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Statistics on E-Waste Generation and Management Scenario in India

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***Abstract**: Rapid technological advances in electronics industry coupled with increase in purchasing power and decrease in cost of electronic devices has escalated the product obsolescence and led to extremist consumerism throughout the world. As per a study, two of the five Indians replace their smartphones every year. This behavior has brought in a new type of solid waste commonly known as e-waste (electronic waste). Recently, e-waste has become the fastest growing solid waste stream all over the world. Due to its non-biodegradable nature and long life-span, e-waste piles up about three times faster in comparison to other types of solid wastes; thereby exacerbating the ever existing problem of solid waste management,especially in developing countries like India.Within a short span of three years, 2017 to 2020, Indiahas ascended from fifth to third position in global e-waste generation rankings.Despite several initiatives taken by the government, 90% of e-waste in India is still handled in unsustainable manner. This is an alarming cause of concern as poor infrastructure along with inadequate practices for e-waste management endangers human health as well as the environment. In this context, this paper presents a statistical review of the current state of e-waste management in India.*
***Keywords**: e-waste, e-waste management, e-waste statistics in India.*

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I. INTRODUCTION

Availabilityand affordability of technological innovations has ushered in widespread economic development and high living standards for most of the global population. In todays' era, technology dominates every single facet of human life and therefore electrical and electronic equipment (EEE) has become an integral part of day to day activities.EEEs include any business or household item having electrical components with power or circuitry or battery supply [1]. EEEs range from basic kitchen appliances such as electric kettle, microwave, toaster etc. to home appliances such as TV, fridge, washing-machines, air-conditioners and personal gadgets such as desktops, laptops, tabs, smartphones, smart-watches and other wearable devices etc. Besides business and home usage, other sectors such as security systems, healthcare, transport and energy generation (i.e. photovoltaic), are increasingly making use of EEE. Even the traditional products such as furniture, clothing and toys are often endowed with EEE. The ideas of "smart cities" and "smart homes" have provided further impetus to the use of EEE in the emerging area of Internet of Things (IoT). All these EEE systems and gadgets make work more efficient and lives much more convenient. These gadgets have immensely helped people to survive under severe restrictions posed in the wake of COVID-19 as they facilitated the pretence of normal and regular life through video calling, homeschooling (online-classes), online shopping, online-hangouts and gaming nights with friends, movie streaming and work from home culture (home offices). However, the huge volume of electronic devices being used raises concerns about their proper and scientific disposal.

The ever increasing demand for efficiency in processing power, memory capacity, networking capabilities and battery management etc. triggers the superior innovation and results in shorter replacement cycles for EEE thereby leading toshort life cycle, faster productobsolescence and few repair options which eventually leads the way for higher consumption rates of EEE. In the last decade, the global EEE consumption has increased by nearly 2 million metric tons (Mt) annually [2, 3]. When the useful life of EEE is over and these are no longer required; they get disposed of, generating a waste stream known as EEE waste (WEEE) or electronic waste or e-waste. Due to constant up gradation in specificities,increasing complexities and higher consumption rates of EEE fuelling the growing amount of e-waste;it is becoming difficult to manage the WEEE [5].WEEE consists of potentially hazardous and toxic materials, such as heavy metals (mercury, lead beryllium and cadmium etc.) glass and plastics along with valuable minerals such as gold, aluminum, copper, iron, nickel etc. and rare materials like palladium and indium[2,3,4]. Most of these metals can be retrieved from the waste and after recycling can be reused for producing new goods. Given the huge amount of e-waste generated globally, e-waste management presents new challenges as well as significant business opportunities.

WEEE is non-hazardous if it is handled, stored, transported and recycled in formal sector through scientific methods [6]. However, if primitive methods are used or it is processed by informal sector then WEEE is considered hazardous. WEEE may constitute only 2% of the total solid waste yet it represents a whopping 70% amount of the hazardous waste dumped in the landfills [7].Due to its non-biodegradable nature, WEEE accumulates in the environment and stays there for a long period if not collected and recycled. Thus, improper handling of WEEE endangers human health as well as the environment.

