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An overview of sustainable e-waste management based on a case study

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***Abstract*— It is established that the e-waste comprised of personal computers, air conditioners, refrigerators, fluorescent lamps and old telephones handsets. Such discarded equipment is found to contain useful metals such as iron, copper and aluminium as well as ecological contaminants such as lead and mercury. The huge amounts of waste from electrical and electronic equipment (WEEE) have made it very urgent to make such systems that can guarantee selective collection and legal treatment of such electronic waste. But, in some countries now and today also not having legislation or yet not devised a waste management system to comply with the law. Our country India today working on it for better waste managements. In some status dumping yards are developed for waste management. On daily basic local recycling companies who can get benefits from these materials for doing management of waste.**

Keywords— E-waste; EEEs; Management; Recycle; Environment; Sustainable

I. Introduction

In previous years, a drastic increase in the production of electrical and electronic equipment (EEEs) as shown in Figure 1, As production increases more gadgets are introducing in market so that peoples are buying such electronic and electrical (EEEs) gadgets and old ones are thrown in wastes [1]. E-waste is the electronic equipment for everyone life style and is of no further use [1]. As electronic equipment is growing more faster than population of world so that it is also a fastest waste growing all over the world [2]. Present of various hazardous materials in e-waste, it is important to manage the waste carefully. As our India is growing country then also, we are facing issues of e-waste. According to the global e-waste, India generates about 2 million tonnes of annually and ranks only behind the US, China, Japan and Germany, now we can use options such as the 3Rs (reuse, recycle, recovery) would minimize e-waste. For waste management everyone has to use 3Rs for good and better results in waste management [3].

II. Case Study

In the country, there is a rising tide of e-waste generated by domestic consumption of electrical and electronic equipment (EEEs) as shown in Figure 2. Main contribution in increasing of waste of electronic is local markets [4]. Right now, today we do not have any eco-friendly or environment friendly system to dispose e-waste in our country. The electronic waste is mainly result of technologies advanced in daily used devices like laptops televisions, computers, mobiles, wired phones, chargers, washing machines and much more used in hospitals and in

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various industrious. It is very costly to recycling of such heavy e-gadgets [3]. Less knowledge and awareness of recycling workers are risking their lives and environments. They have not advance methods for recycling waste. They use strong acids to retrieve metals like gold and silver for wastages [2].

A. E-waste management: a review

According to a report, 41.8 Mt per year of e-waste are produced globally with Africa holding 1.9 Mt of that share [3]. For proper e-waste in India companies like Lenovo has partnered with their recycling solutions. They have rules about e-waste management which provides environmentally sound management also they have construct am e-waste processing facility for receive and recycle customers returned equipment [1]. Developing regions such as South Africa, Morocco, Brazil and Mexico are recorded as the leading e-waste generators [3]. In 2015, personal computers, televisions and cell phones contributed 9 million tons of e-waste which was a rise from 5.5 million tons in 2010 [3]. Most of e-waste made and includes metals and non-metals like plastic, glass, solid, ferrous, thermoplastic, rubber, elastic and more other substances [1-4]. The upgrading or consuming of the equipment is related to affordability and availability of the market which are factors to do with the economic state of a region. Out of the constituents in the waste, iron and steel is about 47.9%, plastics at 21% and non-ferrous metals at 13%. According analysis, the proportion of precious metals is estimated as 0.2%, 0.1% and 0.005% for silver, gold and palladium respectively [2, 5]. Compared to the other components which make up electrical gadgets, printed circuit boards contain high amounts of precious metals. They project that computers and mobile phones are rich in precious metal content [3-6]. The values of metal compositions of printed circuit boards from different sources like televisions, personal computers, DVD players, calculators and others were obtained and analyzed to conclude that printed circuit boards from personal computers and mobile phones contain the highest amounts of valuable metals as shown in Table 1 [7].

E-waste hosts hazardous substances embedded in various e-waste components [1-4]. Lead is commonly used in solders, as an alloy element for machining metals, incandescent light bulbs, cable covering and printed circuit boards. Its oxide is used in the cathode ray tubes leaded glass and batteries. Tin-lead lead solder is the chief solder type used in most motherboards; 50 g/m^2 lead are expected per typical motherboard [1-3]. Cadmium is concentrated in semi-conductor chips and resistors in printed circuit boards, batteries, photocopying machines, printer inks and toners, cathode ray tubes, and infrared detectors. The element is also used in stabilizing PVC. In nickel-cadmium batteries, cadmium forms the negative electrode material. It is conjointly used as associate alloying part in creating low melting brazing or attachment alloys. Cadmium bio accumulates in body parts such as the liver, pancreas, kidney and thyroid thereby posing irreversible effects on the human health. Furthermore, inorganic mercury mixes with water to form methylated mercury which bio-accumulates in incarnate organisms, mostly fish hence affecting the food chain [3, 4].

TABLE 1.

