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E-Waste threat and solution to the impending e-waste threat in India with special reference to West Bengal

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Abstract:

E-Waste is becoming the biggest problem since the 1980s and a lot of awareness is spreading among the general public and institutions worldwide regarding the issue of e-Waste and its harmful effect. Though the European Though the European countries and developed countries are considering, it as a threat but in many countries like India, China, and South East Asia, there is little concern about it. In West Bengal too, there is little awareness regarding the same. There are many registered e-Waste Dismantler/Recycler in the country India but very few of them are from West Bengal. The main motivation of the work is to understand the threat associated with e-waste and studying the initiative taken by different Government and Non-Government organizations to find the solution to the impending e-waste threat. One of the possible solutions of the problem is recycling and reuse. Further, we as a society should go for the product which has a longer lifetime and is repairable rather than cheap non-repairable ones. We should avoid disposing of the e-waste but rather give it to the merchants associated with recycling. In the future, we need more organizations associated with e-Waste Dismantler/Recycler in West Bengal. Our study indicates that in comparison to countries like the UK and USA, in India the percentage of the 'E-waste formally collected' is very small, though presently the 'Electric and Electronic Equipment (EEE) Put on Market Kg Per capita' is very small compared to countries like UK, USA. But, in the future, there will be a drastic increase in the same in India. Our study also indicates that the installed capacity of e-Waste Dismantler/Recycler in West Bengal is very small nearly ~0.24% in comparison to the rest of India, the same need to be improved to deal with the impending threat of e-waste.

Keywords: *E-waste Generation per capita, Electric and Electronic Equipment Put on market per capita, Hazardous Waste Management, Informal Sector in e-Waste Management, Extended Producer Responsibility, Advance Recycling Fee, Advance Disposal Fee, Social Security to Urban Poor*

1. Introduction:

e-waste or more generally termed as Waste Electrical and Electronic Equipment (WEEE) refers to old and un-usable gadgets like power or battery supply, radio, television, telephone, desktop computers, laptops, printers, cell phones, VCR, DVD players, FAX, ATM Machines, etc. The amount of e-waste entering our nation's waste stream is growing each year. The term 'e-waste' is relatively new in comparison to the term 'waste' as the google ngram analysis as shown in figure 1. But there are processes to handle e-waste and recycle them. This essential involves

(UPL ENVIRONMENTAL ENGINEERS LTD., 2011)[1] the following steps like Collection, Storage, Dismantling, and Recycling/ Recovering-

a) Collection Scrap dealers: They are generally from the informal sector and are involved in the collection of large e-waste from the different collection points.

b) Storage Scrap dealers: They have contacts with the scrap dealers working at a different location; they collect the e-waste from them and store them at their respective scrap yard locally.

c) Dismantling & Segregation Scrap dealer: They segregate the WEEEs different dismantle parts and have the primary knowledge about the materials present in them. After segregation, they carry out further dismantling that would help to extract their iron, gold, copper, plastics, etc, and other such precious materials.

d) Recycling/ Recovery: This step essentially involves understanding the composition of e-waste and the methods to separate the hazardous elements/ compounds from the e-waste and recovery of the precious elements after proper treatment.

Some interesting facts need to be understood that may encourage recycling activities of e-waste which are available in literature like for "*every 1 million cell phones that are recycled, 35,274 pounds of copper, 772 pounds of silver, 75 pounds of gold, and 33 pounds of palladium can be recovered*" (Earth911, 2021) [2]and only 12.5 percent of e-waste is currently recycled worldwide (Mathur, Mahajan, & Purohit, 2014, Jan-Mar)[3].

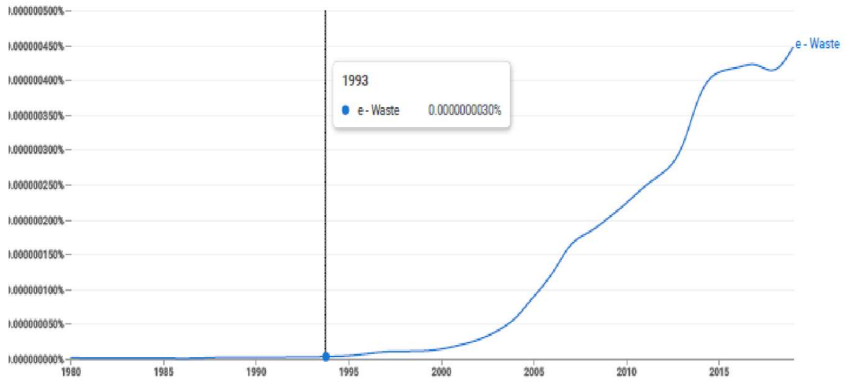

Figure 1: e-Waste (WEEE)

2. Objective & Motivation:

[1]UPL ENVIRONMENTAL ENGINEERS LTD. (2011, 09). *STATUS OF E-WASTE GENERATION/ MANAGEMENT*. Retrieved 03 20, 2021, from http://goaspcb.gov.in: http://goaspcb.gov.in/Media/Default/uploads/6)%20Ewaste.pdf

[2] Earth911. (2021, 03 26). *20 Staggering E-Waste Facts in 2021*. Retrieved 04 2021, from earth911.com: https://earth911.com/eco-tech/20-e-waste-facts/

[3]Mathur, D. S., Mahajan, D. V., & Purohit, D. (2014, Jan-Mar). E-waste health hazards. *WorkOSH, Vol 9, No.1, ISSN: 2393-8943*, 1-8

