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E- Waste management – Identifying the loopholes in the current e-waste management system

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Abstract *— The issue of electronic waste is becoming a major problem in India, but now perhaps, if not properly dealt, the matter may be worst to the environment and public health. Whether it is mobile phones or television sets or computers, managing and recycling electronic waste is big business in India. More than 500,000 tonnes of e-waste is generated in India every year while some developed countries also ship their waste here. But most of the e-waste is not being handled properly and is threatening the environment and public health. This is only because we are not implementing appropriate and effective methods for the collection of e-waste and the management of its hazardous constituents, a big quantity of it ends up at scrap markets to be recycled using high polluting technologies or in landfills resulting in high environmental risk and public health hazards. In India, the significance of e-waste management cannot be ignored, not only due to the generation of its own e-waste but also because of the dumping of e-waste from other developed countries. Considering the intensity of the issue the Government of India, The Ministry of Environment and Forest (MOEF) has notified the e waste management rules (2011) for the first time. In this paper an attempt has been made to provide a clear overview of India's present E waste scenario, its impact on the environment and human health. Also this paper includes the Government's initiatives towards the matter, the legal structure in the country, identification of problems and gaps in the legislation and proposing the recommendations for an efficient e-waste management system.*

Keywords *— E-waste management, E-waste legislations, Guidelines, Recycling, Government.*

1. INTRODUCTION

Electronics industry may be considered as the world's largest and fastest growing industry. There has been a rapid growth, which has resulted in discarded electronics which is now the fastest growing waste material in the industrial and corporate world. Electronic waste, "e-waste" or "Waste Electrical and Electronic Equipment" ("WEEE") is waste material which consists of any broken or unwanted electrical or electronic appliances. As per the CPCB (Central Pollution Control Board, India) Guidelines, 2008, e-waste is defined as waste generated from used electronic devices and household appliances which are not fit for their originally intended use and are destined for recovery, recycling

and disposal. Generally, e waste comprises of old, end-of-life electronic appliances such as computers, laptops, TVs, DVD players, refrigerators, freezers, mobile phones, MP3 players, etc., which have been disposed of by their original users. According to WEEE Directive, the components in WEEE are: IT & Telecom Equipments, Electrical & Electronic Tools, Large Household Appliances, Toys, Leisure & Sports Equipment, Small Household Appliances, Medical Devices, Consumer & Lighting, and Monitoring & Control Instruments.

Despite its common classification as a waste, disposed electronics are a considerable category of secondary resource due to their significant suitability for direct reuse (for example, many fully functional computers and components are discarded during upgrades), refurbishing, and material recycling of its constituent raw materials. The unauthorized e waste dismantling, recycling, resource recovery has become a global concern because many components of the above equipment are toxic and non-biodegradable and the processes employed for material recovery are hazardous. The phenomenal growth of IT and electronics industry, changing lifestyle of people, technological development and low cost availability of electronic gadgets has led to increased rates of consumption of electronic products. The high rates of obsolescence of the above mentioned items coupled with steady rise in the demand have also resulted in substantial growth of e-waste generation. The present study has been undertaken to introduce the concepts of e-waste, components of e-waste management and analyses of the major issues related to e-waste management in India.

1.1 Review of past studies

In the paper India: A Matter of Electronic Waste; the Government Initiatives, *Ravinder Pal Singh, Lecturer, Seth Sushil Kumar Bihani Institute of Management & Information Technology, Sri Ganganagar,(Raj), India* say that rapid technology change, low initial cost, high obsolescence rate have resulted in a fast growing problem of E waste.In another paper E-waste hazard: The impending challenge,*Violet N. Pinto* through the light upon the problem and issues in the current e-waste management legislations and the management system. A roadmap for development of sustainable E-waste management system in India, *Sushant B. Wath , Atul N. Vaidya, P.S. Dutt, Tapan Chakrabarti. National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur-440 020, India* say that Assessment of the E-waste management system of developed as well as developing countries with a special emphasis on Switzerland, which is the first country in the world to have established and implemented a formal E-waste management system and has recycled 11 kg/capita of WEEE against the target of 4 kg/capita set by EU. Further, studies, considerations and research are required for reforming the policies, legislature and laws related to E-waste to suit the Indian scenario. Also there exists a need for finding out the most environmental friendly recycling/disposal processes and treatment options for handling the E-waste containing the various toxic and hazardous materials. Electronic waste management in india–issues and strategies,
Kurian Joseph, Centre for Environmental Studies, Anna University, Chennai, India say that Policy level interventions should include development of e-waste regulation, control of import and export of e-wastes and facilitation in development of infrastructure. Bringing E waste in regulatory regime alone will not solve the problem of E-waste. There is a need to make aware people also about the environmental aspects of E-waste. Awareness about e- waste should be propagated highlighting the measures that an individual can take to reduce the E-waste. Government should also take stringent actions to enforce the “E-waste (Management and Handling) Rules, 2011”.

1.2 Significance of the topic

E-waste contains a number of hazardous substances. Heavy metals and halogenated compounds are of particular concern. Improper handling and management of e-waste during recycling and other end-of-life treatment options may develop potentially significant risks to both human health and the environment. Current simple recycling carried out in many developing countries like India is causing risks that could to a large extent, be avoided through the use of improved treatment methods and by imposing proper rules and regulations. Such methods can improve scenario of current treatment practices available for e-waste. The electronic waste accumulation in the country if not disposed-off properly may become a serious challenge for the environmentalists and technologists in the coming future. From the Government side the enforcement of the laws needs to be stricter than ever with an intention to reduce this problem as soon as early before it becomes a threatening hazard for the country. This emphasize the immediate efforts on the part of Government, corporate, environmentalists to manage the Electronic waste through implementing a proactive and protective protocol for the agencies working in E waste reuse, recycle and disposal properly. Need is also felt to educate the general public about this critical issue which can become a major threat for the health of the public and the environment if not handle with care and consciousness.

