

Development of an Android-friendly E-video to raise awareness of E-waste management as part of the Swachh Bharat Mission in Pali District, Rajasthan

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ABSTRACT

Background: Electronic/Electrical products, which are of no use anymore, are referred to as electronic waste. Electronic waste causes contamination of the environment with heavy metals during the process of informal dismantling. Initiatives such as Extended Producer Responsibility and Design for Environment, together with the 3Rs (Reduce, Reuse, and Recycle), were suggested by the Swachh Bharat Mission (SBM2.0). The purpose of this study was to evaluate urban dwellers' knowledge and practices around e-waste and raise awareness through an e-video created by Phase III MBBS students. **Objectives:** 1. To estimate the knowledge, attitudes, and practices on E-waste management in PALI urban. 2. To increase awareness and assess satisfaction levels among the residents regarding prepared E video. **Methods:** 384 residents of the UHTC's catchment region participated in an analytical cross-sectional study using the purposive sampling technique. They were interviewed using a semi-structured pre-validated questionnaire on e-waste-related knowledge and practice parameters and were shown a video on recommended disposal practices. Data was analyzed using Epi info 7.2 using appropriate tests of significance. **Results:** Among respondents, 95% had heard of E-waste from media. Domestic e-waste generated was kept at home (3.5%), given to the kabari wala/scrap collector (73%), exchanged at electronic shops (4.2%), or thrown in dustbins (3.5%). Some knew of companies willing to collect their e-waste (16%) but only 6% utilized that service and 4 % knew what was finally done with it. Younger ages <27 years and Higher levels of education were found to be statistically significant with respect to better knowledge and practices (p-value <0.05). The e-video increased knowledge of respondents by 68% and 83% were satisfied by its content. **Conclusions:** No streamlined system of disposal, collection, or dismantling of e-waste existed in the town and the video on recommended practices was well received. Increased awareness of E-Waste Tax Credits for Manufacturers, E-waste ATMs for encouraging recycling, and E-waste tracking and certification are feasible solutions.

KEYWORDS

E-Waste; Management; Heavy Metals; Western Rajasthan; Disposal

INTRODUCTION

Electronic/Electrical products which are of no use anymore are referred to as electronic waste.(1) United Nations reports mention e-waste recycling is less than twenty percent accounting for risk to global environment and loss of valuable natural

materials. By 2050, there will be 120 million tons of electronic trash produced worldwide, up from the current 50 million tonnes.(1) The economic worth of global production of e-waste is 62.5 billion dollars. India is the second largest producer of electronic waste in Asia .(2)

Electronic waste is categorized as toxic (e.g. Arsenic, Cadmium, Chromium, Lead, Selenium, etc.) and non-toxic products (e.g. iron, plastic, non-ferrous metals (Copper, Aluminum, Gold, Silver, Platinum)). (1) The constituent of e-waste depending on manufacturing material affects the organs-heart (Barium), skin (Cobalt), renal (Cadmium), liver (Cadmium), eyes (Copper), respiratory (Chromium), nervous system (Lead), and poisoning (Arsenic poisoning). (2,3) Electronic waste leads to atmospheric contamination due to informal dismantling and recycling processes. According to studies, elements like lead, manganese, copper, chromium, bismuth, and cobalt have been found in the air close to Indian e-waste reprocessing facilities. Furthermore, heavy metal-induced groundwater and soil contamination has been connected to a number of electronic activities, including manufacturing, selling, repairing, disposing of, and recycling, particularly in close proximity to former e-waste landfills. The aquatic ecosystem is also affected by the leaching of hazardous substances from unprocessed or processed e-waste dumped in landfills. (4) The World Health Organization (WHO) has emphasized that informal e-waste disposal poses significant health risks, particularly to children, adolescents, and pregnant women. (5) Despite growing awareness of the Swachh Bharat Mission (SBM 2.0) since its launch on October 2, 2014, the concept of electronic waste remains largely unfamiliar to the general public. (1) Initiatives like Extended Producer Responsibility, Design for Environment, and the 3Rs (Reduce, Reuse, Recycle) are meant to address this problem by supporting sustainable consumption practices, increasing the rates of reuse and recycling, and promoting responsible e-waste disposal. (6,7) Guidelines, legislation are less known to Public health professionals and even less to the common person. Apart from the earlier objective of eliminating open defecation all local urban bodies under SBM 2.0 aim for source segregation of garbage and use reduce, reuse, and recycle for e-waste management. (1,8)