The main motivation of the work is to understand the threat associated with the increasing volume of e-waste put on the market in India and in particular in the state of West Bengal. The objectives of the work are the following-

1) To study the initiative taken by Non-Government Organization (NGO) to find a solution to the impending e-waste threat.
2) To have an understanding of the predicted rate at which e-waste is growing in India
3) To compare the state-wise capacity of e-waste dismantler/recycler and know the current status of west Bengal
4) To suggest the possible solutions to the problem

3. Methodology:

Both the primary data and secondary data for analysis are collected from trusted websites of the Central Pollution Control Board, Delhi, and Global e-waste Statistics Partnership. The information related to the effects of e-Waste on humans is collected through the literature review of Scientific/Technical articles. Also, a list of NGOs and networks associated with e-waste management is prepared through web search and literature surveys including news articles. Collection of data regarding e-waste dismantler/recycler is done through the website of Central Pollution Control Board, Delhi. Through, literature survey of Research Unit (LARRDIS), RAJYA SABHA SECRETARIAT and few Related Articles, we have collected the information regarding chronological development of e-waste management rules in India.

4. India as the producer of e-Waste:

India is the fifth-largest producer (PTI 2016, 2016)[4] of the e-waste (Manish & Chakraborty)[5]. e-waste is taken very seriously in other nations of the world (U.K, U.S, Canada) due to the presence of several toxic chemicals like arsenic, cadmium, chromium, copper, lead, zinc, mercury, metals, and organic chemicals like brominated flame retardants (BFR) in printed wire boards which are the parts of most of the gadgets (E-Parisaraa Private Limited)[6]. These chemicals present in e-waste can contaminate groundwater and if they entered the human body may cause serious damage (Table 1) to nervous and reproductive systems. Seelampur, Delhi (Koshy, 2019)[7] is the largest e-waste dismantling centre in India. In this e-waste dismantling site, workers ranging from children to adults give more than eight hours to collect and extract the reusable

[4] PTI 2016. (2016, 10 18). *India fifth largest producer of e-waste study*. Retrieved 02 20, 2020, from- http://www.thehindu.com/sci-tech/energy-and-environment/india-fifth-largest-producer-of-ewaste-study/article8646446.ece

[5] Manish, A., & Chakraborty, D. P. (n.d.). E-Waste Management in India: Challenges and Opportunities. (TERI) Retrieved 03 20, 2021, from- https://www.teriin.org/article/e-waste-management-india-challenges-and-opportunities

[6] E-Parisaraa Private Limited. (n.d.). Welcome to E-Parisaraa. Retrieved 03 20, 2021, from http://ewasteindia.com/

[7] Koshy, J. (2019, 09 28). *Nearly 50,000 people make a living out of Seelampur's e-waste*. Retrieved 03 20, 2021, from https://www.thehindu.com/ : https://www.thehindu.com/sci-tech/nearly-50000-people-make-a-living-out-of-seelampurs-e-waste/article29531237.ece

components that may help extraction of precious mental and reusable components of various functional parts from the devices.

Table- 1: Effects of E-Waste on humans

Sl. No.	Some toxic chemical & their Effects of E-Waste on humans[8]
1.	**Mercury** may cause an effect on human emotion and change it, in children and fetuses may cause neurological development problem even impairment, it may affect cognition and motor function can even cause changes in nerve response, kidney-related problem, and respiratory failure leading to death
2.	**Lead** is a poison substance for human as it may damage the brain and nervous systems, can cause the hearing problem, cognition problem, diarrhea, behavioural changes, blindness and physical disorder etc
3.	**Chromium** may irritate the skin, respiratory system, may cause asthmatic bronchitis, pulmonary congestion, epigastria pain, perforated eardrums, liver function problem, kidney problems, may affect motor function, discoloration and erosion of teeth, etc.
4.	**Brominated Flame Retardants** may affect the lymph system and digestive system and increase the cancer risk in them, it may also cause an endocrine disorder
5.	**Cadmium** Inhalation can cause severe damage to cognition, kidney failure, and lungs related problem

To educate the public about the threat posed by WEEE, there should be massive awareness campaigns and exhibitions by different organizations. Solving the e-waste problem starts with education, and the mindset to change habits due to improper knowledge. Most people are trained to recycle items like newspapers, bottles, and cans. Similarly, almost anything electronic in nature can be recycled properly with some effort and proper skill and knowledge. Given below are the data that may be useful to have an idea about the e-waste generated per category in India (Table 2), the USA (Table 3), and the UK (Table 4). But, to understand the data in a better way, we need to understand few terms such as EEE Put on the market, E-waste generated and E-waste formally collected. "*EEE Put on market is defined as any supply of a product for distribution, consumption, or use on the market in the course of commercial activity, whether in return for payment or free of charge*".[9]

"E-waste generated is defined as the amount of discarded electrical or electronic products (e-waste) due to consumption within the national territory in a given reporting year, before any *collection, reuse, treatment, or export*"[10]. "*E-waste formally collected represents the e-waste collected as e-waste and regulated by environmental protection laws specifically designed for e-waste. This includes e-waste that is collected and later exported and treated according to national standards in another country*."[11]

[8]Pinto V. N. (2008). E-waste hazard: The impending challenge. *Indian journal of occupational and environmental medicine*, *12*(2), 65–70. https://doi.org/10.4103/0019-5278.43263

[9] Global E-waste Statistics Partnership. (2021). COUNTRY AND REGIONAL SHEETS, INDIA, 2015-2019. Retrieved 04 04, 2021, from Global E-waste Monitor Statistics: https://globalewaste.org/statistics/country/india/2019/