1.3 Scope and limitations

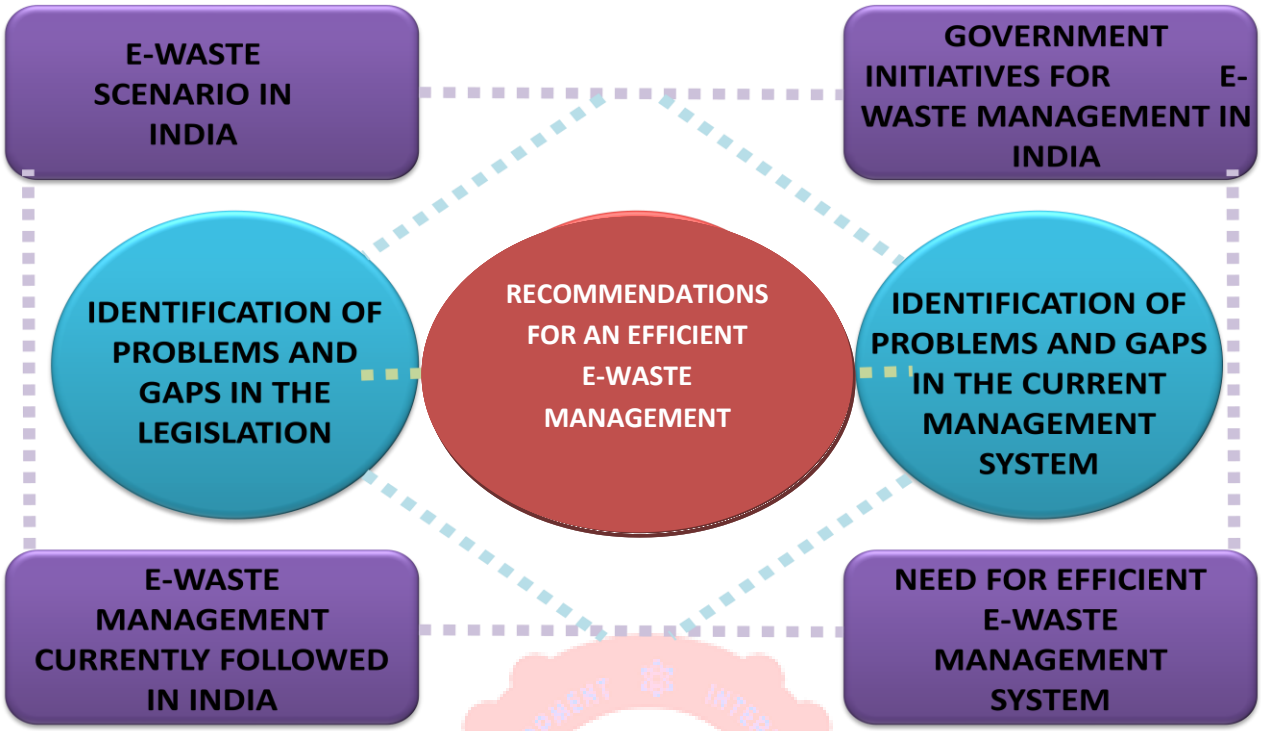
The study focuses on e-waste management in India. The recommendations shall be restricted to India only. Considering the time, the study is limited to recommendations for an efficient e-waste management system. The recommendations would be based on the past studies made, the government initiatives for e-waste management and the current system followed in India. India is placed in a very interesting position. The need of the hour is an urgent approach to the e-waste hazard by technical and policy-level interventions and implementation and increase in public awareness such that it can convert this challenge into an opportunity to which India is ready to deal with the future problems.

1.4 Aims & Objectives

Aim: To study and analyse the problems in the current e-waste management system followed and the gaps in the legislations pertaining to e-waste.

Objectives:
1. To study the laws and regulations (legislations) for e-waste management in India.
2. To study the e-waste management system currently followed in India.
3. To identify the problems and gaps related to formal e-waste management system in India.
4. Finding out the loopholes in the e-waste management rules and regulations followed in India.
5. Analyse the issues and problems of e-waste management system.
6. Propose recommendations for an efficient e-waste management system.

