waste handling practices, safety levels, and how the unorganized sector can be organized and utilized for collaborating with the e-consumers to dispose of equipment safely at the end of its life.

7. Conclusions

Studies conducted in various countries on electrical and electronics devices and consumer disposal behavior found that consumers tend to store End of Life (EoL) devices rather than discarding them safely. We found a similar situation in India as well where

72.18% responded saying that they have at least one discarded mobile phone with them for various reasons. E-waste is growing at a Compound Annual Growth Rate (CAGR) of about 30% in the country. The storage of e-waste may create potential spots of health and environmental hazards across the country.

The findings of the hypotheses testing suggest that factors such as awareness, convenience, subjective norms producer interventions, and regulations were found to significantly impact safe disposal intentions. Safe disposal intentions were found to significantly influence safe disposal behavior. However, the direct effect of regulation on safe disposal behavior was found to be non-significant. The implications of these findings are that without the intention of behaving in a certain manner, the direct regulations may not influence the consumers to engage in safe disposal behavior. Our study's results emphasize two areas that may trigger the consumer's intentions for the safe disposal of e-waste. First, the subjective norms. Subjective norms in society regard how acceptable pro-environmental behavior influences safe disposal behavior. Since social norms have a direct impact on safe disposal behavior, electronics consumers need to encourage their neighbors to join and spread the word about the safe disposal of e-waste and make people responsible for disposing of or recycling the old items whenever they buy a new electrical or electronic device. The second important area of producer responsibility in creating the required reverse logistics infrastructure, such as convenience and producer interventions in the safe disposal of e-waste, was found to influence safe disposal intentions. Safe disposal sites near consumers' locations and a proper drop-off location provided by the manufacturers/producers by collaborating with agents are highly recommended along with the clear communication to customers for the safe disposal of e-waste. Producers need to play a major role in creating awareness among the electronic equipment users. India has rules in place for proper collection and authorized recycling for the implementation of these rules; the role of the informal sector in the recycling business needs to be re-positioned without discounting environmental safety and amenable labor conditions. EPR Plans should be made incorporating an e-waste flow verification system by the producers. Producers may be compelled to issue statutory warnings in their product advertisements, catalogues describing the disposal techniques, and reverse logistics plan. Government regulations also help in developing safe disposal intentions. Policy makers should formulate innovative and creative support mechanisms that encourage safe disposal intentions of e-waste, instead of devising prohibitory or restrictive mechanisms.

Appendix A

Measuring items adapted from-Kochen et al. [52], Kumar [55], Aagia et al. [56], and Kaur and Goel [45].

- Identified measures: SDB1–SDB3: Safe Disposal Behavior, AW1–AW3: Awareness, INT1–INT5: Intention,
- SN1–SN3: Subjective norms, CO1–CO7: Convenience, RE1–RE3: Regulations, PI1–PI2: Producer Interventions.

Table A1. Measures for the constructs used in the study.

S.No	Item	Abbreviation	Reference
Intention			
1	I intend to recycle all my mobile phones (e-waste) regularly	INT1	[58]
2	I intend to drop off used mobile phones at a nearby recycling station	INT2	[58]
3	I intend to return e-waste to the retailer or the manufacturer	INT3	[58]
4	I intend to pay e-waste re-cycling or management fee if required	INT4	[58]
5	My intention in safe disposal of mobile phone is to recycle e-waste	INT5	[61]
Behavior			
6	I have un-usable mobile phone/s in my house	SDB1	[58]
7	I normally re-sell my mobile phone	SDB2	[58]
8	I normally donate my old mobile phones	SDB3	[58]
Awareness			
9	E-waste recycling is a major way to reduce landfills	AW1	[58]
10	Mobile phone waste contains hazardous materials such as mercury, cadmium, lead, etc. E-waste recycling improves the environment	AW2	[58]
11	Mobile phone waste contains precious metals such as gold, silver, copper, aluminum, etc. We can conserve natural resources by recycling	AW3	[58]
Subjective Norms			
12	My friends expect me to safely dispose the old mobile phones	SN1	[58]
13	My family expects me to safely dispose the mobile phones	SN2	[58]
14	Media influences me to safely dispose the mobile phones	SN3	[58]
15	My community expects me to safely dispose the mobile phones	SN4	[58]
Convenience			
16	I have enough space to store the used mobile phones	CO1	[58]
17	It is convenient for me to keep the mobile phones for safety of my data	CO2	[58]
18	I can easily determine prior to shopping whether the online store will offer what I need (purchase with exchange offer)	CO3	[62]
19	I can easily get e-waste disposal advice at the store or a drop-off facility	CO4	[54,62]
20	The store (branded item) takes care of product exchange and returns	CO5	[62]
Regulations			
21	I do not mix-up e-waste with other wastes	RE1	[51,68]
22	I follow the local municipal regulations in safe disposal of e-waste	RE2	[51,68]
23	I file an annual return to the State Pollution Control Boards (SPCBs)	RE3	[51,68]
Producer Intervention			[51,68]
24	I follow the mobile phone manufacturer's instructions in safely disposing the phones	PI1	[51,68]
25	I use manufacturer's help line number for safe disposal of e-waste	PI2	[51,68]
26	I follow the manufacturer's instructions for safe disposal of e-waste	PI3	[51,68]
27	I follow the safe disposal symbols displayed by the manufacturer	PI4	[51,68]

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