[10] Ibid; See Footnote- 9

[11] Ibid; See Footnote- 9

Table 2: E-waste generated per category (kt) in India[12]
(Source of the data: Global E-waste Statistics Partnership)

Year	Population	E-waste generated (kt)	EEE Put on Market (kt)	E-waste formally collected (kt)	E-waste generated Kg Per capita	EEE Put on Market Kg Per capita
2015	1,282,920,000	1973	4506	30	1.5	3.5
2016	1,299,800,000	2225	5636	30	1.7	4.3
2017	1,316,900,000	2529	6799	30	1.9	5.2
2018	1,334,220,000	2863	7155	30	2.1	5.4
2019	1,351,770,000	3230	7783	30	2.4	5.8

Table 3: E-waste generated per category (kt) in the USA[13]
(Source of the data: Global E-waste Statistics Partnership)

Year	Population	E-waste generated (kt)	EEE Put on Market (kt)	E-waste formally collected (kt)	E-waste generated Kg Per capita	EEE Put on Market Kg Per capita
2015	320,930,000	6502	7362	1230	20.3	22.9
2016	323,225,000	6618	7536	1070	20.5	23.3
2017	325,326,000	6721	7912	1020	20.7	24.3
2018	327,352,000	6817	7745	1020	20.8	23.7
2019	329,559,000	6918	8354	1020	21	25.3

Table 4: E-waste generated per category (kt) in the UK[14]
(Source of the data: Global E-waste Statistics Partnership)

Year	Population	E-waste generated (kt)	EEE Put on Market (kt)	E-waste formally collected (kt)	E-waste generated Kg Per capita	EEE Put on Market Kg Per capita
2015	65,648,000	1512	1879	971	23	28.6
2016	65,648,000	1512	1879	971	23	28.6
2017	66,040,000	1540	1896	871	23.3	28.7
2018	66,466,000	1568	1949	871	23.6	29.3
2019	66,867,000	1598	1996	871	23.9	29.8

[12] Ibid; See Footnote- 9

[13]Global E-waste Statistics Partnership. (2021). *COUNTRY AND REGIONAL SHEETS. THE UNITED STATES OF AMERICA, 2015-2019*. Retrieved 04 04, 2021, from Global E-waste Monitor Statistics: https://globalewaste.org/statistics/country/united-states-of-america/2019/

[14]Global E-waste Statistics Partnership. (2021). *COUNTRY AND REGIONAL SHEETS, UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND, 2015-2019*. Retrieved 04 04, 2021, from Global E-waste Monitor Statistics: https://globalewaste.org/statistics/country/united-kingdom-of-great-britain-and-northern-ireland/2019/

5. Some Organizations and networks working on e-waste issues within India:

5.1 Waste Electrical and Electronic Equipment (WEEE) Forum:

WEEE Forum was founded in the year 2002 in April and now is the world's largest forum which acts as a central agency having competence regarding operational knowledge concerning the effective management of Waste Electrical and Electronic equipment (WEEE in short) and has a global presence. Now, it is a non-profit association in which about forty Electrical & Electronic Equipment producers responsibility organization joined [15]across the globe. In the year 2018, the WEEE Forum has given the concept regarding the celebration of the International E-waste Day [16]on fourteen days of October. On October 14, 2019, the second international e-waste day celebration took place in which about a hundred and twelve organizations from forty-eight countries participated. Throughout the day, the WEEE forum organized activities and social media campaigns regarding the need to recycle and reuse with a motivation that the e-waste recycling rate may increase day by day.

5.2 Toxics Link:

Toxics Link (TL) is a Delhi-based environmental NGO with members based on 5000+ who work with a mission to work for environmental justice and freedom from toxins. It has dedicated itself to bring toxics-related information into the public domain, both relating to struggles and problems at the grassroots level as well as global information to the local level. The organization is actively involved in its mission to work for environmental justice and has been creating public awareness on environmental issues through the publication of articles, report, environment news bulletins, and organizing conferences/seminars

Areas of the work and campaign[17]: Bio-Medical Waste, Bisphenol A (BPA) Campaign, Persistent Organic Pollutants (POPs) and Pesticides, Mercury Campaign, Chemicals in Products, Lead in Paints Campaign, Electronic Waste, Endocrine Disrupting Chemicals.

"*Toxics Link received funds from large institutional funders like Goa Waste Management Corporation, World Alliance for Mercury-Free Dentistry, International Pollutants Elimination Network, Swedish Society for Nature Conservation Free and Hanseatic City of Hamburg, Norwegian Institute for Water Research-NIVA, European Environment Bureau, , The United Nations Environment Programme*".[18]

[15] WEEE Forum. (2021). *Who we are*. Retrieved 04 04, 2021, from weee-forum.org: https://weee-forum.org/who-we-are/

[16] WEEE Forum. (2021). *International E-Waste Day - 14 October 2020*. Retrieved 04 04, 2021, from weee-forum.org: https://weee-forum.org/iewd-about/#:~:text=International%20E%2DWaste%20Day%20was,itself%20and%20into%20the%20future

[17]Toxics Link. (2021). *ABOUT US*. Retrieved 04 04, 2021, from toxicslink.org: http://toxicslink.org/Page/about-us

[18]Toxics Link. (2021). *FUNDING*. Retrieved 04 04, 2021, from Toxicslink.org: http://toxicslink.org/Page/funding

5.3 National Solid Waste Association of India :

NSWAI[19] is a professional non-profit organization NGO that works in the area of awareness as well as Research and Development in the field of solid-waste management and its toxic effect. This NGO was formed in 1996 and since its inception involved in the development of solid-waste management as a profession, research, and development. In the past, the members of this organization actively participated along with the Ministry of Environment and Forest for improvement in legislation and creating awareness and community involvement as given below.