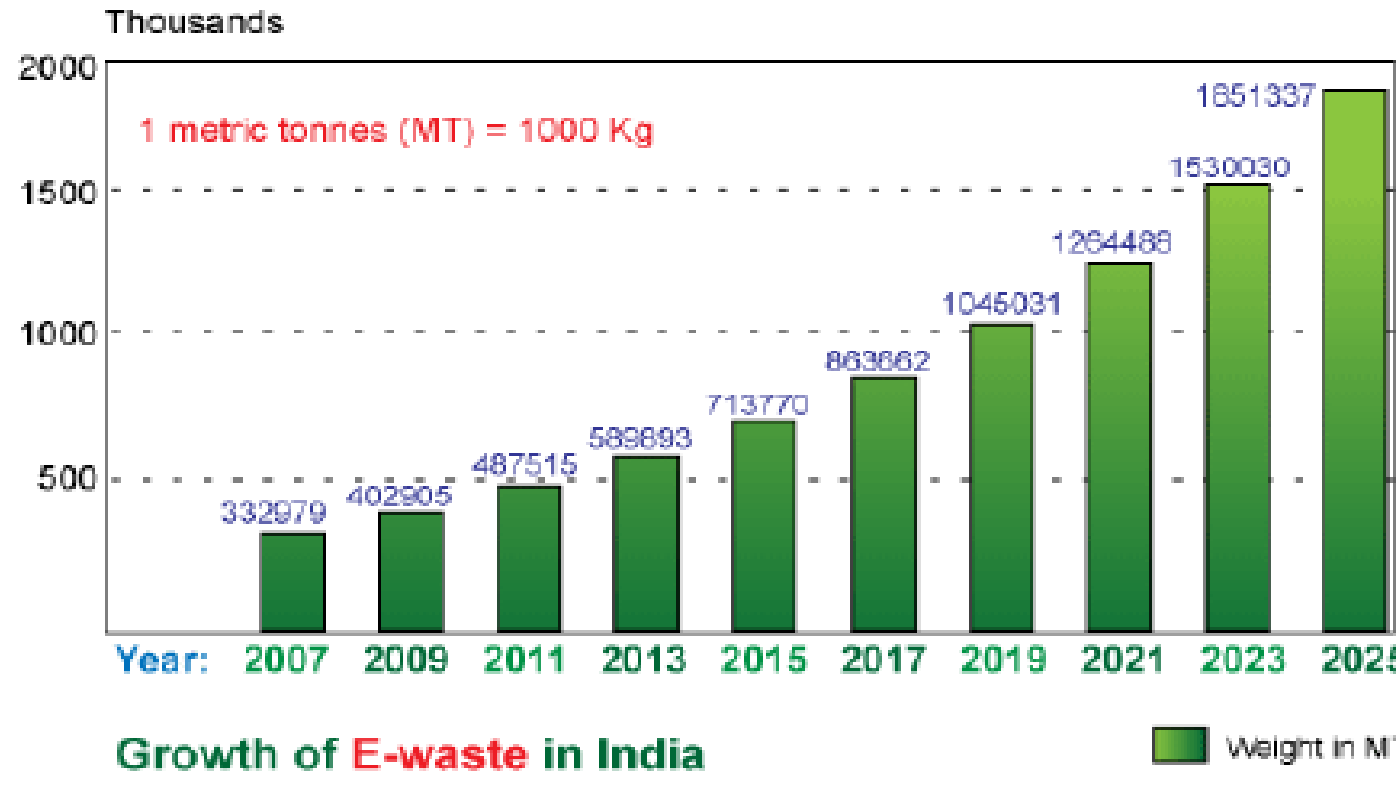
1.5 *Methodology*



2 E-WASTE SCENARIO

2.1 In India

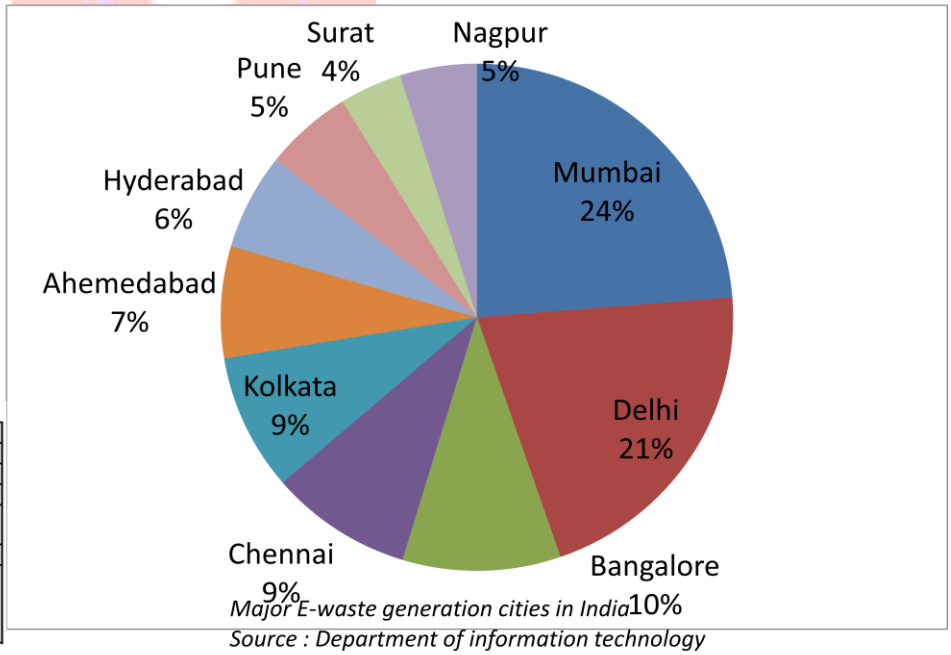
The electronics industry has emerged as the fastest growing segment of Indian industry both in terms of production and exports. The share of software services in the electronics and IT sector has gone up from 38.7% in 1998-99 to 61.8% in 2003-04. The IT industry is the prime mover with an annual growth rate of 42.4% between 1995 and 2000. By the end of financial year 2005-06, India had an installed base of 4,640,000 desktops, about 431,000 notebooks and 89,000 servers. According to the estimates made by MAIT the Indian PC industry is growing at 25% annually. During 2007-08 ICT PC sales grew at 16% annually and consumer electronics sales grew at 13-15% annually while the cellular phone subscribers reached a growth rate of 96.8% in 2008. With the increased use of electrical and electronic equipments the e-waste generation also increased but the assessment show that only about 5.7% of this e-waste is being recycled. The fate of the rest of the waste is still unknown. According to the assessments made, 60-70% of the total e-waste generated is from ten states and sixty-five cities in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e-waste generating states in India. Among the top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. There are a number of e-waste dismantling facilities that are operating in almost all of these cities. At these facilities the e-waste is usually dismantled and exported, and sometimes even processed locally to extract precious metals. Some large scale organization e-waste recycling facilities are being set up in India.(as per the report by MPCP)