Rationale:

There are gaps in knowledge regarding what is being done with E-waste and what are the good practices in its management at administration and public levels about E-waste in Western Rajasthan. Therefore, this study was carried out with the intention of examining the existing levels and raising awareness through a brief video film created at the Medical College by a group of motivated medical students. Further, through this effort, we wish to bring increased awareness among frontline health workers like urban ASHAs and AWWs and

other frontline workers and medical students about E –waste management.

Objectives:

1. To “develop an android friendly E –video which will help in increasing awareness of E-waste management as part of the Swachh Bharat Mission among residents of Pali, Western Rajasthan .
1. To estimate the knowledge, attitudes and practices on E –waste management in urban areas
2. To evaluate the satisfaction levels among the residents regarding prepared E video using Likert scale.
3. To recommend other strategies to stakeholders and district authorities for supporting good practices for E waste management in the” district.

MATERIAL & METHODS

Study design: ‘Analytical Cross –sectional study’

Study setting: Participants were residents of the District Hospital/Urban Health and Training Center (UHTC) catchment area of Government Medical College Pali, Rajasthan.

Inclusion criteria:

1. Should be above 18 years of age
2. Should possess a smartphone
3. Shows interest in knowing more about E-waste management.
4. Is willing to share information/e-video with three other residents.

Exclusion criteria:

1. Shows no interest in knowing more about E-waste.
2. Reluctant to provide three additional residents with information

Study period: Six months

Sample size: Assuming that 50% of Pali residents are correctly knowledgeable about e-waste disposal, the sample size was determined. The following formula was used to calculate the sample size, with a 5% acceptable error in the prevalence:

$$n = \frac{4pq}{d^2} = \frac{4 \times 0.5 \times 0.5}{0.05^2} = 400$$

Where:

- $p=0.5$ (percentage of participants with adequate knowledge of e-waste)
- $q=1-p=0.5$
- $d = \text{relative permissible error} = 5\% \text{ of } p$
- $n = \text{required sample size}$

After substituting the values, the calculated sample size was 384.

Using a practical sampling technique, 384 inhabitants were questioned while maintaining an

80% research power and a 10% non-response rate until the required sample size was achieved.

Study sampling procedure: The households within 10 kilometers of the health centers were chosen using a suitable selection technique, and the participants were taken one after the other until the desired sample size was reached.

Data collection: Following the creation of the e-video, the Principal Investigator and trained volunteers gathered data. Four medical students from the 2019 class created the e-video. Data on respondents' sociodemographic characteristics, knowledge, attitudes, and practices surrounding e-waste were gathered using a semi-structured questionnaire on Google Forms. The residents were then shown the e-video as part of the Swachh Bharat initiative, and a Likert scale was used to gauge how satisfied they were. Prior to finalization, 20 residents participated in a field test of the questionnaire. MS Excel (version 16) and Epi Info (version 7.2) were used to enter and analyze the data.

Data analysis: Proportions for key indicators regarding satisfaction, acceptance, quality of e-video, information provided, change in attitude toward E-waste disposal were analyzed. The chi square test was employed to see whether there was a significant correlation between the groups. A statistically significant result was defined as a p-value of less than 0.05.

Quality assurance: Quality of data was assured by peer review during protocol preparation. A pre testing of questionnaire among residents was done. Proper training and supervision of field volunteers was done by the Principal Investigator and 10% of the filled questionnaires were cross-checked for correctness.