METAL INGREDIENTS IN E-WASTE COMPONENTS [7]

Metal	Key boards	Personal computers	Printed circuit boards	Car electronics	Typical copper ore	Recycling efficient (%)
Ag	0.05	0.009	0.3	0.12	0.00034	80
Au	0.05	0.001	0.008	0.007	0.00001	99
Cu	13	7	25	20	0.8	90
Zn	3	1.2	1.5	1	0.12	60
Pd	0.0002	0.0004	-3	-	0.04	60
Al	18	11	0.5	-	-	80
Ni	0.16	0.2	-	0.3	-	0

Hazardous e-waste affects the environment through soil, air, water and humans in case of inappropriate handling methods. They describe 3-levels of emission of e-waste toxins into the environment as primary emission which involves the release of dangerous constituents in e-waste like mercury and cadmium, secondary emission which implicates subsequent discharge of products of reaction due to improper treatment such as furans or dioxins formed due to burning of plastics containing flame retardants made up of halogens, tertiary emission which involves the release of hazardous substances or reagents used in e-waste treatment such as cyanide or other leaching agents [5]. Therefore, the environmental risk of such hazardous pollutants could be due to nature of the generated waste and how it is being collected, processed, recycled or disposed. Since a significant portion of people are not really aware of what e-waste is and what to do with their e-waste, there could be need for training on mitigating dangers of e-waste. Encouraging reuse and investing in recycling could help in alleviating e-waste problems [7].

Figure 1. E-waste generation all over the world [5]

Figure 2. E-waste generation all over the world [5]

B. An overview: e-waste in India

E-waste is big issue in India as the new technologies increases with in country. As recent study says, e-waste from old computers will jump up to 500% by 2020 and till continues as well as mobile phones reaching up to 18 times higher than in 2007[2-6]. This is growing awareness in peoples is to urgently address the problems of e-waste in developing countries like with huge population i.e. India and where no correct management of e-waste is not yet properly regulated. As per yearly survey revealed that about 1.47 lakh million tonnes of e-waste per annum were being produced by major status such as Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Delhi, Gujarat, Punjab because these are of dense population [1-3]. Waste is distributed in different status as per value of that waste. Growing population leads to more awareness about e-waste management so many champions are head in India.

III. ENVIRONMENTAL, SOCIAL, ECONOMIC AND HEALTH IMPACTS

There are many adverse effects of improper waste management and it leads to environment, social, health and economic disasters. Respiratory illness has increased due to improper waste management and water purity as plummeted. There is no any modern methods and treatments available on respiratory problems in India. Such treatments are costly and not affordable for common man. It is likely due to rainwater [1] applies it to modern day sustainable waste management. By conducting a literature review on available literature, and then conducting real-life surveys in South Indian cities, it combines an international framework with an Indian perspective, and proposes a technological approach, using technology to innovate within the home and begin sustainable waste management at one of its accumulating in non-biodegradable waste, providing a ground for mosquitos [2-5]. It makes mosquito transmitted diseases much more prevalent and likely to happen [1-6].

IV. Citizens issues

Waste management is as much a city's issue as a citizen's issue. The people's ways of thinking and behaving adequately reflects the values and culture of both their city/village, and by extension, their nation; regardless of the layers of culture, growth, and history [1-4]. It accurately details the evolution of sustainable thinking, and then largest sources [3-7]. For example, reports propose utilizing less water-intensive toilets and improving sewage transportation methods, this reducing the issue in homes and on a 9 societal scale [3-7]. It is important research, because it specifically targets Bangalore. Bangalore generates 3000 tonnes of waste per day, 70% of which is organic; by restructuring the waste management system from every aspect – including the household – organic waste and nonorganic waste can be significantly reduced [2-3]. The waste generation is extremely indicative of the western patterns of consumption perpetuated by consumerism and capitalism [1, 2]. Caste also comes into play while discussing on waste management in India. It recounts a journalist's experiences exploring how caste and waste management are intertwined, mostly by examining Dalit occupations with compared to waste management and removing human excrement [3-5]. It precisely analyses how caste structures have hindered the evolution of sustainable waste management in India. We must first restructure caste's role with relation to waste management [6]. By legitimizing and incentivizing this work, dignity and humanity will be restored to the job and the caste, and waste management at that level will greatly improve. Due to casteism in the past, certain castes, specifically those that work with waste, are looked down upon in society. They are seen as lower than the lowest because they with trash and human/animal waste, which dehumanizes both that caste and those jobs. The dehumanization, coupled with rampant consumerism and capitalism, leads the Indian middle and upper classes to see waste management as a problem for the "other" to deal with [1-6].

V. Methodology

To understand better waste management practices, it was decided to study the problem and interventions through the work of a leading civil society advocacy group such as environmental support group [1, 2]. The organization is a legal advocacy group, litigates on behalf of poor citizens who are disproportionately impacted with environmental harms - especially those living near landfill sites, or those who are waste pickers etc. They also work with the municipal government to bring new regulations on waste management- such as the institution of ward committees. Govern their legal and civil society engagement, ESG seemed to be the perfect case study. It was interned with environmental support group for 2.5 weeks [2-4]. The internship involved close examination of some of their programs such as the formation and maintenance of ward committees, and their public interest litigation suits in waste management and green spaces in Bangalore [2-4]. During the time, they assisted in interviews with dry waste collection centres, bulk generators, and the ward coordinator for Ward 182 in Bangalore. Major highlights of these interviews are listed in Table 2.