State wise E-waste Generation in

Table1. E-Waste Inventory in India

Sr No	Items	Weight (MT)
1	Domestic Generation	332979
2	Imports	50000
3	Total	**382979**
4	WEEE available for recycling	144143
5	WEEE actual recycled	19000
6	Projected quantity of WEEE by 2011 (without including the imports)	467098



Major E-waste generation cities in India
Source : Department of information technology

2.2 In Maharashtra

Since liberalization began in India, no other industry has performed so well against global competition than the software industry. The Information Technology industry in India originated in Mumbai. Among Indian cities, Mumbai ranks first among top ten cities generating WEEE in India. Mumbai, the financial nerve centre of India, is also India's largest port city. The Mumbai-Pune industrial belt is one of the electronic items manufacturing hubs of the country. As a result, Mumbai is not only the port of import for new and used electronics; it is also home to a large user and manufacturer base, both generating large volumes of e-waste. The e-waste recycling market exists in a major way in Mumbai. The market of e-waste in Mumbai is not concentrated in a single place, but spread over different areas, each handling a different aspect of recycling. The city has a large network of scrap traders, with the main centers in Kurla, Saki Naka, Kamthipura- Grant Road, Jogeshwari and Malad. In spite of the absence of proper technology, each component is disassembled and recycled or reused in Mumbai. The general practices of recycling of the most complex parts of PCs, for instance, circuit boards and PVC wires by open roasting and acid bath to recover different metals, has not been observed in Mumbai. Most of the WEEE generated in the Pune and Pimpri Chinchwad Region is transported to the Mumbai Metropolitan Region (MMR) for further treatment and distribution. The items, which require extraction through wet processes are sold to traders from Delhi. Though it is claimed nothing is dumped in open fields, the report prepared by the IRG Systems South Asia under the aegis of the Maharashtra Pollution Control Board (MPCB) acknowledges that the hazards involved in product recycling can cause environmental damage.

The urgent need to have a well coordinated mechanism on the collection, treatment and disposal of the e-waste in the MMR has been recognized. E-waste has been identified as a priority area by the MPCB and it has initiated certain initiatives to create awareness among various stakeholders on the e-waste. As per country level e-waste assessment study, Mumbai generates maximum wastes among all the cities in India. Total electrical and electronic waste generation in Maharashtra is 20270.6 tonnes, out of which Navi Mumbai contributes 646.48 tonnes, Greater Mumbai 11017.06 tonnes, Pune 2584.21 tonnes and Pimpri-Chinchwad 1032.37 tonnes.

3 GOVERNMENT INITIATIVES FOR E-WASTE MANAGEMENT IN INDIA

In view of the ill-effects of hazardous wastes to both environment and health, several countries felt the need for a global agreement to address the problems and challenges posed by hazardous waste. However, the policy level initiatives regarding E-waste in India is quite rudimentary and needs immediate attention. Following are some of the policy level Initiatives in India regarding E-waste.

3.1 The Hazardous Waste (Management & handling) Amendment Rules,2003

Under Schedule 3, of the Hazardous waste (management & Handling) rules, E-waste is defined as "Waste Electrical and Electronic Equipment including all components, sub-assemblies and their fractions except batteries falling under these rules". The definition provided here is similar to that of Basal Convention. E-waste is only briefly included in the rules with no detail description.

3.2 The Hazardous Material (Management ,handling & transboundry movement) Rules,2008

In its endeavor to frame appropriate legislation for e-waste, the Central Government drafted the Hazardous Material (Management, Handling and Transboundary Movement) Rules, 2007 to prohibit transboundary movement of hazardous waste as envisioned by the Basel Convention,

3.3 Guidelines for Environmentally Sound Management of E-waste, 2008

Considering the growing concern on the issue of e-waste, the Government of India has supported several initiatives, particularly the assessment conducted by the CPCB on the management and handling of e-waste which led to the preparation and the publication of the Guidelines for Environmentally Sound Management of E-waste in March 2008. This guideline was a Government of India initiative and was approved by Ministry of Environment and Forest and Central Pollution Control Board. It classified the E-waste according to its various components and compositions and mainly emphasizes on the management and treatment practices of E-waste. The guideline incorporated concepts such as “Extended Producer Responsibility”.

3.4 The E-waste (Management and Handling) Rules, 2011

For the first time, the Ministry of Environment and Forests has notified the e-waste (Management and Handling) Rules, 2011. These rules have come into effect from 1st May, 2012. The e-waste (management and handling) Rules, 2011 recognize the producers’ liability for recycling and reducing e-waste in the country. These rules have the potential to turn a growing problem into a development opportunity. Under the new rules, producers will have to make consumers aware about the hazardous components present in the product. Also, instructions for consumers for handling the equipment after its use along with the do’s and don’ts. They will also have to give information booklets to prevent e-waste from being dropped in garbage bins. However, according to the rules, bulk consumers such as enterprises and government will be responsible for recycling of the e-wastes generated by them. The bulk users, personal computer manufacturers, mobile handset makers and white goods makers will be required to have to ensure that the e-waste generated by them is channelized to authorized collection centers or is taken back by the producers. They also have to maintain records of e-wastes generated by them and make such records available with State Pollution Control Boards or the Pollution Control Committees.

Application:-

Applicability of the Rules	**Rule doesn’t apply**
These rules shall apply to every producer, consumer or bulk consumer involved in the manufacture, sale, purchase and processing	a. batteries as ,covered under the Batteries (Management and Handling) Rule, 2001 made under the Act;

of electrical and electronic equipment or components as specified in Schedule-I of these rules, collection centre, dismantler and recycler of e-waste	b. Micro and small enterprises as defined in the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006); and c. Radio-active wastes as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under.