Human subject protection: The Government Medical College's Institutional Ethical Committee gave its approval to the project. Following an explanation of the study's goals and an assurance of data confidentiality, written informed consent was acquired. The participants were informed that their participation in the study was entirely voluntary and that they might leave at anytime without paying any fees.

RESULTS

Most respondents were of mean age 28 years with 60% working in private sector jobs (Table 1). The domestic waste was segregated at source by 89% of them mostly by members of the family itself as stated by 97% of the respondents

Table 1 Demographic characteristics of the participants

Variable	Frequency	Percentage
Age (mean±SD)	27.87±7.759	
Gender		
Male	144	37.5
Female	240	62.5
Occupation		
Private jobs	229	59.7
Housewife	69	18.0
Government employee	24	6.3
Volunteer	28	7.3
Self-employed	28	7.3
Retired	2	0.5
Unemployed	4	1.0
Education		
Primary	11	2.9
Secondary	33	8.6
Higher Secondary	77	20.1
Graduation	185	48.2
Post-Graduation	63	16.4
Informal Education	2	0.5
Diploma	1	0.3
Can read and write only	5	1.3
Illiterate	7	1.8
Marital Status		
Single	194	50.5
Married	190	49.5
Religion		
Hindu	369	96.1
Muslim	13	3.4
Other	2	0.5
Housing		
Kachcha	1	0.3
Semi-Pucca	69	18.0
Pucca	314	81.8
Domestic Waste Disposal		
Street Disposal	37	9.6
Municipal Van	347	90.4
Domestic Waste Segregation		
Yes	342	89.1
No	28	7.3
Don't Know	14	3.6
Waste Handlers		
Members of Family	373	97.1
Domestic help	9	2.3
Outside help	2	0.5

Most respondents had heard of E waste from friends (26%), internet (11%) or NGO campaigns (9%). Participants knew about cancer but skin diseases (5.7%), nerve damage (4.2%) and reproductive disorders (2%) were lesser known. (Table 2)

Table 2 : Knowledge regarding E -waste among participants

Knowledge points	Frequency	Percentage
Heard of the term "E-waste"		
Yes	364	94.8
No	20	5.2
From Whom Heard		
Friends	99	25.8
Office Colleague	9	2.3
Family	19	4.9
NGO campaign	34	8.9
Television	6	1.6
Programme		
Internet	43	11.2
Newspaper article	10	2.6
Own thinking/Self-awareness	6	1.6
Teacher	46	12.0
Not heard	112	29.2
Harmful Effects of E waste *		
Cancer	252	65.6
Skin Diseases	22	5.7
Nerve damage	16	4.2

Knowledge points	Frequency	Percentage
Reproductive disorders	4	1.0
Soil, air and water contamination (multiple choice)	90	23.4
Knowledge on entry routes of E-waste toxins in human body		
Nose	63	16.4
Mouth	21	5.5
Open wound	14	3.6
Skin	286	74.5
Adverse Chemicals Affects on Health		
Yes	265	69.0
No	119	31.0

Among respondents 85% went to local healers for injuries/illnesses due to E-waste. Unused devices were given /sold to a known personal contact and 4% used the formal system of disposal. Around 79% knew that E-waste cause environmental and Health hazards both but only 22% were aware of policies regarding E waste disposal.(Table 3)

Table 3 Attitudes and Practices among participants regarding E waste management

Practice point	Frequency	Percentage
Health seeking behavior for management of injury/ Illnesses by E-waste		
None	4	1.0
Government hospital	16	4.2
Private hospital	24	6.3
Local healers	327	85.2
Home remedy	13	3.4
Reason new Mobile/Laptop		
Physical "Damage	24	6.3
Loss of Function	12	3.1
Need for Greater Functionality	133	34.6
Desire for Newest Technology	213	55.5
Other	2	0.5
What done unused Devices		
Kept in Home	37	9.6
Given/Sold to a Personal Contact	318	82.8
Sold to Informal System	9	2.3
Sold to Formal System	16	4.2
Trash	4	1.0
Unused Equipments have Purpose		
No, Can be Repaired and/or Reused	63	16.4
Can Utilize Components / Raw Materials	21	5.5
Yes, It Is Waste	14	3.6
Conditional (dependent on whether product is functioning)	286	74.5
Know Persons (like kabariwala) who collect & Recycle		
Yes	265	69.0
No	119	31.0
Increasing E-waste Dangerous		
Yes (but no specific information)	22	5.7
Yes, Toxicity or Safety Hazard	23	6.0
Yes, Environmental Problem	34	8.9

