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Assessment of Knowledge and Awareness of the proper disposal of e-waste and study of its relationship with the Intent for proper disposal of e-waste

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Abstract

Technological advancements have led to digitalization in every aspect of life. Whether at home or in offices or in the industrial setup every place is flooded with digital equipments. The life of these digital equipments is short which led to increase in electronic waste everywhere. Electronic waste is not only a health hazard but also detrimental to the environment. So the investigators intend to take up this study. The aim of the present study was to assess the knowledge and awareness of proper disposal of e-waste and its relationship with the intent for proper disposal of e-waste. A sample of 81 participants was collected through Google form from the tri-city of Chandigarh. The data was collected using questionnaires relating to knowledge and awareness of the proper disposal of e-waste and intent for proper disposal of e-waste. Two-way Factorial design and Pearson's Correlation were used to analyse the data. The results of the study showed that different levels of knowledge and awareness of the proper disposal of e-waste were not found to affect the intent of the proper disposal of e-waste. Even gender was not found to affect the intent of the proper disposal of e-waste. Different levels of knowledge and awareness and gender were not found to show any significant interaction which could affect their intent of the proper disposal of e-waste. Different levels of knowledge and awareness of the proper disposal of e-waste were not found to show any significant correlation with the intent for proper disposal of e-waste. The results are significant in the present setup which reflects the mindset of people of the tri-city.

I. Introduction

With the advent of new technologies, different types of electrical and electronic goods flood the market every day. There is a tendency to replace the old electrical and electronic goods with new technology. This led to the accumulation of large quantities of e-waste all over the world. Ozdemir Deniz, Aydın, & Evci Kiraz (2019) mentioned in their study, 'urbanization and industrialization in many developing countries lead to an increasing number of electrical and electronic devices and thus higher e-waste amounts'. Since these electronic items are not disposed off correctly so these devices eventually become e-waste or electronic waste and become extremely hazardous to both the environment and human beings. Sankhla, Kumari, Nandan, Mohril, Singh, Chaturvedi, & Kumar (2016) highlighted that e-waste is dangerous and pose threat to human health and the environment.

E-waste includes blu-ray players, stereos, televisions, speakers, video game systems, fax machines, copiers, printers, cell phones, smartphones, desktop computers, iPads, iPods, and tabs. It is also generated through laptops, headphones, earphones, mobile chargers, connection wires, smartwatches, remote controls, television electronic thermometers, hard disks, pen drives, SD Cards, CDs, DVDs, and batteries.

The consumption of Electronic devices has increased exponentially in the past 2 decades. Currently, India is the third biggest generator of E-waste producing over 3.23 million metric tons of e-waste per year, behind the US and China. The report published by Central Pollution Control Board (CPCB) in the year 2020 mentioned that during the financial year of 2019-2020, the estimated generation of e-waste was 1014961.2 tonne for 21 types of electrical and electronic equipment (EEE). India's e-waste generation has risen nearly 43 percent between the financial years of 2018 and 2020. The pandemic-induced increase in the use of electronic devices has accentuated this problem. Bandela (2018) in his blog highlighted the study by KPMG and ASSOCHAM which says, 'computer equipment accounts for almost 70 percent of e-waste in India, followed by telecom/phones (12 percent), electrical equipment (8 percent) and medical equipment (7 percent)'.

Electronic waste is one of the most hazardous types of waste which contains chemicals including mercury, lead, cadmium, chromium, nickel, poly-brominated flame retardants, barium, and lithium. These chemicals create water, air and land pollution, and are hazardous to human health. Santhanam, Samuel & Chidambaram (2014) showed that most of the components in electronic devices contain lead, cadmium mercury, PVC, brominated flame retardants, chromium, beryllium, etc.

Now the question is whether the people are aware about e-waste, and its dangerous effects? Whether the people have knowledge about e-waste management, disposal, and its legislation?

Kwatra, Pandey & Sharma (2014) showed that a significant population of the middle class in Delhi, India, is still unaware of the issue of e-waste. Despite some awareness, they were unable to link the impacts of improper management of e-waste with detrimental effects on health.