Activities carried out by the NSWAI are —

- Compilation of database on solid-waste management in India
- Dissemination of information through courses and seminars and publication of reports even using audio-visual techniques;
- Actively involve with the enhancement of professional competence regarding solid waste management by providing training program;
- Assisting the institutions on matters related to solid waste management;
- Providing consultancy regarding solid waste management;

NSWAI helps in promoting clean technologies provides a platform for the sharing of know-how in the matter related to solid waste management and is a forum for the exchange of national and international experience, expertise, and information in the field of solid waste management. The renowned actress “Hema Malini” is a brand ambassador of NSWAI[20].

5.4 KaroSambhav:

KaroSambhav is a joint venture project that started to work actively in October 2020. In this project, 31 leading producers of e-waste and plastic waste in India launched Asia’s Largest Packaging Waste Management Venture[21] to address the growing concern of plastic waste in India and creating a formal plastic circular economy in the country. This joint venture project is first-of-its-kind and is a producer-led owned venture in which the participating companies set a vision investment upwards of INR 1000 Crore and will mobilize and converge assets, resources. Since the inception of this project in 2020, they are Publicly Campaigning through- social media, News release, Conference, Organizing Workshop,

[19]National Solid Waste Association of India. (2018). *About Us*. Retrieved 04 04, 2021, from www.nswai.org: https://www.nswai.org/about.php

[20] National Solid Waste Association. (2018). *NSWAI BRAND AMBASSADOR*. Retrieved 4 4, 2021, from nswai.org: https://www.nswai.org/ambassador.php

[21] Karo Sambhav. (2018). *Closing Material Loops*. Retrieved 04 04, 2021, from karosambhav.com: https://karosambhav.com/closing-material-loops

Others are the Microbial Biotechnology Area of Tata Energy Research Institute, INDIA HABITAT CENTRE, Clean India, Indian Environmental Society, and step Work web.

6. Current situations of E-Waste recycling units in India:

The current situation of E-Waste recycling in West Bengal is very poor compared to the other states. The table (Table 5) below shows the situation based on the data of the E-Waste Dismantler/Recycler in the country [22]as of 27.06.2019 uploaded in the website of the Ministry of Electronics & Information Technology. The cause of the same may be that the people of the state of West Bengal have less awareness about WEEE. So, there is a need for initiative for awareness among the general people regarding e-waste in West Bengal. The percentage of e-waste generated in West Bengal is about 9.8 % (Mathur, Mahajan, & Purohit, 2014, Jan-Mar)[23] but the Table 5 indicates that the Capacity of E-Waste Dismantler/Recycler in the state of West Bengal is only 0.24%

Table 5: State Wise Capacity of Dismantler/Recycler

States	Number of Units	Installed Capacity (MTA)
Andhra Pradesh	01	480
Chhattisgarh	01	600
Gujarat	16	49052.92
Goa	01	103
Haryana	28	87378
Himachal Pradesh	01	1000
Jammu Kashmir	01	165
Karnataka	71	52722
Maharashtra	75	78179
Madhya Pradesh	02	9600
Orissa	03	3680
Punjab	03	4850
Rajasthan	26	90769
Tamil Nadu	24	97271.2
Telangana	11	41493
Uttar Pradesh	41	243627.5
Uttarakhand	04	19250
West Bengal	03	1860
Total	312	782080.62

[22] Ministry of Electronics & Information Technology. (2018). *Download*. Retrieved 04 04, 2021, from greene.gov.in: https://greene.gov.in/wp-content/uploads/2019/09/2019091881.pdf

[23]Mathur, D. S., Mahajan, D. V., & Purohit, D. (2014, Jan-Mar). E-waste health hazards. *WorkOSH, Vol 9, No.1, ISSN: 2393-8943* , 1-8.

5. Predict Growth of E-Waste in India and related rules to curb the problem:

The chart (Figure 2) below indicates the rapidity with which e-waste is increasing with time. In the year 2007, the e-waste is about 332979 metric ton whereas in 2015 it has increased to 713770 (Chatterjee, 2011)[24] (Mathur, Mahajan, & Purohit, 2014, Jan-Mar)[25] which are predicted to cross 1851337 in the year 2025. As per available literature[26], the ranking of the 10 big Indian cities as WEEE generators starting from higher to lower is Mumbai, Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat, and Nagpur, respectively.

Figure 2: Predicted Growth of E-Waste

In 1986, India enacted Environmental Production Act (EPA)[27], the Rules under the EPA give *"comprehensive powers to the Union Government take all such measures as is necessary or expedient for protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution"*. In 1989 the EPA, the *"Hazardous Waste Management and Handling Rules"* were enacted. After it, the Indian Government passed the amendment as they felt that there should be a dividing line between waste and by-product streams. Thus, bringing forward the rule named "*Hazardous Wastes Management and Handling Rules, 1989"*. After it, the Government of India, draft another amendment Rules, 2002 were notified as *"The Hazardous Wastes Management and Handling Rules, 2003"* on 20 May 2003 (Yoheeswaran, 2013)[28].