Practice point	Frequency	Percentage
Recognition of Both Health and Environmental Hazards	303	78.9
No	2	0.5
E-waste Management Policies India		
No Policy Present	12	3.1
No Knowledge of Policy or Governing Body	288	75.0
Knowledge of Any Related Policy or Governing Body	84	21.9
Satisfied" with E video	300	78.2

Younger ages and better literacy levels had better knowledge and practices regarding disposal,

dangers and health and environmental hazards of E-waste found to be statistically significant(Table 4)

Table 4 : Relation of age and good practices among respondents regarding E- waste

Variable	Education			p-value
	More than primary level		Primary and Illiterates	
Good Knowledge				
Heard E-waste	341(95.0%)		23(92.0%)	0.516
Collection Process	231(64.3%)		13(52.0%)	0.215
Unused equipment's have purpose	299(83.3%)		22(88.0%)	0.538
Know Person collect & Recycle	250(69.6%)		15(60.0%)	0.314
Increasing E-waste Dangerous	337(93.9%)		23(92.0%)	0.709
E-waste Management Policies India	79(22.0%)		5(20.0%)	0.815
Good Practice				
Disposal Method	52(14.5%)		2(8.0%)	0.553
Management injury illness	49(13.6%)		4(16.0%)	0.742
Variable	Age			p-value
	<30 years	≥ 30 years	OR (95% CI)	
Good Knowledge				
Heard about E-waste	228(93.8%)	136(96.5%)	1.8(0.6-5.03)	0.264
Collection Process	138(56.8%)	106(75.2%)	2.3(1.5-3.6)	<0.0001
Unused equipment's have purpose	186(76.5%)	135(95.7%)	6.9(2.9-16.5)	<0.001
Know Person collect & Recycle	148(60.9%)	117(83.0%)	3.1(1.9-5.2)	<0.0001
E-waste is Dangerous	219(90.1%)	141(100.0%)	NA	0.996
E-waste Management Policies India	66(27.2%)	18(12.8%)	0.392	0.001
Good Practices				
Disposal Method	50(20.6%)	4(2.8%)	0.1(0.04-0.3)	<0.0001
Management injury /illness	44(18.1%)	9(6.4%)	0.3(0.1-0.7)	0.001

Figure 1 Reason for acquiring new equipment like Mobiles/Laptops among respondents