Being second populous country on this planet and third largest e-waste generator in the world with lack of awareness on e-waste and poor infrastructure for waste management, India is struggling with the tsunami of e-waste and finds itself in a very precarious situation. In this context, the statistics on current state of e-waste in India along with challenges and strategies for its management are presented in this paper.

II. E-WASTE: DEFINITION, COMPOSITION AND CLASSIFICATION

Several authorities have provided different definitions of e-waste. According to European Union (EU), any EEE waste, including its sub-assemblies, components and consumables, is WEEE or e-waste [8]. According to Step Initiative, "any EEE becomes e-waste once it has been discarded by its owner as waste without the intent of reuse" [1]. In India, E-waste (Management) Rules, 2016 has defined the e-waste as "any EEE, whole or in part, discarded as waste by consumers (individual or bulk) as well as rejects from manufacturing, refurbishment and repair processes" [9]. The key characteristic of any EEE, for the purpose of labeling it as e-waste, is that it no more serves its original purpose and is permanently discarded by its user. E-waste includes all the end-of-life EEE which are discarded with the intention of dismantling and recycling. The unused EEE kept in households and stored in warehouses or repositories is not treated as e-waste [10]. Also, the electrical parts of vehicles, accumulators and any type of batteries are not accounted in e-waste assessments [10]. E-waste mainly consists of metal, plastic and glass. These components of e-waste are shown in Figure 1.

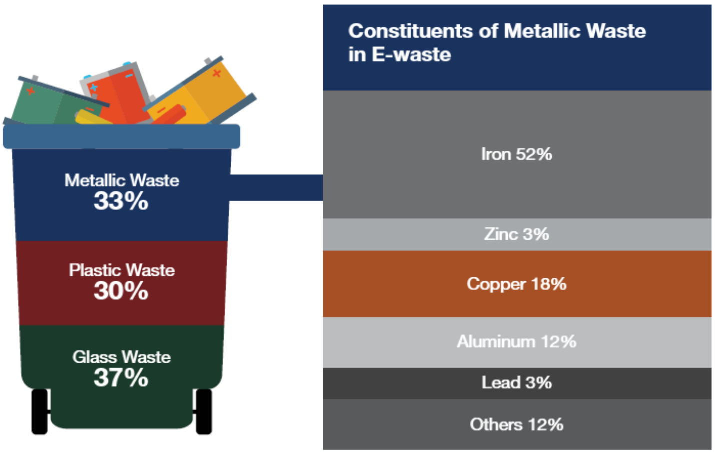

Figure 1: e-waste components [11].

However, each type of EEE has different composition and therefore unequal impact on the human health and environment and thus different methods need to be employed for handling different types of EEE. EEE covers a wide range of products. In order to assess the quantum of e-waste generation and handling, EEEs are grouped based on average weight, comparable material composition, similar functionality and similar en-of-life features. Internationally, EEE are divided into 54 product centric categories as per the EU's directive 2012/19/EU [8]. Based on their waste management characteristics, these 54 product specific categories are arranged into following six general groupings [2,3,4,8]:

i. Temperature exchange equipment: also known as "cooling and freezing equipment", consists of freezers, refrigerators, air conditioners etc.
ii. Small equipment: comprises of toasters, microwaves, electric kettles, fans, vacuum cleaners, radio sets, calculators, electric shavers and trimmers, epilators, smart toys, video cameras and small sized medical devices, other tools, monitoring and controlling devices.
iii. Large equipment: include dish washers, washing machines, dryers, large printing machines, electric stoves and photovoltaic panels etc.
iv. Small IT and telecommunication equipment: consists of pocket calculators, GPS devices, mobile phones, telephones, routers and printers etc.
v. Screens and Monitors: comprise of e-book readers, tablets, LCDs/LEDs, televisions, laptops, desktop monitors and flat panel displays.
vi. Lamps: consist of all types of fluorescent lamps (straight and compact), LED lamps, metal halide lamps and pressure sodium lamps etc.