Mishra, Shamanna, and Kannan (2017) also highlighted that the majority population in Hyderabad, India, is not aware of e-waste and its ill effects on health.

A large number of studies have been conducted on e-waste, its knowledge and awareness, management of e-waste disposal, and health and environmental hazardous of e-waste. Investigators intend to study the knowledge and awareness of proper disposal of e-waste and its relationship with intent for proper disposal of e-waste.

Key words

Knowledge and awareness, e-waste, e-waste management, proper disposal, intent

Review of Previous Studies

Sivathanu (2016) discussed "the consumers' awareness and preference towards the disposal of e-waste in this paper. The data was collected using a structured questionnaire from consumers in Pune city. The exploratory factor analysis technique was employed on the sample. The purpose was to identify the awareness factors contributing to the consumer's preference towards the proper disposal and management of e-waste. The results showed that five important factors contribute to the consumer's preference during

the disposal of e-waste. The factors are- awareness of toxic effects on human health, awareness of environmental hazards, awareness of proper disposal of e-waste, awareness of e-waste management by various stakeholders, and awareness of convenience of recycling. This paper suggests the various pathways to create awareness so that the attitude of the consumers towards disposal of e-waste can be changed".

Navarette, Rosete, & Valdez (2018) measured "the awareness levels of the sample. Four hundred and two Business Economics majors of the University of Santo Tomas College of Commerce and Business Administration were studied. Primary data via an online survey revealed that twenty-six percent of the respondents learned about electronic waste in high school than those who encountered it in college. Seventy-eight percent of the respondents had a high e-waste awareness complemented with a high awareness level for the need to properly dispose of e-waste. Respondents had the lowest relative mean of 1.87 in their attitude towards participative e-waste recycling. However, this e-waste awareness was not complemented by the provision of waste disposal facilities that address the specific requirements for proper waste disposal".

Mahat, Hashim, Nayan, Saleh, & Norkhaidi (2019) in this article "aim to identify the level of e-waste disposal awareness among the Malaysia community. 500 people from nine districts in Selangor, Malaysia were taken as samples using a stratified random sampling method. Data was collected using a questionnaire. The results showed that the respondents' e-waste disposal knowledge and e-waste disposal attitudes were at a high level, while their e-waste disposal practices were at a medium leve"l.

Miner, Rampedi, Ifegbesan, & Machete (2020) investigated through a survey about awareness levels and knowledge among the households in the Jos metropolis, Plateau State (Nigeria). "A sample of 228 participants was interviewed by means of close-ended questionnaires. Cell phones and television were acquired by the majority of the respondents as around 50% felt that they could be easily replaced the damaged ones, around 38% responded that these could be upgraded frequently, and around 35% felt that in case of theft these could be easily purchased. 25% of participants responded that they dispose of e-waste in an illegal manner by dumping in open spaces along with household waste, around 28% store it indefinitely at home, around 17% sell it to others for possible reuse. The Majority showed their willingness to participate in its management provided they are given appropriate knowledge on its safe disposal and recycling. No significant correlation was found between existing awareness levels on e-waste and willingness to participate in its management based on the socio-demographic profile of respondents".

Delcea, Crăciun, Ioanăș, Ferruzzi, & Cotfas, (2020) in their study "analyzed the influence of social media along with the actions taken by the government and non-governmental organizations. The purpose was to include and to capture, as much as possible, a high amount of determinants in the e-waste recycling process. Nevertheless, the demographic or socioeconomic variables, such as age, gender, income, education, number of family members, etc., have shown over time to have a contribution to predicting the consumers' pro-recycling behavior. In this paper, the authors showed that demographic variables, such as age and gender, can have a contribution to predicting residents' pro-e-waste recycling behavior".