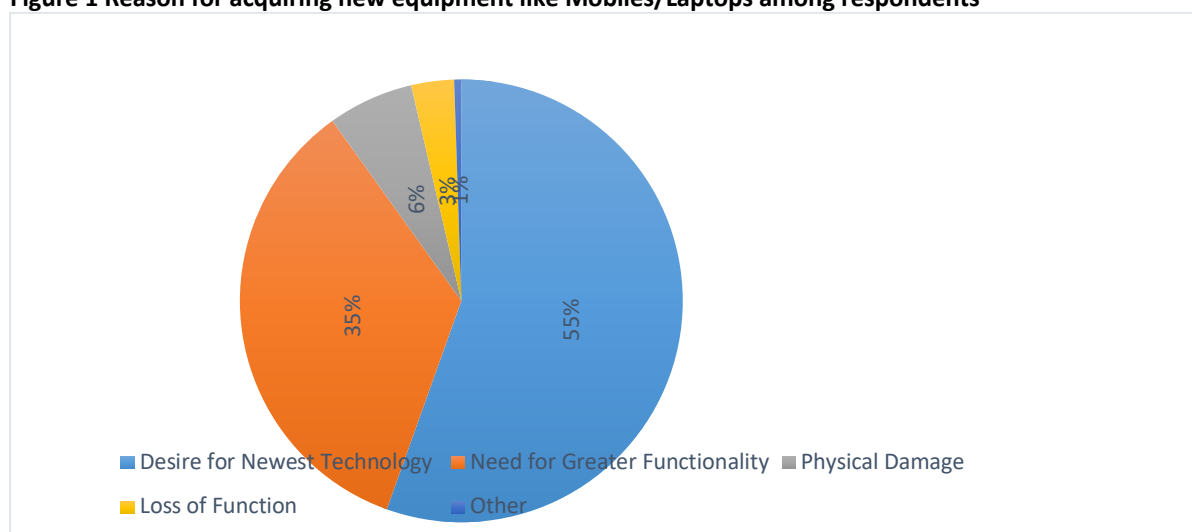


Figure 2: Reasons for Discarding Equipment among respondents

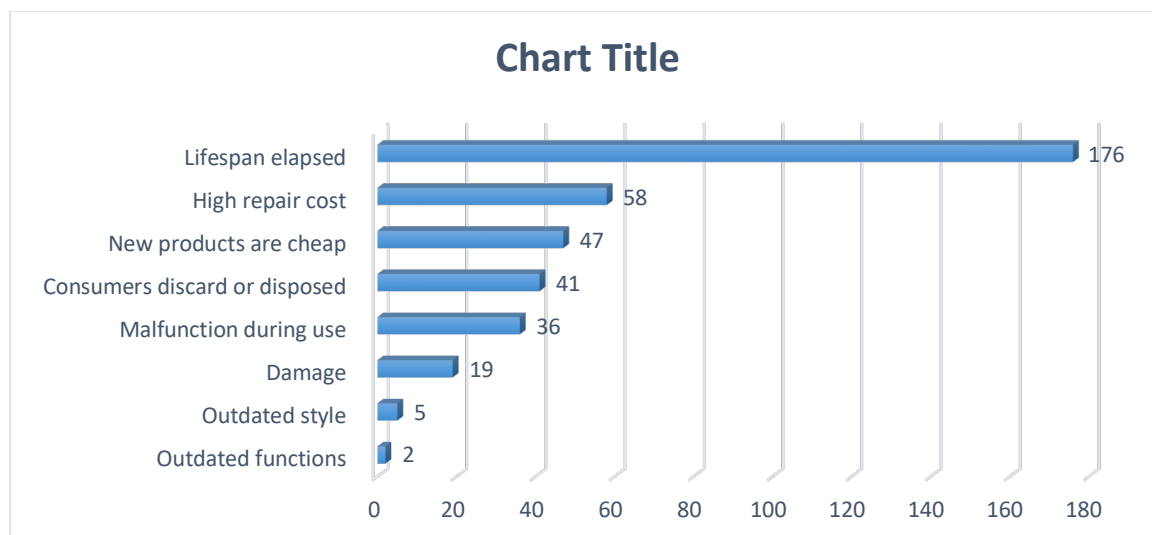
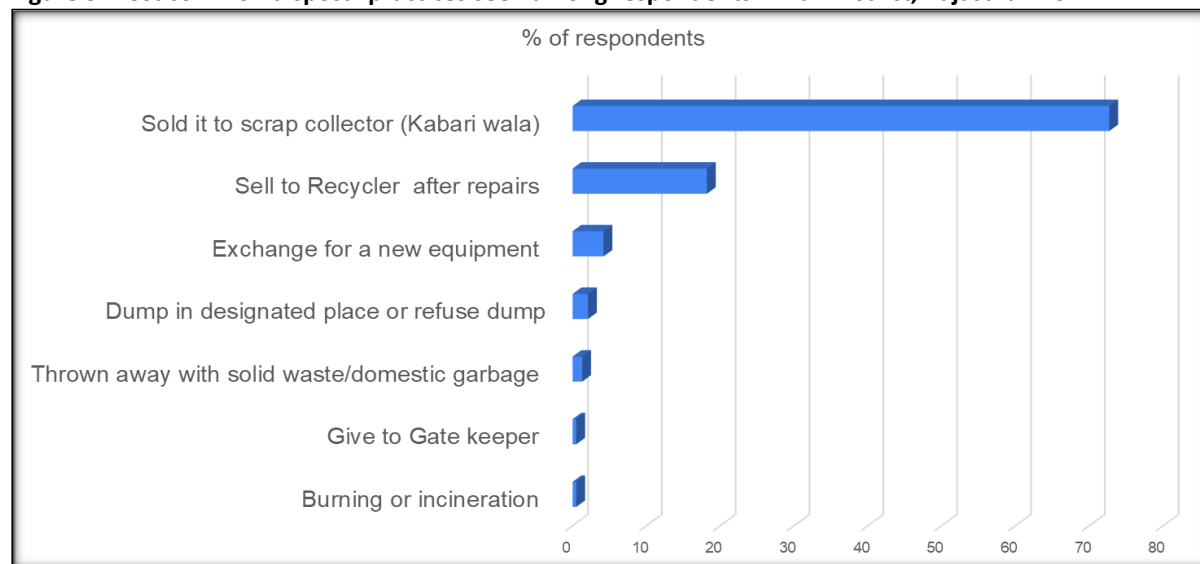