TABLE II
INTERVIEW QUESTIONNAIRES [1-7]

[1]	How did you/ESG develop the ward committees for waste management? Why did only some wards participate?
[2]	Do citizens mobilize themselves to organize for sustainable waste management? If so, how? How do you work in terms of building community partnership?
[3]	How would you assess ESG's role in bringing a conversation on segregated waste management in Bangalore?
[4]	What will be the biggest challenge to sustainable waste management moving forward?
[5]	What has been the biggest success with sustainable waste management in Bangalore, either directly or indirectly involving ESG's efforts?
[6]	Who benefits from the current state of waste management in Bangalore? Who suffers?

VI. E-WASTE LEGISLATIVE FRAMEWORK

The whole spectrum of respondents entirely agreed that, the industries and the country at large have no policies or legislations related to e-waste. Although the environmental management act (20:27) forbids the liberation of harmful materials to the environment it lacks specificity to e-waste [1, 2]. The reason for the above could be that, e-waste is a newly emergent waste type in the country hence no action has been on the waste is unknown yet [3-5]. Legislative policies would aid in clarifying the roles and planes of affected stakeholders towards a successful management system such as extended producer responsibility. Furthermore, an observation made during the survey was that no policy are known to govern the standard of imported electronic and electronic equipment (EEEs), hence counterfeits and equipment with high use of hazardous elements end up in the industries posing disposal threats [2, 7]. About 95% of companies were found not to be subscribing to ISO14001 whilst only 5% comply with this international standard. However, 100% of the companies hinted on that they look forward to introduce e-waste management policies at individual level [1-5].

VII. IMPACT OF E-WASTE

Storage is done without proper segregation of the waste types and these sites are mainly open back yards or warehouses. As a result, the environmental risk lies in that, fragile fluorescent tubes are found on the same site as heavy motor casing in industrial warehouses hence increasing chances of breakages of the light tubes that can possibly leak off mercury pollutants [4-6]. Varying weather conditions affect the openly stored equipment at backyards such that fragile material such as glass give in due to cyclic stresses related to temperature changes induced by alternating cold and sunny weathers. The resulting leachates can possibly be washed by rain into storm water drains hence contaminating water sources. The present e-waste management approach in the industrial community could be deemed a threat to sustainability of the environment as it holds higher risks to the communities around the industrial area. As number of companies resort to storage of e-waste, the increasing storage can be viewed as loss of potential revenue for local investors. Most companies storing e-waste were seen to be doing it chaotically within premises hence potential health and safety risk to workers due to injuries by sharp objects. Landfill disposal is being exercised without proper segregation hence the resource value of waste is failing to be discovered. The informal sector players involved in recycling are generating income from the auctioned products from various companies [3-4].

VIII. AN OVERVIEW OF ENVIRONMENTAL SUPPORT GROUP

The environmental support group formally originated in 1998 (Banashankari (BSK) II Stage Bangalore, India) as a public interest with group focusing on environmental and social justice. Public interest is the use of with legal action to benefit minorities or other such groups, which may not be able to defend themselves, or to benefit the common good or the public interest [2-7]. Keeping these directives in mind, environmental support group specifically focuses on environmental rights and social justice. Environmental support group has done much work in the past with Pourakarmikas, a lower-caste group that works in waste management and segregation [1-3]. The generated e-waste graph in different countries all over the world is shown in Figure 3 [3].

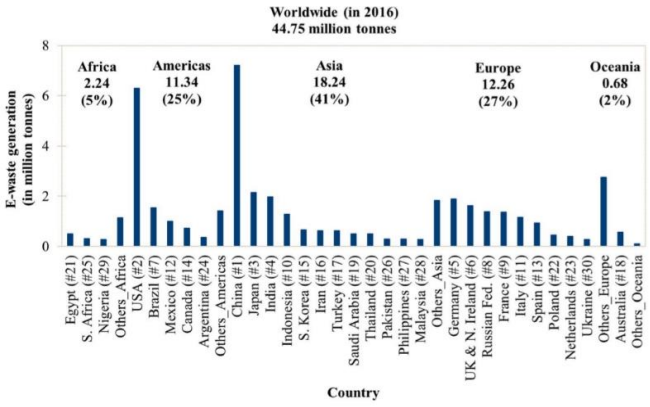

Figure 3. E-waste generation all over the world [3]

IX. Summary and Conclusion

The review paper discusses all major concern on e-waste generation and its sustainable planning in India. The 3Rs such as reduce, reuse, and recycling should be done with sustainable planning. The caste system as discussed above is a major hurdle in e-waste collection, which impacts the issue. The dumping areas in major cities such as Bangalore, Delhi, etc. are potential sources of e-waste. E-waste causes serious health problems particularly respiratory issues, so on and so forth. The government and local non-government organizations should come up with local issues related to EEEs and implement all possible strategies based on statistical analyses to improve 3Rs policies as per the UN guidelines.

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