The lifetime profiles of the products in each of the categories differ implying that quantities of e-waste generated under these categories is different as well as the health impacts if handled inappropriately. As per Global E-waste Monitor 2020 [2], a total 0f 53.6 million tons (MT) of e-waste was generated world over in the year 2019. The amount of category-wise e-waste generationfor the abovementioned six categories is shown in Figure 2. As seen from the figure, the waste in small equipment category (32.5%) constituted the largest proportion of the total waste followed by large equipment (24.4%), temperature exchange equipment (20.1%), screens and monitors (12.5%), small IT and telecommunication equipment (8.8%) and lastly the lamps (1.7%)[2, 4].

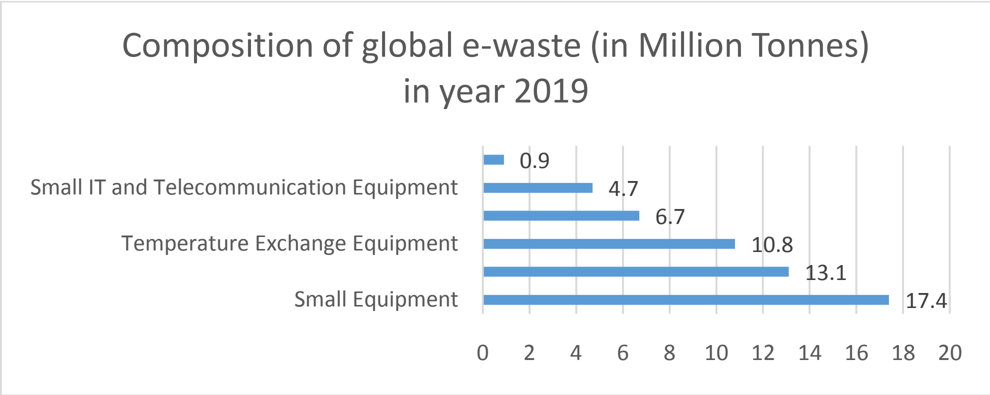

Figure2: Category-wise global e-waste generation in year 2019 [2].

The categorization of e-waste is India is shepherded by Schedule I of the E-waste (Management) Rules, 2016 [9] which groups the EEE into following two major categories:

i. Information, technology and communication (ITEW)
ii. Consumer electrical and electronics (CEEW)

A total of 21 types of EEE are covered under these rules where 16 types of EEE are included in ITEW category and the rest 5 types are accounted under CEEW category.Though the rules have been amended afterwards [12] and recently E-waste Rules (Draft) 2022 [13] have been proposed to broaden the categories of e-waste and the types of EEE covered, the assessments of e-waste generated and formally processed are done by the Central Pollution Control Board (CPCB) under the E-waste (Management) Rules, 2016 as data is available till 2019-2020 only.

As per a study conducted by KPMG in association with ASSOCHAM [14], the composition of e-waste in India is depicted in Figure 3. As evident from the figure, personal devices (computers + phones) make a whopping 82% of the e-waste generated in India.