Figure 3 Most common disposal practices seen among respondents in Pali District, Rajasthan 2024



The reason for acquiring newer equipment replacing older equipment was for adoption of newer technology as stated by 55% of the respondents followed by need for greater functionality (35%) and physical damage (6%) as seen in (Fig 1). Among the respondents 176 stated that reasons for discarding equipment were that their lifespan had elapsed, 58 stated that repair costs were too high among other reasons as seen in (Fig 2). More than 70% respondents sold E-waste to scrap collectors or to known recyclers after repairs (30%). Less than 10% exchange for a new equipment or dumped in a designated place, Less than 2% threw equipment in domestic garbage, gave to the gate keeper or burnt it (Figure 3)

Link of the E-video on E-waste disposal awareness by medical students:

E-waste management GMC Pali Awareness video (<https://youtu.be/DVYyAFB4NIY?si=WBgsk34l1pT-4pG->)

DISCUSSION

The participants in our study were 28 years old on average, with a standard deviation of 7.7 years. 62% were females most were self employed. The educated were illiterates were 1. 82% lived in pucca houses with 90% reporting waste segregation and disposal by municipal van. Most E-waste was handled by family members themselves. Among them 95% had heard of E-waste from friends, internet, other sources and local NGOs. Most common domestic e waste generated was mobiles, televisions, laptops which were mostly kept at home, exchanged at electronic shops given to the kabari wala/scrap collector.

Most families knew of some such person willing to take their non –usable electronic equipment

82.8% , but 9.6% respondents kept the unused equipment at home only leading to unnecessary space occupied. Among the respondents 66% knew of cancer as the commonest adverse health effect and soil water and air contamination. Not many were aware of the skin disease, nerve damage, and reproductive disorders that could also be possible outcomes. 80% were aware that heavy metals released from e-waste may be entering through the skin or nose. 90% of respondents were not aware that hands should be washed and all hand hygiene measures should be taken prior to and while handling E-waste.