But there are some issues left as the issue of import of e-waste and its disposal was not mentioned in the above-mentioned rules. The matter was reported by Shri Vijay J. Darda, and on

[24] Chatterjee, S. (2011, 09 11). *Electronic Waste and India.* Retrieved 03 20, 2021, from- https://www.meity.gov.in/writereaddata/files/EWaste_Sep11_892011.pdf

[25] Mathur, D. S., Mahajan, D. V., & Purohit, D. (2014, Jan-Mar). E-waste health hazards. *WorkOSH, Vol 9, No.1, ISSN: 2393-8943* , 1-8.

[26] Envirocare Enterprises. (2021). E-Waste Management. Retrieved 04 04, 2021, from envirocareint.com: http://www.envirocareint.com/electronic_waste.htm

[27] Research Unit (LARRDIS). (2011). *E-WASTE IN INDIA.* NEW DELHI: RAJYA SABHA SECRETARIAT.

[28] Ibid; See Footnote- 27

December 23, 2005, Bill on 'The Electronic Waste (Handling and Disposal) Bill, 2005'[29] was introduced in Rajya Sabha as a Private Member's Bill on 'The Electronic Waste (Handling and Disposal) Bill, 2005'[30]. Under this bill, the Ministry of Environment and Forests (MoEF), Government of India, is the nodal agency. MoEF as the nodal agency will make policy, plan, promote, and coordinate the environmental program including electronics waste. After it, the management of e-waste come under the "*Environment and Forests Hazardous Wastes (Management and Handling) Rules 2008*"[31].

In the year 2009, the "*Department-related Parliamentary Standing Committee on Science & Technology, Environment & Forests"* in its 192nd Report on the Functioning of the Central Pollution Control Board (CPCB), concluded, *"e-waste is going to be a big problem in the future due to the augmentation of economic growth".* The Committee suggested a more proactive role for the CPCB. The suggested that CPCB should devise steps to check the menace and conduct studies to make future projections[32].

On May 12th, 2011, the notification on E-waste (Management and Handling) Rules, 2010 under the Environment (Protection) Act, 1986 was notified[33]. It addressed the issue related to the safe and environment-friendly handling, transporting, storing, and recycling of e-waste. The notification also covers the issue regarding the reduction of hazardous substances during the manufacturing of Electronic and Electrical equipment. In this regard, the Central Pollution Control Board (CPCB), India has released guidelines in 2008. In the guidelines, it was mentioned that environmentally sound management of e-waste should also be applied to all those who handle the e-waste. The Guidelines have been formulated to provide broad guidance for the identification of various sources of e-waste and the approach and methodology for handling and disposal of e-waste in an environmentally sound manner.

To ensure effective implementation of Extended Producer Responsibility (EPR) (Central Pollution Control Board, Delhi, 2016)[34] by producers and to increase their role, effective management of E-Waste, MoEF & CC, GoI has notified the E-Waste (Management) Rules, 2016 vide G.S.R. 338(E), dated 23.03.2016 which will be effective from 01-10-2016. The main feature of E-Waste (Management) Rules, 2016 is Extended Producer Responsibility (EPR). The Government of India issued the guidelines for the "*target-based approach for implementation of EPR as adopted in*

[29] Ibid; See Footnote- 27

[30] Yoheeswaran, E. (2013, 4). E-Waste Management in India. *GLOBAL RESEARCH ANALYSIS,Volume : 2 | Issue : 4 | April 2013 • ISSN No 2277 - 8160* , 54-55.

[31] Ibid; See Footnote- 27

[32]Ibid; See Footnote- 27

[33] Ibid; See Footnote- 27

[34]Central Pollution Control Board, Delhi. (2016). Implementation Guidelines for E-Waste (Management) Rules, 2016. Retrieved 3 20, 2021, from- https://greene.gov.in/wp-content/uploads/2018/01/Guidelines_for_environmentally_sound_management.pdf

the E-Waste (Management) Rules, 2016"[35]. Phase wise collection target has been fixed for producers for the collection of e-waste, which can be either in number or weight and shall be 30% of the quantity of waste generation as indicated in EPR Plan during the first two years of implementation of rules followed by 40% during third and fourth years, 50% during fifth and sixth years and 70% during seventh year onwards (Central Pollution Control Board, Delhi, 2016)[36].

e-Waste Regulatory Framework of the Central and State Governments: As per the current situation, the e-Waste Regulatory Framework of the Central and State Government is guided by the E-Waste (Management) Amendment Rules, 2018 (Government of India in the Ministry of Environment, Forest and Climate, 2018)[37]. As per the Gazette notification, Central Pollution Control Board is the regulatory body. The State Pollution Control Boards or committees act following the guidelines and rules framed for e-Waste Management by the Central Pollution Control Board. The portal links of some State Pollution Control Board for e-Waste Management is given in table 6. In Table 7, the chronology of the development of E-Waste management rules, 2018 from EPA act 1986 is given.