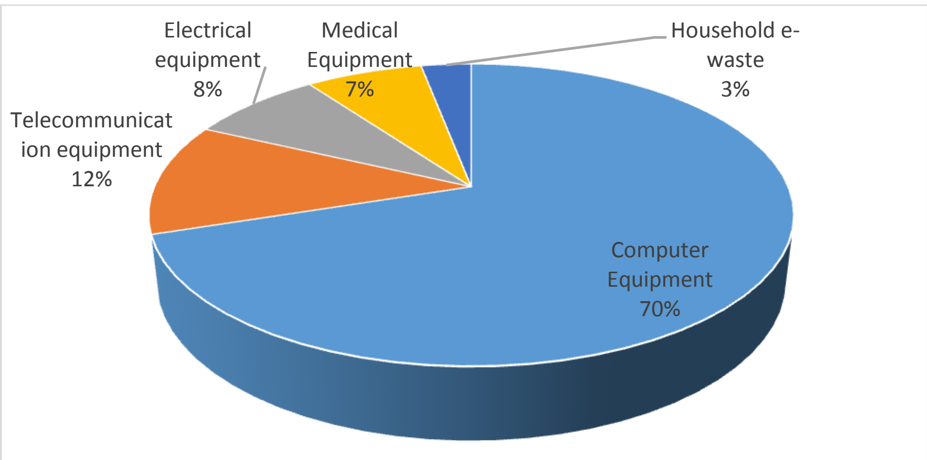

Figure3: E-waste composition in India [14].

III. E-WASTE SCENARIO IN INDIA

As per Global E-waste Monitor 2017, India ranked fifth in the world [3] and as per Global E-waste Monitor 2020 [2], with 3.23MT of e-waste in 2019, India has ascended to third spot in global e-waste generation rankings. Within a short span of three years, the e-waste in India has risen nearly 45%. This increase is petrifying considering the humongous population of India coupled with poor infrastructure for waste management, poor implementation of rules and policies and lack of awareness about the impacts of improper handling of e-waste on human health and the surroundings i.e. air, water and soil. India has touched rock bottom in environmental protection as out of 180 countries, India is listed in the bottom five in the World Bank ranking for environment protection for the year 2022 [16]. Therefore, this is the high time to take stock of situation and to take necessary actions. The e-waste generation scenario in India for year 2019 is shown in Figure 4. Government establishments and public & private sector are the major contributors (around 70%) to the e-waste generated in India. Other sources of e-waste include individual households, manufacturers, assemblers and import of e-waste. Import of e-waste is carried out legally as well as illegally or in a quasi-legal way as e-waste is either easily misclassifies as 'metal scrap' or imported as second hand products which soon turns into e-waste.

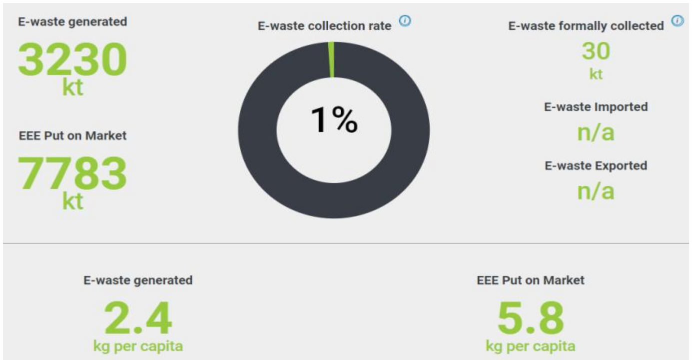

Figure 4: e-waste statistics in India for year 2019 [3].

As seen from figure 4, India supplied 7.78MT of EEE to the market for consumption, distribution or use and produced 3.23MT of e-waste out of which only a meager 0.03MT (around 1% of the total e-waste generated in India) was formally collected. The data for e-waste import and export is not available/applicable as it is hard to calculate in terms of weight and units of WEEE and second-hand products.

The statistics depicting growth of e-waste generation in India over last couple of years are presented in Figure 5.1 (based on assessment by international agencies) and 5.2 (based on data provided by CPCB). As evident from these figures, CPCB estimates are substantially lower than that of international agencies (Global E-waste Monitor (GEM)). The differences in estimates are attributed to following three major factors [10]:

- CPCB estimates are based on E-waste (Management) Rules, 2016 which lists 21 types of EEE to be accounted for calculation of e-waste while GEM considers 54 categories listed under EU's directive 2012/19/EU and followed by all UN agencies.
- CPCB doesn't consider imports and thus estimated figures are much lower than actual as e-waste import constitutes a significant portion of total e-waste in India.
- CPCB estimates are derived from the number of producers who have taken extended producer responsibility authorization (EPRA) as actual number of producers who supply EEE to the market every year is not known; thus widening the gap between estimated and actual quantity of e-waste generated.