Analysis of the practices showed that most respondents changed their E –equipment only after its lifespan had elapsed or for newer cheaper technology. Most respondents 73% sold it to the local scrap collector or kabari -wala and were not aware of what was further done with the e-waste. They felt local doctors were sufficient to handle any such problem with e-waste similar to a study by Monika et al (9) and Turaga et al (10) . Any unused equipment was given away to a known person by 69 %. Overall younger ages < 30 years had better knowledge and practices. Higher levels of education among respondents were also found to be statistically significant with respect to better knowledge and practices

Only 22% of participants in our study knew about the rules and laws pertaining to the treatment of e-waste. Knowledge about the reduce, reuse, and recycle (3Rs) process for entire electronic equipment was limited to 16%, while only 5% were aware of component reuse. These findings align with studies conducted by Borthakur A et al. in Bangalore and Singhal D et al. in Delhi. (11,12)

In Rajasthan, each district, including Pali district, has designated e-waste collection centers. However, none of the participants were aware of these facilities. The lack of awareness, combined with the expenses involved in returning obsolete electronic devices to formal collection centers, discourages both households and institutions from utilizing these official services as seen in a study by Yanez et al. (13) On the other hand, the informal sector attracts consumers by offering convenient doorstep collection and financial incentives. Informal e-waste recycling creates jobs, especially for underprivileged populations, but it also puts workers and the surrounding communities at considerable danger for environmental and health problems (14). Since resolving this issue is essential to the long-term viability of any e-waste management system, it presents an ethical conundrum for politicians.

Possible solutions for small towns (15,16,17):

- Tax Credits for Sustainable Electronics: By promoting electronics makers to provide more durable and repairable goods, a tax credit system might encourage sustainability and deter planned obsolescence.
- E-Waste Recycling ATMs: By providing cash incentives or gift cards in return for used electronics, E-Waste ATMs placed in public spaces can encourage recycling. To raise awareness, these devices might also have instructional materials.
- Blockchain-Based E-Waste Tracking: The manufacture, ownership, and disposal of electronic gadgets might all be tracked by a blockchain system, which would grant a digital certificate to each object. This would ensure appropriate disposal of garbage.
- E-Waste Art for Awareness: Exhibits or sculptures created from abandoned electronics could be effective visual reminders of the problem of e-waste, promoting appropriate recycling and disposal methods.

CONCLUSION

No streamlined system of disposal, collection, dismantling of e-waste existed in the town and the video on recommended practices was well received. The process of reducing, reusing, recycle of e- equipment was known only by 16% and just 5% knew about components reuse. Twenty-three percent were aware of the negative impacts that e-waste has on the environment and human health. 72% of respondents, or the majority, dispose of their e-waste in the unorganized sector. Less than 25% of respondents were aware of extended producer responsibility, manufacturers' e-waste tax credits, e-waste ATMs, e-waste tracking and certification policies, and local NGOs.

RECOMMENDATION

Inadequate knowledge and expertise in rural and small communities contribute to the growing e-waste issue. Formalizing the Collection of E-Waste: To collect e-waste, a thorough regulatory structure is required. To regulate and standardize the procedure, collection facilities, and recyclers should be required to register and obtain licenses.

Many workers involved in manual dismantling face health risks, highlighting the need for preventive measures, safe handling practices, and proper personal protection. Legislation, a collecting system, logistics, and skilled workers are all necessary for efficient e-waste management. Addressing e-waste issues requires integrating the

informal and formal sectors, and developing nations like India need to set up long-term systems for processing and treating e-waste safely.

LIMITATION OF THE STUDY

The knowledge, attitudes, and practices of a tiny city in Western Rajasthan are the exclusive focus of this study.

RELEVANCE OF THE STUDY

E-waste management is a pertinent public health issue and though guidelines for consumer level disposal are in place there are gaps in public awareness and behaviour change which were identified by this study. Sharing the findings with competent authorities helped to channelize their efforts to address these gaps and improve E waste management as a pioneer initiative in the city.

AUTHORS CONTRIBUTION

LNS and YC conceptualized the study, scripted the E-video interpreted the data and drafted the manuscript, KKS and LP helped in data collection, data entry and E-video development, SD and SC helped in data validation and review of manuscript.

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CONFLICT OF INTEREST

There authors declare no conflicts of interest.

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DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors haven't used any generative AI/ AI assisted technologies in the writing process.

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