4 NEED FOR EFFICIENT E-WASTE MANAGEMENT SYSTEM

The current practices of e-waste management in India suffer from a number of drawbacks like the difficulty in inventorisation, unhealthy conditions of informal recycling, inadequate legislation, poor awareness and reluctance on part of the corporate to address the critical issues. The consequences are as follows:

i. Toxic materials enter the waste stream with no special precautions to avoid the known adverse effects on the environment and human health and
ii. Resources are wasted when economically valuable materials are dumped or unhealthy conditions are developed during the informal recycling.

The paper highlights the associated issues and strategies to address this emerging problem, in India.

Waste from Electrical and Electronic Equipments (WEEE) is stored, processed, recycled, reused and finally disposed in a manner, which is detrimental to environment. As per studies, there is hardly any attention paid to the management of the e-waste generated in this industrial belt, which incidentally also houses large number of Info-tech parks especially in New Mumbai and Pune. There is an urgent need to have a well organized mechanism on the collection, treatment and disposal of the e-waste in this region. MPCB has taken certain initiatives to create awareness among various stakeholders on the e-waste and as a part of this exercise carried a feature article in the Indian Express.

5 E-WASTE MANAGEMENT CURRENTLY FOLLOWED IN INDIA

It is estimated that 75% of the electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, warehouses, etc. and normally mixed with household wastes, which are finally disposed off at landfills. In industries management of E-waste should begin at the point of generation.

5.1 Handling of e-waste in India

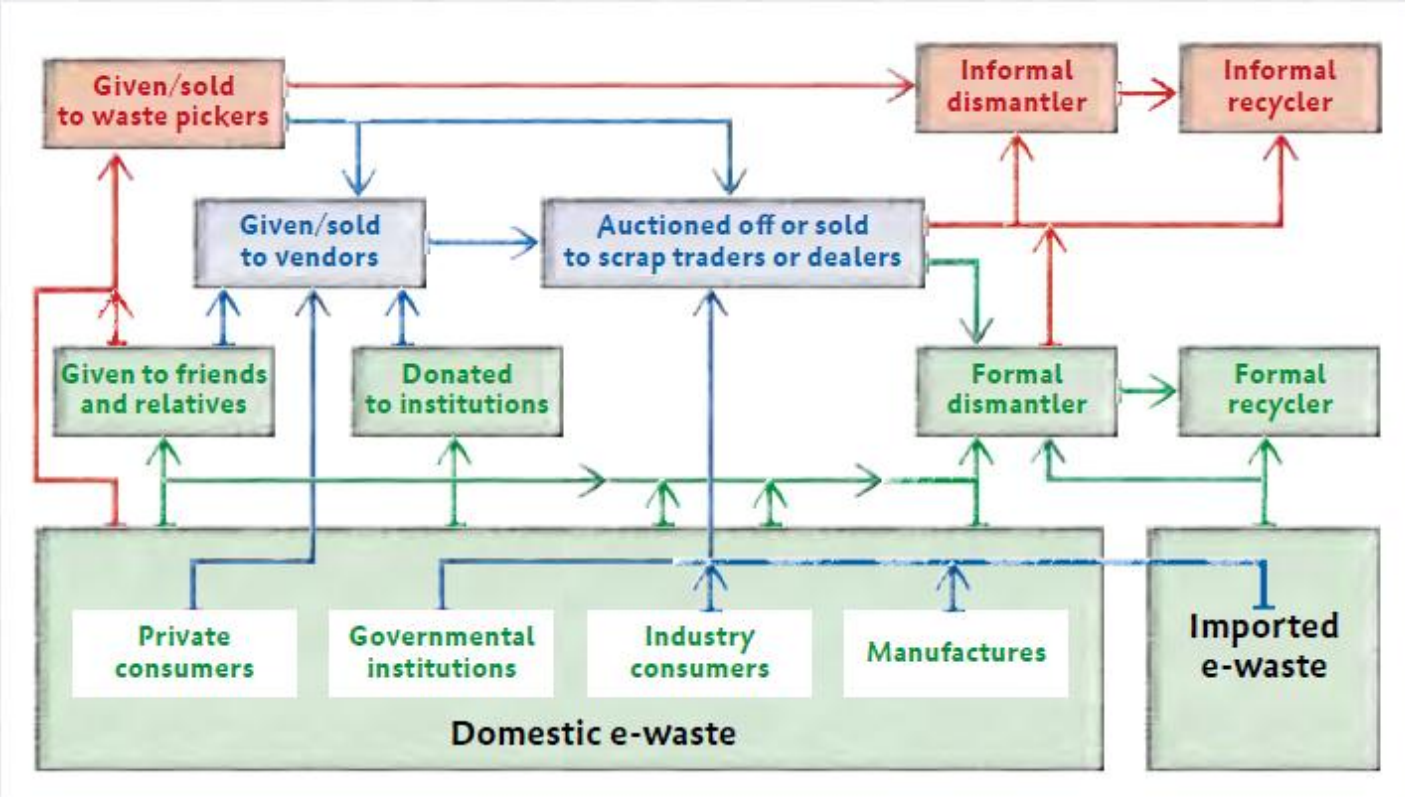
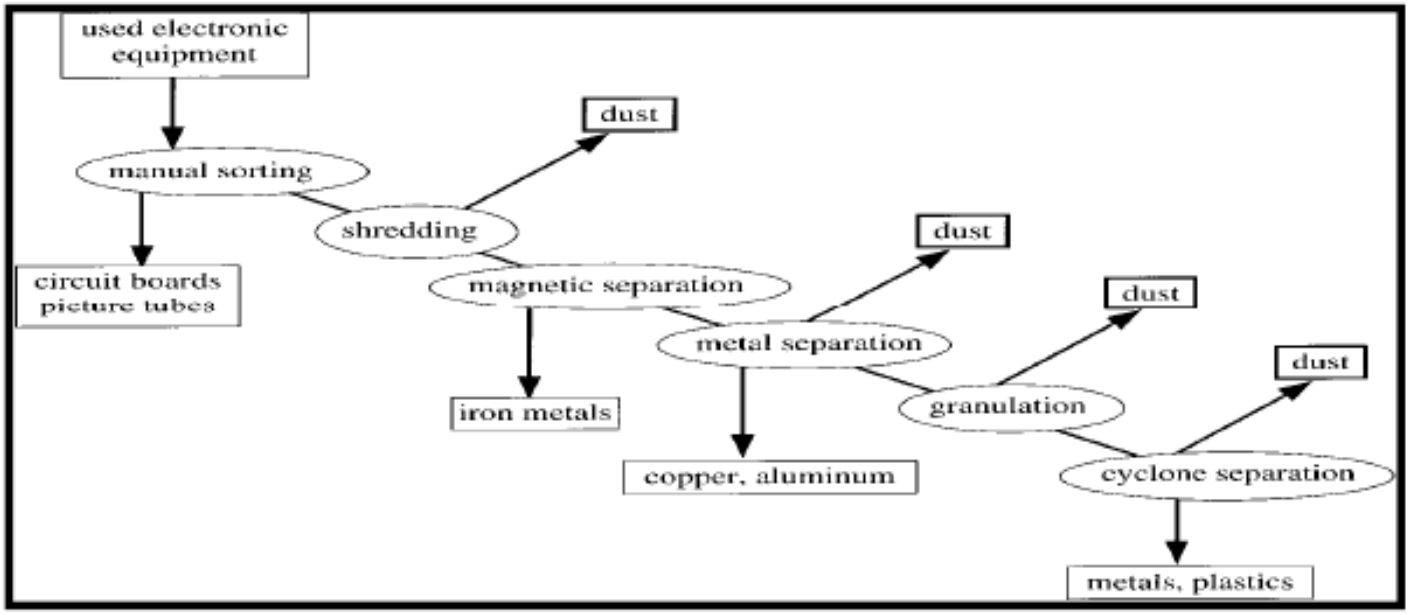