Nuwematsiko, Oporia, Nabirye, Ali Halage, Musoke, and Buregyeya (2021) studied Knowledge, Perceptions, and Practices of Electronic Waste Management among Consumers in Kampala, Uganda. "A cross-sectional study was conducted among people who used, repaired, and sold electronics. Data was collected through both qualitative and quantitative methods. Modified Poisson regression was used to analyse the data. Results showed that 2/3rd of the electronic consumers had poor knowledge of managing e-waste. Around 80% of consumers had a positive perception of e-waste management. They also perceive that e-waste is harmful to human health and the environment. Those participants who are employed in e-waste setup show less positive perception towards e-waste management as compared to that e-waste setup. Mobile phones and television were the most owned e-waste. Selling e-waste to repair shops and donating were the common options of disposal".

II. Objectives

1. To study the main effect of knowledge and awareness in terms of intent for proper disposal of e-waste.
2. To study the main effect of gender in terms of intent for proper disposal of e-waste.
3. To study the interaction between different knowledge and awareness and gender in terms of intent for proper disposal of e-waste.
4. To study the relationship of different levels of knowledge and awareness with their intent for proper disposal of e-waste.

III. Hypotheses

1. There is no significant difference among the high, middle, and low levels of knowledge and awareness in terms of intent for proper disposal of e-waste.
2. There is no significant difference between Females and Males in terms of intent for proper disposal of e-waste.
3. There is no significant interaction between knowledge and awareness and gender in terms of intent for proper disposal of e-waste.
4. There is no significant correlation between high, middle and low levels of knowledge and awareness with their intent for proper disposal of e-waste.

IV. Methodology

Sample

The study was conducted on a sample of 81 participants taken randomly from Tricity of Chandigarh. The sample consisted of male and female participants. The data was collected through Google forms.

Tools used

Following tools were used to collect the data.

1. Questionnaire relating to knowledge and awareness of the proper disposal of e-waste, prepared by investigators themselves.

2. Questionnaire relating to intent for proper disposal of e-waste, prepared by investigators themselves.

Design of the study

The study was conducted using a two-way ANOVA with 3x2 factorial designs. Knowledge and awareness of the proper disposal of e-waste for the sample was studied and grouped under high, middle, and low levels of knowledge and awareness. The sample was again divided in terms of gender. The intent for the proper disposal of e-waste was taken as a dependent variable.

The participants were distributed in three different groups according to their score of Knowledge and awareness of the proper disposal of e-waste. Kelly's method was used to divide the sample in three different groups. Gender acted as a classifying variable. The scores obtained from the dependent variable that is, intent for proper disposal of e-waste, were subjected to statistical treatment. F- values were calculated and inferences were drawn out. Further Pearson's correlation technique was used to find the coefficient of correlation between high levels of knowledge and awareness and their intent for proper disposal of e-waste, middle levels of knowledge and awareness and their intent for proper disposal of e-waste and low levels of knowledge and awareness and their intent for proper disposal of e-waste,

Procedure

After preparing a questionnaire for knowledge and awareness of the proper disposal of e-waste, and intent for proper disposal of e-waste by the investigators, google form was prepared for collection of data. The link was mailed to concerned participants residing in the tricity of Chandigarh. The responses were tabulated in the excel sheet. The raw data was subjected to descriptive and inferential statistics using SPSS software. Thereafter results were interpreted and conclusions drawn out.

Statistical tools used

Descriptive statistics such as mean and standard deviation were used to describe the data. Two-way ANOVA, t-test and Pearson's coefficient of correlation were administered to draw out the inferences.

V. Analysis of the data

The raw data was analysed using descriptive and inferential statistics. The F-values and coefficient of correlation values are depicted as under in different tables.

A. Analysis of Variance- Two-way Factorial design

Table 1: Mean and Standard deviation values for different levels of Knowledge and Awareness for proper disposal of e-waste (A) in terms of intent for proper disposal of e-waste.