Table 6: Portal Links of State Pollution Control Board for e-Waste Management

States	Portal Links
Andhra Pradesh	https://pcb.ap.gov.in/UI/wastemanagement.aspx
Chhattisgarh	https://www.enviscecb.org/E-Waste_management.htm
Gujarat	https://gpcb.gujarat.gov.in/webcontroller/viewpage/ewaste
Goa	http://goaspcb.gov.in/E-Waste-Management
Haryana	https://hspcb.gov.in/ewaste-rules
Himachal Pradesh	http://hppcb.nic.in/ewaste/chklist.pdf
Jammu Kashmir	http://jkspcb.nic.in/Content/Electronic.aspx?id=231
Karnataka	https://kspcb.karnataka.gov.in/waste-management/e-waste
Maharashtra	https://mpcb.gov.in/waste-management/electronic-waste
Madhya Pradesh	http://www.mppcb.nic.in/ewaste.htm
Orissa	http://ospcboard.org/divisions/waste-management-division/e-waste-management/
Punjab	https://ppcb.punjab.gov.in/en/waste-management/e-waste-rules
Rajasthan	https://environment.rajasthan.gov.in/content/environment/en/rajasthan-state-pollution-control-board/information/WasteManagement/E-Waste_Management.html

[35] Yoheeswaran, E. (2013, 4). E-Waste Management in India. *GLOBAL RESEARCH ANALYSIS,Volume : 2 | Issue : 4 | April 2013 • ISSN No 2277 - 8160* , 54-55.

[36] Central Pollution Control Board, Delhi. (2016). Implementation Guidelines forE-Waste (Management) Rules, 2016. Retrieved 3 20, 2021, from- https://greene.gov.in/wp-content/uploads/2018/01/Guidelines_for_environmentally_sound_management.pdf

[37] Government of India in the Ministry of Environment, Forest and Climate. (2018, 03 22). E- Waste (Management) Amendment Rules, 2018. New Delhi, Delhi, India. Retrieved 09 30, 2021, from- https://cpcb.nic.in/uploads/Projects/E-Waste/e-waste_amendment_notification_06.04.2018.pdf

Tamil Nadu	https://tnpcb.gov.in/wastenew.php
Telangana	https://tspcb.cgg.gov.in/Pages/eWaste.aspx
Uttar Pradesh	http://www.uppcb.com/pdf/E-waste_inventory_310721.pdf
Uttarakhand	https://ueppcb.uk.gov.in/pages/display/187-e-waste
West Bengal	https://www.wbpcb.gov.in/e-waste-management
Central Pollution control Board	https://cpcb.nic.in/e-waste/

Table 7 : Chronology of the development of E-Waste Management Rules[38]

Year	Act/Rule/Reports
1986	"Environmental Production Act (EPA), Act" gives necessary or expedient for protecting and improving the quality of the environment and preventing, controlling, and abating environmental pollution
1989	"Hazardous Waste Management and Handling Rules" to have a dividing line between waste and by-product streams
2003	"The Hazardous Wastes Management and Handling Rules"
2008	The management of e-waste was covered under the "Environment and Forests Hazardous Wastes (Management and Handling) Rules 2008"
2009	The "Department-related Parliamentary Standing Committee on Science & Technology, Environment & Forests in its 192nd Report" on the Functioning of the Central Pollution Control Board (CPCB), has concluded that e-waste is going to be a big problem. The Committee has suggested a more proactive role for the CPCB
2011	An exclusive notification on "E-waste (Management and Handling) Rules, 2010" under the "Environment (Protection) Act, 1986 has been notified" on 12th May 2011 to address the safety and environment-friendly handling, transporting, storing, and recycling of e-waste and also to reduce the use of hazardous substances during manufacturing of EEE
2016	Implementation of Extended Producer Responsibility (EPR) by producers and to increase their role, effective management of E-Waste, MoEF & CC, GoI has notified the E-Waste (Management) Rules, 2016 vide G.S.R. 338(E) dated 23.03.2016
2018	E-Waste (Management) Amendment Rules, 2018

6. Analysis of the collected data and Result:

From the collected data of the source https://globalewaste.org/country-sheets/ , we studied the different aspects and plotted the bar graph for E-waste generated per capita along with EEE Put on Market per capita for India as well as USA and UK as shown in Figure 3, Figure 4, and Figure 5 respectively. The bar graph of E-waste generated / EEE Put on Market per capita indicated that there is a sharp rise in E-waste generated per capita as well as EEE Put on Market per Capita in comparison to countries like the USA and UK. For UK and USA, there is no significant rise of EEE Put on Market per capita on a year-on-year basis but for India, there is a jump of 39% from 2015

[38]Yoheeswaran, E. (2013, 4). E-Waste Management in India. *GLOBAL RESEARCH ANALYSIS,Volume : 2 | Issue : 4 | April 2013 • ISSN No 2277 - 8160* , 54-55.

to 2019, whereas in the UK it is only a 4% rise in the same period and for the USA the growth is only 9.5%.