Fig.1 shows the E-waste flow in India.
Source: Skinner, Lloyd, dinter & Strothmann, 2010

Currently, in India, e-waste processing is being handled in two ways, formal and informal recycling. According to a recent study, the Indian recycling industry recycles 19,000 million tons e-waste every year. Of which, 95 % e-waste is recycled in the formal sector and remaining goes for formal recycling. There is a very well-networked informal sector in the country involving key players like vendors, scrap dealers, dismantlers and recyclers. However, the disposal and recycling of computer specific e-waste in the informal sector are very rudimentary. The process followed by these recyclers is product reuse, refurbish, conventional disposal in landfills, open burning and backyard recycling. Of late, formal recycling is being pursued in a big way. Some initiatives have been taken to dismantle and dispose electronic items in the most environmentally sound manner; they also comply with occupational health and safety norms of the workers. Some major e-waste recycling companies are Trishiraya (Chennai), Info trek (Mumbai) and E-parisaraa (Bangalore). Sony has been on the recycling bandwagon way before the recycling rules came in to effect. But, as already mentioned, this is the story of just 5 % of the e-waste generated in India, the remaining 95 % is sold to scrap dealers in underground informal recycling markets of Delhi viz. Seelampur, Mayapuri, Shastri Park, and Meerut, Noida, etc. According to the recent report of Toxic Link(2012), a leading environmental NGO, about 1 ton of e-waste is daily passed through the hands of about 300 dismantling units alone of Seelampur in Delhi. There are 25000 recyclers working in Delhi National Capital region (NCR) only. Similar

trends are observed in Firozabad, Mumbai, Bangalore, Chennai, and Pune. Laborers working in informal recycling units, especially children, get exposed to hazardous chemicals that pose serious health risk. Environmentally sound recycling of e-waste requires sophisticated technology and processes that are not only very expensive, but also need specific skills and training for the operation. Whereas, in the informal sector, workers are poorly protected. Presently, around 23 recycling facilities in various levels of infancy have come up.



Source[3]: Brandl et al. 2001

Fig. shows the e-waste management system currently followed in India.

Comparison of the e-waste economy between the informal and formal sectors in the table given below provides a comprehensive insight into the methods, safeguards, capital investments and earnings involved in the e-waste business.

Informal	Formal
1. Cathode Ray Tubes' (CRTs) are broken manually to separate its components – glass, metal and copper. The glass, comprising lead, is sold to bakeries or bangle makers. Since it retains heat, the glass goes into the base of ovens. Phosphors, if inhaled, can be toxic. The CRTs are sold to non-branded television makers.	Components of the CRTs are separated by heating in a closed chamber, which sucks out phosphors from the components. They are then crushed in shredder machines. Glass containing lead is sold to the companies that manufacture the CRTs.

2. Circuit boards have gold-plated brass pins, microchips and condensers which are separated by heating. Fumes released during heating are toxic. Gold-plated brass pins are soaked in acid to recover the gold and brass separately. Microchips and condensers are heated in big containers filled with acid to extract metallic parts.	Circuit boards are crushed in shredder machines. They are sent to approved smelters abroad, where after smelting at 1200°C, the metals in the circuit board collect together. Since smelting is carried out in closed chambers at high temperature, it is not hazardous. The metals—lead, copper, nickel, tin, gold, silver, palladium—are then separated by electro-refining.
3. No safety precautions followed. Informal recyclers paid Rs.200-300 daily in Seelampur; Rs. 100-150 in Moradabad.	Protective equipments—gloves, masks, shoes, caps—are provided to employees. Rs. 5,000 per month paid to unskilled workers.
4. Minimal capital investment required. Cost includes price of e-scrap, bribes to transfer it across state borders and set up and run shops, and rent for the workspace.	Investment for a dismantler is about Rs. 30 lakh and for a recycling plant, about Rs. 25 crore.