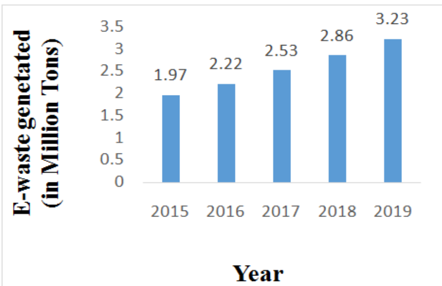

Figure 5.1: Growth of e-waste generation in India (based on assessment by international agencies)[2]

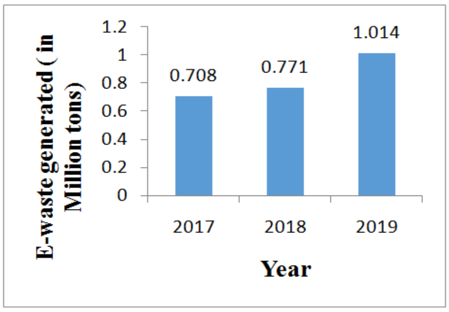

Figure 5.2: Growth of e-waste generation in India (based on data provided by CPCB)[10]

The data in figure 5.1 show that yearly growth rate is around 13%. By extrapolating on this rate, it is surmised that India will be generating 8MT of WEEE annually by 2025 which will further grow to become around 178MT annually by 2050. This projected growth in e-waste generation in India is shown in Figure 6 below.

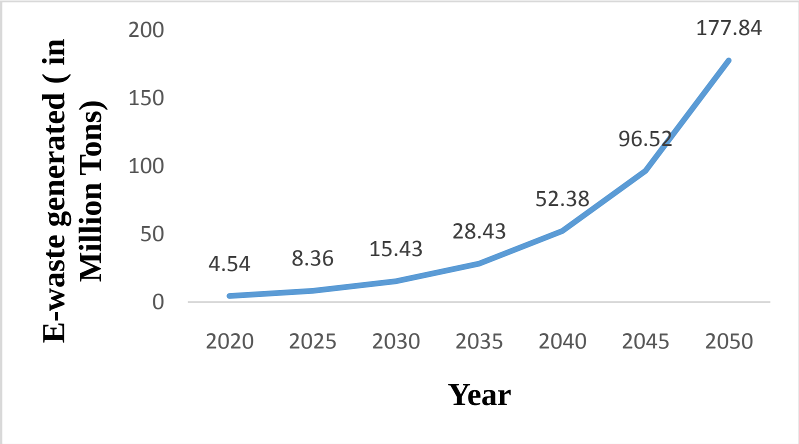

Figure 6: Projected growth of e-waste in India [10].

State-wise contribution (in %) to annual e-waste generation is presented in Figure 7 and percentage contribution by top e-waste generator cities is shown in Figure 8.

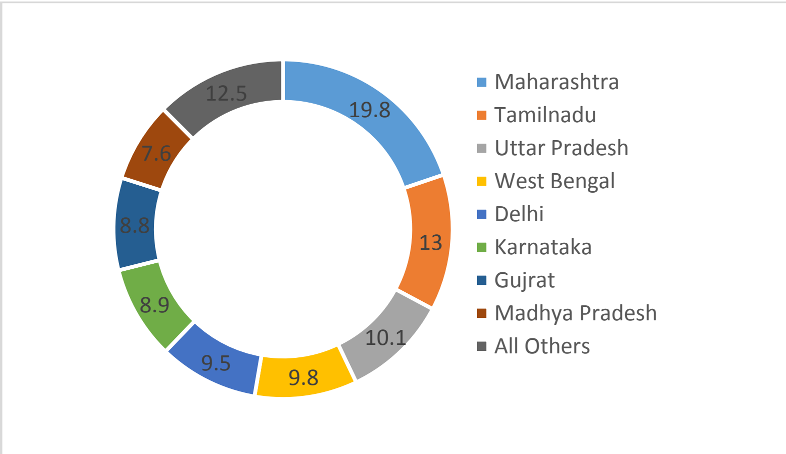

Figure 7: State-wise contribution (in %) to annual e-waste generation in India [11].