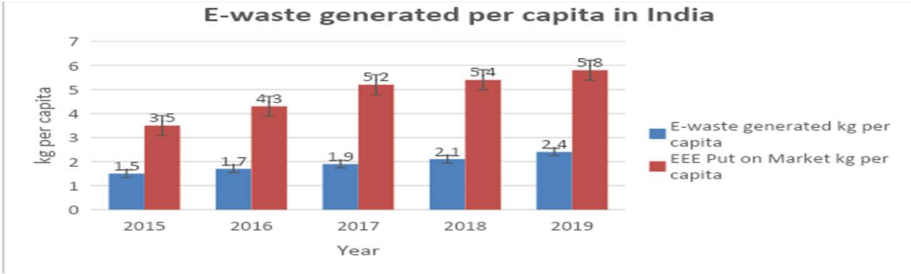

Figure 3: E-waste generated and EEE Put on Market per capita in India

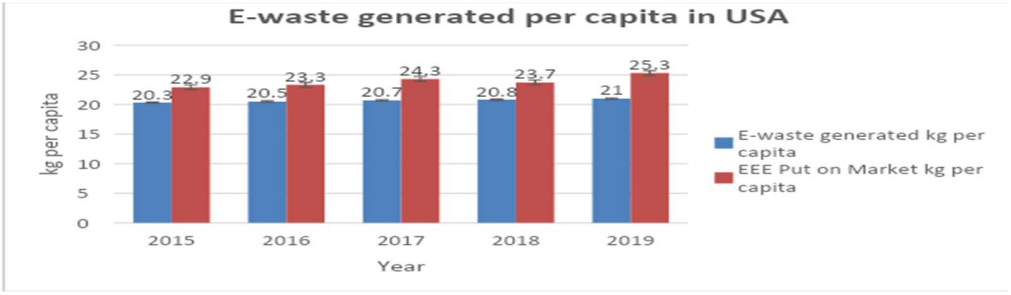

Figure 4: E-waste generated and EEE Put on Market per capita in the USA

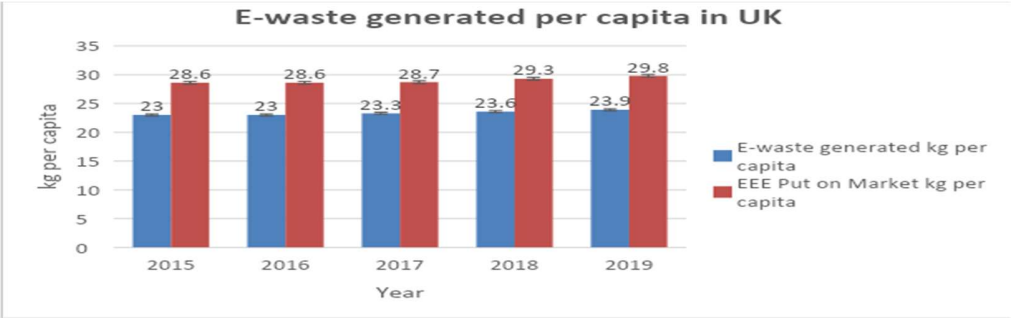

Figure 5:E-waste generated and EEE Put on Market per capita in the UK

Using Table 5, we have plotted the bar graph for State-wise Installed capacity (MTA) of Registered E-Waste Dismantler/Recycler.

7 Conclusions:

Figure 6 indicated that there is a wide variation in installed capacity from state to state in India; though West Bengal produces 9.8% of waste its installed capacity is very small nationally about ~0.24%. There is no significant awareness program launched in the state of West Bengal. Under the present scenario, Schools, hospitals, colleges, universities, etc in West Bengal have huge quantities of obsolete goods /E-waste lying with them. So awareness programs have to be

designed for the collection and disposal of E-Waste from such organizations. Each organization should have a monitoring committee to look after the issues relating to e-Waste management and its proper recycling.

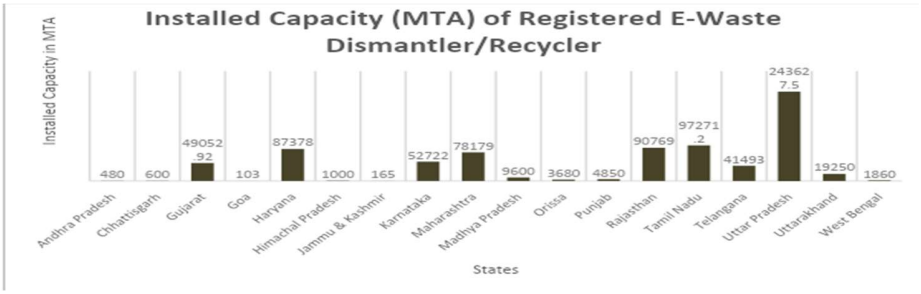

Figure 6: State-wise Installed capacity of Registered E-waste Dismantler/Recycler

Though, the Government has put forward the policy instrument under the EPR, which put the mandatory responsibility of the producer to take back e-waste. But, in the presence of an informal sector with strength in collection logistics, mandatory take back targets might not be a good idea as suggested by Turaga (Turaga, 2019)[39] rather the economic instrument like advanced recycling fee (ARF) or advanced disposal fee (ADF) on every unit of the product sold in the market would relieve the producers of the physical responsibility of collection and the generated revenue of this way may be used for market developments of the end-of-the-life products through various means such as funding the recyclers, assist informal sector workers through training/skill development or provide social security to the workers in the informal sector. Further, there should be incentives for designing and producing the eco-friendly product.

Sinha (Sinha, 2019) [40]suggested that the Ministry of Environment, Forest and Climate Change (MoEFCC) needs to review the current regulation to more explicitly recognize the role that the informal sector is associated with e-waste management. Such decisions may play a crucial role to cover a vast geographical area due to the ability of the informal sector to collect and their aggregate strength. Further, such a decision may help the urban poor and give them better employment.