Table.1. shows the comparison between formal and in formal sector of e-waste management system. Source : Report by MPCB

6 IDENTIFICATION OF PROBLEMS AND GAPS IN THE LEGISLATION

6.1 Loopholes in EXIM (Export-Import) legislations

Some provisions contained in some specific policies enable import of e-waste. For instance, India's EXIM (export-import) policy allows import of the secondhand computers not more than 10 years old, besides letting computers in as donations.

The Foreign Trade (Development and Regulation) Act, 1992 provides for import of computers and peripherals from zones which have been set up primarily for export, *i.e.* EOU (Export Oriented Units), EPZ (Exports Processing Zones), STP (Software Technology Parks) and EHTP (Electronics Hardware Technology Parks) at a zero custom duty. These computers can be donated to the recognized non-commercial educational institutions, registered charitable hospitals, public libraries, public-funded research and development establishments and organizations of the Government of India and State/ UT Governments.

Moreover, there is no EXIM code for trade in second-hand computers for donation purpose or for resale. Both second hand and new computers are placed under the same EXIM code in the Indian Customs Tariff Act allowing exporters to club new computers with the old ones. Besides, the Directorate-General of Foreign Trade (DGFT) rules are flexible to interpretation enabling the Customs Authorities to take on- the- spot decisions and provide rules exemption. Thus, if a consignment of second hand computers is found without a license, traders manage to get their shipment released by paying a penalty. Importers also escape full penalty by an under-assessment of illegally imported goods. Such provisions in the law can be misused by the developed countries to export hazardous e-waste to the country.

In the rules on e-waste, Rule 16 in Chapter VI says that 'every producer, distributor collection centre, refurbisher, dismantler, recycler, consumer or bulk consumer shall not import used electrical and electronic equipment or components in India for use unless it is imported for the purpose of repair or refurbishment or to fulfill obligations under the Extended Producer Responsibility (EPR)'. The fact that e-waste could still be imported under the pretext of metal scrap and second-hand electrical appliances have been a matter of serious concern.

As per the e-waste rules, 2011, the clause for import of used electrical and electronic equipment in India for use has been deleted. However, as per the EXIM Policy of Ministry of Commerce import of second hand computers including personnel computers/lap tops and refurbished / re-conditioned spares is restricted.

6.2 Issues in the current e-waste management system.

The main issues posed by e-waste are as follows:

1. High volumes – High volumes are generated due to the rapid obsolescence of gadgets combined with the high demand for new technology.
2. Toxic design – E-waste is classified as hazardous having adverse health and environmental implications. Approximately 40% of the heavy metals found in landfills come from electronic waste.

3. Poor design and complexity – E-waste imposes many challenges on the recycling industry as it contains many different materials that are mixed, bolted, screwed, snapped, glued or soldered together. Toxic materials are attached to non-toxic materials, which makes separation of materials for reclamation difficult. Hence, responsible recycling requires intensive labour and/or sophisticated and costly technologies that safely separate materials.
4. Labour issues – These include occupational exposures, informal sector domination causing health and environmental problems, lack of labour standards and rights.
5. Financial incentives – In general, there is not enough value in most e-waste to cover the costs of managing it in a responsible way. However, in line with EPR policies, new opportunities can be realized with the rise in the price of many of the materials in electronics, such as gold and copper. Furthermore, with rising e-waste quantities, formal recyclers are increasingly entering the e-waste recycling sector
6. Lack of regulation – Many nations either lack adequate regulations applying to this relatively new waste stream, or lack effective enforcement of new e-waste regulations.

The key questions about the effectiveness of legislation would include:

1. What is to be covered by the term electronic waste?
2. Who pays for disposal?
3. Is producer responsibility the answer?
4. What would be the benefits of voluntary commitments?
5. How can sufficient recovery of material be achieved to guarantee recycling firms a reliable and adequate flow of secondary material?

7 RECOMMEDATIONS FOR AN EFFICIENT E-WASTE MANAGEMENT

7.1 Proposals for an efficient E-waste management system.

The following proposals are the solutions to the concerns associated with international trade in E-waste:

1. Minimum standards and improved awareness are needed for recycling in India, especially in the receiving countries.
2. Alternatives for recycling technologies and materials must be developed.
3. Harmonization is needed among government concerning environmental issues and trade in India.
4. Enforcement and regulation policies must be included in any discussions.
5. The informal sectors that are deeply involved in materials cycling must evolve into more formal sectors, especially in developing countries. This is a big issue for all downstream businesses.
6. All costs must be internalized rather than ignored as externalities.

7. Generation of E-wastes must be reduced. This could be accompanied by the promotion of appropriate reuse.

7.2 Formalization of the recycling sector in developing countries

In many developing countries, informal sectors play significant roles in recycling E-wastes. Although some people suggest that these informal activities should not necessarily be formalized, formalization remains an important issue .As an example of formalization, the Japanese experience in recycling lead batteries in the 1970s was presented, based on Kojima's analysis. 31 Participants at the Workshop learned that:

1. Pollution control regulations were imposed by the local government of the area where each recycler was located, not by the central government.
2. Recyclers formed an association to share information and improve compliance with the regulations. This association also helped fund the activities of recyclers.
3. The first stage of the formalization involved registration of all recycling facilities. To encourage registration, heavy obligations were not imposed.
4. After registration, the next stage involved tightening of the regulations. However, the standards remained reasonable and enforceable.
5. At this stage, it was also better to set a time limit for adoption of the standards.
6. A notification system should be formalized to improve information sharing.