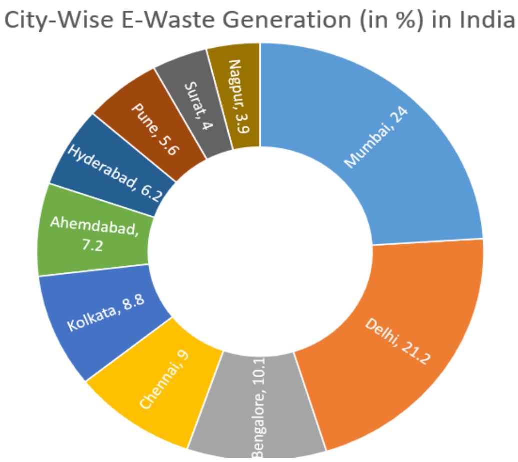

Figure 8: Percentage contribution by top e-waste generator cities in India [11].

According to the data provided by CPCB [15], there are 472 dismantlers/recyclers in India with a total dismantling/recycling capacity of 1426685.22 metric tons per annum. The state-wise distribution of dismantlers/recyclers and their capacities(on 29th April 2022) is given in Table 1. It is easily inferable from the table that India's total e-waste handling capacity of around 1.57MT per annum is far below the required capacity.

Table 1: State-wise dismantlers/recyclers and their total capacity [15]

Sr. No.	**State**	**No. of dismantlers/recyclers**	**Total dismantling/recycling Capacity (in Metric Tons per annum) of the state**
1.	Andhra Pradesh	8	32122.5
2.	Assam	1	120
3.	Chhattisgarh	2	6750
4.	Delhi	2	120
5.	Gujrat	33	84301.92
6.	Goa	1	103
7.	Haryana	42	137415.6
8.	Himachal Pradesh	2	1500
9.	Jammu & Kashmir	3	705
10.	Jharkhand	2	660
11.	Karnataka	71	52842
12.	Kerala	1	1200
13.	Maharashtra	116	106280.5
14.	Madhya Pradesh	2	9600
15.	Orissa	5	5690
16.	Punjab	7	9492
17.	Rajasthan	24	83604
18.	Tamilnadu	32	132049
19.	Telangana	17	113012
20.	Uttar Pradesh	89	494042.7
21.	Uttrakhand	6	153125
22.	West Bengal	4	1950
Total		**472**	**1426685.22**

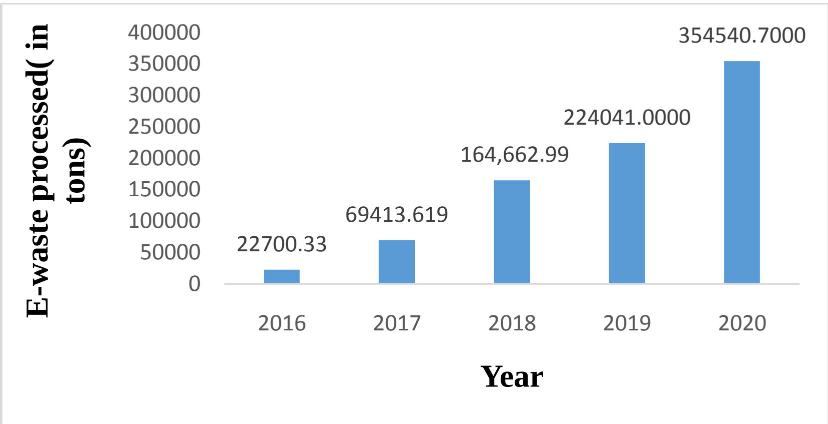

Figure 9: Amount of e-waste processed in India [17].