S.No.	Groups	Gender	N	M	SD
1.	High level of knowledge & awareness (A1)	Female	18	44.11	3.708
		Male	9	41.67	5.362
		Total	27	43.30	4.384
2.	Middle level of knowledge & awareness (A2)	Female	21	39.76	4.323
		Male	10	43.00	3.232
		Total	31	40.81	4.238
3.	Low level of knowledge & awareness (A3)	Female	15	41.33	4.515
		Male	8	41.88	7.318
		Total	23	41.52	5.484
	Total	Female	54	41.65	4.511
		Male	27	42.22	5.221
		Total	81	41.84	4.734

Table 2: Depicting F- values through 3x2 Factorial Design

Source	Type III Sum of Squares	Df	Mean Squares	F	Significance
Corrected Model	201.118	5	40.224	1.895	.105
Intercept	125262.902	1	125262.902	5901.962	.000
Knowledge & Awareness (A)	32.427	2	16.213	.764	NS
Gender (B)	3.524	1	3.524	.166	NS
AxB	102.748	2	51.34	2.421	NS
Error	1591.796	75	21.224		
Total	143587.00	81			
Corrected Total	1792.914	80			

a. Main effect of Knowledge and Awareness in terms of Intent for the proper disposal of E-waste

Table 1 shows the mean and standard deviation values for high, middle and low levels of knowledge and awareness in terms of intent for proper disposal of e-waste. The mean values for high, middle and low levels of knowledge and awareness have been found to be 43.30, 40.81, and 41.52 respectively. The standard deviation values for the said levels have been found to be 4.384, 4.238, and 5.484 respectively. Table 2 shows the main effect of knowledge and awareness in terms of intent for proper disposal of e-waste. The F- value has been found to be .764 for 2 degrees of freedom, which is not significant at .05 levels of

significance. Hence the hypothesis, 'There is no significant difference among the high, middle and low levels of knowledge and awareness in terms of intent for proper disposal of e-waste,' may be accepted.

b. Main effect of Gender in terms of intent of the proper disposal of E-waste

Table 1 shows the mean and standard deviation values for Females and Males participants in terms of intent for proper disposal of e-waste. The mean values for Female and male have been found to be 41.65 & 42.22 respectively. The standard deviation values for the Females and Males have been found to be 4.511, and 5.221 respectively. Table 2 shows the main effect of Gender in terms of intent for proper disposal of e-waste. The F- value has been found to be .166 for 1 degree of freedom, which is not significant at .05 levels of significance. Hence the hypothesis, 'There is no significant difference between males and females in terms of intent for proper disposal of e-waste,' may be accepted.

c. First order interaction effect

Table 2 shows the interaction between knowledge and awareness and gender in terms of intent for proper disposal of e-waste. The F- value for the interaction has been found to be 2.421 for 2 degree of freedom, which is not significant at .05 levels of significance. Hence the hypothesis, 'There is no significant interaction between different levels of knowledge and awareness and gender in terms of intent for proper disposal of e – waste,' may be accepted.

B. Coefficient of Correlation

Table 3: Coefficient of Correlation value for high level of Knowledge & Awareness and the intent for proper disposal of e-waste

S.no.	Group	N	M	SD	Coefficient of correlation 'r'	Significance
1.	High level of Knowledge & awareness	27	12.85	.864	.296	NS
2.	Intent for proper disposal of e-waste	27	43.30	4.384		

Table 3 shows the coefficient of correlation value between the mean scores of high level of Knowledge and Awareness of the proper disposal of E-waste and the Intent for proper disposal of e-waste of the sample taken. The analysis was done on the sample of 27 participants with mean scores of 12.85 and 43.30 respectively for high levels of Knowledge and Awareness of the proper disposal of E-waste and the Intent for proper disposal of e-waste. The coefficient of the correlation value has been found to be .296, which is not significant at 0.05 levels. Hence, the hypothesis, "There is no significant correlation between high levels of knowledge and awareness with the intent for proper disposal of e-waste", may be accepted.

Table 4: Coefficient of Correlation value for middle level of Knowledge and Awareness and the intent for proper disposal of e-waste.

S.no.	Group	N	M	SD	Coefficient of correlation 'r'	Significance
1.	Middle level of Knowledge & awareness	31	10.45	.506	-.222	NS
2.	Intent for proper disposal of e-waste	31	40.81	4.238		

Table 4 shows the coefficient of correlation value between the mean scores of the middle level of Knowledge and Awareness of the proper disposal of E-waste and the Intent for proper disposal of e-waste of the sample taken. The analysis was done on the sample of 31 participants with mean scores of 10.45 and 40.81 for middle level of Knowledge and Awareness of the proper disposal of E-waste and the Intent for proper disposal of e-waste respectively. The coefficient of the correlation value has been found to be -.222, which is not significant at 0.05 levels. Hence, the hypothesis, "There is no significant correlation between middle levels of knowledge and awareness with the intent for proper disposal of e-waste.", may be accepted.