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[39] Turaga, R. M. (2019). Public Policy for E-Waste Management in India. vikalpa, DOI: 10.1177/0256090919880655, 130-132.
[40] Sinha, S. (2019). The Informal Sector in E-waste Management. VIKALPA, DOI: 10.1177/0256090919880655,133-135

Bibliography:

Central Pollution Control Board, Delhi. (2016). *Implementation Guidelines forE-Waste (Management) Rules, 2016.* Retrieved 3 20, 2021, from https://greene.gov.in/ https://greene.gov.in/wp-content/uploads/2018/01/Guidelines_for_environmentally_sound_management.pdf

Chatterjee, S. (2011, 09 11). *Electronic Waste and India.* Retrieved 03 20, 2021, from www.meity.gov.in: https://www.meity.gov.in/writereaddata/files/EWaste_Sep11_892011.pdf

Earth911. (2021, 03 26). *20 Staggering E-Waste Facts in 2021*. Retrieved 04 2021, from earth911.com: https://earth911.com/eco-tech/20-e-waste-facts/

Envirocare Enterprises. (2021). *E-Waste Mangement*. Retrieved 04 04, 2021, from envirocareint.com: http://www.envirocareint.com/electronic_waste.html

E-Parisaraa Private Limited. (n.d.). *Welcome to E-Parisaraa*. Retrieved 03 20, 2021, from http://ewasteindia.com/: http://ewasteindia.com/

Global E-waste Statistics Partnership. (2021). *COUNTRY AND REGIONAL SHEETS, INDIA, 2015-2019*. Retrieved 04 04, 2021, from Global E-waste Monitor Statisitics: https://globalewaste.org/statistics/country/india/2019/

Global E-waste Statistics Partnership. (2021). *COUNTRY AND REGIONAL SHEETS, UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND, 2015-2019*. Retrieved 04 04, 2021, from Global E-waste Monitor Statisitics: https://globalewaste.org/statistics/country/united-kingdom-of-great-britain-and-northern-ireland/2019/

Global E-waste Statistics Partnership. (2021). *COUNTRY AND REGIONAL SHEETS. UNITED STATES OF AMERICA, 2015-2019.* Retrieved 04 04, 2021, from Global E-waste Monitor Statisitics: https://globalewaste.org/statistics/country/united-states-of-america/2019/

Government of India in the Ministry of Environment, Forest and Climate. (2018, 03 22). E- Waste (Management) Amendment Rules, 2018. New Delhi, Delhi, India. Retrieved 09 30, 2021, from https://cpcb.nic.in/uploads/Projects/E-Waste/e-waste_amendment_notification_06.04.2018.pdf

Karo Sambhav. (2018). *Closing Material Loops*. Retrieved 04 04, 2021, from karosambhav.com: https://karosambhav.com/closing-material-loops

Koshy, J. (2019, 09 28). *Nearly 50,000 people make a living out of Seelampur's e-waste*. Retrieved 03 20, 2021, from https://www.thehindu.com/: https://www.thehindu.com/sci-tech/nearly-50000-people-make-a-living-out-of-seelampurs-e-waste/article29531237.ece

Manish, A., & Chakraborty, D. P. (n.d.). *E-Waste Management in India: Challenges and Opportunities*. (TERI) Retrieved 03 20, 2021, from https://www.teriin.org/: https://www.teriin.org/article/e-waste-management-india-challenges-and-opportunities

Mathur, D. S., Mahajan, D. V., & Purohit, D. (2014, Jan-Mar). E-waste health hazards. *WorkOSH, Vol 9, No.1, ISSN: 2393-8943*, 1-8.

Ministry of Electronics & Information Technology. (2018). *Download*. Retrieved 04 04, 2021, from greene.gov.in: https://greene.gov.in/wp-content/uploads/2019/09/2019091881.pdf

National Solid Waste Association. (2018). *NSWAI BRAND AMBASSADOR*. Retrieved 4 4, 2021, from nswai.org: https://www.nswai.org/ambassador.php

National Solid Waste Association of India. (2018). *About Us*. Retrieved 04 04, 2021, from www.nswai.org: https://www.nswai.org/about.php

Pinto, V. N. (2008). E-waste hazard: The impending challenge. *Indian journal of occupational and environmental medicine, 12*(2), 65–70.

PTI 2016. (2016, 10 18). *India fifth largest producer of ewaste study*. Retrieved 02 20, 2020, from www.thehindu.com: http://www.thehindu.com/sci-tech/energy-and-environment/india-fifth-largest-producer-of-ewaste-study/article8646446.ece

Sinha, S. (2019). The Informal Sector in E-waste Management. *VIKALPA, DOI: 10.1177/0256090919880655*, 133-135.

Toxics Link. (2021). *ABOUT US*. Retrieved 04 04, 2021, from toxicslink.org: http://toxicslink.org/Page/about-us

Toxics Link. (2021). *FUNDING*. Retrieved 04 04, 2021, from Toxicslink.org: http://toxicslink.org/Page/funding

Turaga, R. M. (2019). Public Policy for E-Waste Management in India. *VIKALPA, DOI: 10.1177/0256090919880655*, 130-132.

UPL ENVIRONMENTAL ENGINEERS LTD. (2011, 09). *STATUS OF E-WASTE GENERATION/ MANAGEMENT*. Retrieved 03 20, 2021, from http://goaspcb.gov.in: http://goaspcb.gov.in/Media/Default/uploads/6)%20Ewaste.pdf

WEEE Forum. (2021). *International E-Waste Day - 14 October 2020*. Retrieved 04 04, 2021, from weee-forum.org: https://weee-forum.org/iewd-about/#:~:text=International%20E%2DWaste%20Day%20was,itself%20and%20into%20the%20future.

WEEE Forum. (2021). *Who we are*. Retrieved 04 04, 2021, from weee-forum.org: https://weee-forum.org/who-we-are/

Yoheeswaran, E. (2013, 4). E-Waste Management in India. *GLOBAL RESEARCH ANALYSIS,Volume : 2 | Issue : 4 | April 2013 • ISSN No 2277 - 8160*, 54-55. Retrieved 3 20, 20, from www.nswai.org/: https://www.nswai.org/docs/E-Waste%20Management%20in%20India.pdf