The amount of e-waste processed in India during after the E-waste (Management) Rules, 2016 were notification is depicted in Figure 9. As evident from the figure, the amount of waste processed has increased significantly; from 22700 tons in 2016 to 354540 tons in 2020. However, given the increase in amount of e-waste generated over the same period, it is not adequate. For 2019-2020, the amount of e-waste processed is only 11% of the total amount of e-wasted generated. More intriguing is the fact that even the available processing capacity of 1.57MT was not fully utilized as only 0.35MT of e-waste was processed in India. Most of the e-waste processing was done by Gujarat, Karnataka, Uttarakhand, Telangana and Tamil Nadu as these are the top 5 e-waste processing states in the given order [11]. The biggest challenge for India in this area is that 90-95% of processing is done in informal (unorganized) sector and the formal (organized) sector carries out processing for only 5-10% of e-waste [18,19]. The differences in organized vs unorganized sector processing are presented in figure 10.

	Unorganized	Organized
Percentage of E-waste Processed	90-95%	5-10%
General Practices of E-waste Processing	Rudimentary methods: Incineration, breaking, dismantling, dumping, etc.	Industrial recycling/dismantling using technically advanced methods
Current Stakeholders	Dealers/Retailers, unorganized recycling sector (local pawn shops, recyclers, dismantlers, etc.) contractual labors, localized vendors (Kabadis)	Government, consumers, retailers, industries/organizations, registered processing units, NGOs and manufacturers
Binding Laws	Not bound by any laws and regulations	Environmental laws, E-waste rules, labor laws, etc.
Major Functions	Collection, disassembly, extraction and dumping	Disassembly, extraction, recycling, treatment and segregation

Figure 10: Organized vs unorganized processing of e-waste [11].

The e-waste processing techniques employed by unorganized sector can damage the environment and affect the human health. The toxic and hazardous materials in e-waste can contaminate the water sources (rivers, wells, hand-pumps etc), soil (through leaching) and air (toxic gases emitted from burning of e-waste).The onus for protecting environment and consequently human health and making policies for WEEE management in India is on Ministry of Environment, Forests and Climate Change (MoEF&CC). The regulatory responsibilities have been delegated to CPCB and State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs). These agencies have been mandated to enforce E-waste (Management) Rules, 2016. However, no state or national level studies have been conducted by these agencies to estimate the amount of e-waste generation and processing and its health impacts in India. The lack of correct e-waste statistics masks the gravity of the matter in question. The availability of nation-wise statistics on e-waste will help the agencies to understand the magnitude of challenges posed by e-waste, to set realistic and legitimate targets for collection and recycling, to apportion requisite financial resources, to set up priorities for policy-makers and in influencing regulations [2]. The e-waste statistics will also assist in reducing the amount of e-waste generated; to prevent emissions and illegal dumping, to promote recycling and to create jobs [2].

IV. CONCLUSION

Even after becoming third-largest e-waste producer globally, the collection and recycling rate in India remains dismally low pointing towards inefficient management of e-waste and stunted value recovery. Most of the e-waste processing is carried out in informal sector thereby risking waste workers' lives. Moreover, till now, most of the e-waste has been contributed by urban pockets. However, with the technological revolution villages are becoming digitized and are increasingly making use of smart phones and laptops. Having around 60% of population in rural areas with no waste collection and processing infrastructure and lack of awareness about the e-waste,India is sitting on a time bomb. A multipronged approach is needed to tackle the issue of e-waste by increasing capacity in formal sector, curtailing illegal imports, ameliorating inventory management and creating awareness about the e-waste, its health and environmental impacts and proper handling techniques.

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