Table 5: Coefficient of Correlation value for low level of Knowledge and Awareness and the intent for proper disposal of e-waste

S.no.	Group	N	M	SD	Coefficient of correlation 'r'	Significance
1.	low level of Knowledge & awareness	23	7.96	1.637	.134	NS
2.	Intent for proper disposal of e-waste	23	41.52	5.484		

Table 5 shows the coefficient of correlation value between the mean scores of low level of Knowledge and Awareness of the proper disposal of e-waste and the Intent for proper disposal of e-waste of the sample taken. The analysis was done on the sample of 23 participants with mean scores of 7.96 and 41.52 for low level of Knowledge and Awareness of the proper disposal of e-waste and the Intent for proper disposal of e-waste respectively. The coefficient of the correlation value has been found to be .134, which is not significant at 0.05 levels of significance. Hence, the hypothesis, "There is no significant correlation between low levels of knowledge and awareness with the intent for proper disposal of e-waste.", may be accepted.

VI. Results

The results of the study are presented and discussed as under.

Different levels of Knowledge and Awareness of the proper disposal of e-waste were not found to affect the intent of the proper disposal of e-waste.

1. Gender was not found to affect the intent of the proper disposal of e-waste.
2. Different levels of Knowledge and Awareness and gender were not found to show any significant interaction which could affect their intent of the proper disposal of e-waste.
3. Different levels of Knowledge and Awareness of the proper disposal of e-waste were not found to show any significant correlation with the intent for proper disposal of e-waste.

Discussion

The tri-city of Chandigarh is a well-planned and developed urban area in India. The literacy rate is also very high. People are well-educated. They enjoy a modern lifestyle and use goods with new technology. They seem to be aware of e-waste and its disposal. A very small number of them throw the e-waste with the general waste. The main mode of disposal of e-waste includes- selling the goods as scrap or secondhand goods. 33.7 % of the participants keep the electronic goods for future use also. In spite of the higher rate of education, more than 66 % are not aware of the e-waste legislation in the tri-city. 90.4% think that e-waste contains precious metals that can be recycled. They seem to be aware of the benefits of recycling e-waste and the harm of improper waste disposal. In spite of varying levels of knowledge and awareness about the proper disposal of e-waste the intent of proper e-waste disposal has not shown any significant difference. There seem to be different reasons for it. Firstly, this subject is very new to them, thus the intent of proper disposal of e-waste is missing. Moreover, in certain issues participants had no clear opinion, and they showed their intent as neutral. Hence, the results are based on no clear intent. 30.1% feel economic returns from recycling e-waste motivate them to recycle it. 30.1% always sell the old e-waste to scrap dealers. 48.2% always sell old e-waste as secondhand products.

Secondly in general Indian mind set the selling of old goods as secondhand products or to the scrap dealer are common practices, as it brings economic returns. So to forgo the money part and drop the e-waste at collection centers may not be a popular choice. Thirdly the emotional attachments with old products may force them to keep information for any further use. Like parents, old mobiles or laptops can be used by children. Also, the cost of a new product is generally high. So, in spite of being knowledgeable and aware, there seems to lack the intent for proper e-waste disposal. Since males and females are responding in the same way, so there is no effect of gender in terms of the intent of proper disposal of e-waste.

VII. Conclusion

The present study shows that knowledge and awareness about the proper disposal of e-waste have no relationship with intent for proper disposal of e-waste. Whether the level of knowledge and awareness is high or low, it has not affected the intent of the people of tri-city for proper disposal of e-waste. This means that despite the high level of knowledge and awareness, what is required is transferring this knowledge and awareness into action which is missing in the residents of tri-city. Only then the problems faced by e-waste

disposal can be taken care of. More study is needed in this direction so that residents become more responsible.

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