In addition to the previous points, on the basis of the Japanese experience, the following points were raised as policy options to accelerate formalization:

1. Tax reductions/incentives for recycling industries could be provided.
2. Low-interest loans for the installation of pollution control equipment would be useful.
3. More information concerning the potential for cleaner production could help to implement appropriate technologies.
4. Factories can be relocated to industrial parks to upgrade facilities for the reduction of pollution.
5. Environmental awareness should be increased.

7.3 Governmental support and financial incentives

The economics of recycling have been the only criteria for the thriving of the informal sector. This needs to be changed in order to understand the environmental health issues associated with the activities. Due to the limited access of the informal sector to financial resources (e.g. loans) it has to be discussed if financial incentives need to be provided to the informal sector stakeholder to allow

i) Its formalization process and

ii) The improvement of its processes towards compliance with environmental, health and safety standards. E.g. specific allocation of funds for environmental surveillance and evolving Public Private Partnership (PPP) model based systems could be introduced.

Additionally, financial aid/access to credit/ incentives/ subsidies and insurance scheme are further measures that may need to be made available. One of the best methods to improve the practices is to offer incentives to those complying with environment and health norms and also promote marketing of such products through a certification mechanism. This would then likewise benefit the formal recyclers, who in return should not be left out since their motivation to invest in this sector are also crucial basis for development of a sound e-waste recycling system. Hence, competitive aspects between the formal and informal sector require attention, and should not be neglected during the supporting process of the informal sector.

7.4 Technical interventions

7.4.1 Product design and engineering interventions

The solution for the e-waste crisis lies in 'prevention at the manufacturing source' or the 'precautionary principle.' This can be done by employing waste minimization techniques and by a sustainable product design.

Waste minimization in industries involves adopting:

- Inventory management
- Production process modification
- Volume reduction
- Recovery and reuse

Sustainable product design involves:

- Rethinking on procedures of designing the product (flat computers)
- Use of renewable material and energy
- Creating electronic components and peripherals of biodegradable material
- Looking at a green packaging option
- Utilizing a minimum packaging material

Extended Producer Responsibility is considered one of the most appropriate frameworks that amalgamate all the enlisted principles on environmental justice. This shifts the responsibility of safe disposal onto the producers. It promotes sound environmental technology and also aims at better raw material, cleaner production technology and designing for longevity.Restructuring recycling: Some recycling procedures require improvements; up-gradation (both in skills and technologies) and some have to be abandoned altogether due to severe risks for health and the environment.

7.4.2 Policy-level interventions

- Clear definition of e-waste for regulation.
- Import and export regulatory regime.
- An integrated IT waste management policy

7.4.3 Implementation and capacity building

- Legislation for collection, recycling and disposal.
- Institutional capacity building.
- Formalizing the informal recycling sector.

Protective protocol for workers in e-waste disposal: Workers are given formally recognized jobs where they can use skills and where occupational health safety (information about their occupation-related health hazards involved and self protection, protective gear and equipment and periodic medical checkups) is assured.

7.4.4 The role of citizens in e-waste management includes:

- Donating electronics for reuse, this extends the lives of valuable products and keeps them out of the waste management system for a long time.
- While buying electronic products, opting for those that are made with fewer toxic constituents, use recycled content, are energy efficient, are designed for easy upgrading or disassembly, use minimal packaging and offer leasing or take back options.
- Building of consumer awareness through public awareness campaigns is a crucial point that can attribute to a new responsible consumerism.

7.5 Recommendations for efficient e-waste management system

1. Need for stringent health safeguards and environmental protection laws in India
2. Extended Producers Responsibility (EPR)
3. Import of e-waste under license
4. Producer-public-government cooperation
5. Awareness programme
6. Choosing safer technologies and cleaner Substitutes
7. Monitoring of Compliance of Rules
8. Effective regulatory mechanism strengthened by manpower and technical expertise
9. Reduction of waste at source
10. Investment Opportunities
11. Recognizing the Unorganized Sector in India

8. CONCLUSIONS

Some of the major issues and challenges faced in the implementation process can be attributed to the gaps and overlaps in the system. First and foremost the gaps in the legal framework need to be closed. The current framework does not specify the role of different stakeholders. No mandatory requirements are provided for the specific activities that are likely to cause direct or indirect impact on environment or health. These actions are not justified as there is no difference between those who comply and those who do not comply. In other words there is no reward for compliance and no action against the non compliant units.

The IT industry has been an important driver in the growth of Indian economy and will continue to be a very significant player. The Indian economy is expected to be one of the fastest growing economies of the world. The size of the market and large consumer base is expected to boost consumption patterns and result in generation of huge quantities of E-waste. While this throws up a serious new challenge it also brings in new set of opportunities not only to manage this waste but also for innovation of cleaner and more sustainable products. Waste minimization is a cardinal principle to be researched, experimented and adopted for sustainability. These are possibilities not only for a solution to local problems, but are also applicable to global issues on E-waste. New revenue models in the business of E-waste appear as interesting possibilities in the Indian context and could perhaps be used as one of the many working solutions. The ideal mix of skilled labor from the informal sector coupled with appropriate technology, proper monitoring of the rules, creating awareness amongst the public and providing the incentives and investment opportunities perhaps can provide solutions for sustainable and efficient E-waste practices. The policy and an enabling regulation to manage this waste are important instruments, which would provide important drivers for a safe and sustainable E-waste management practice. The concept of Extended Producer Responsibility is the most appropriate framework to be discussed and slowly practiced. However, the challenge lies in the implementation of this framework and the regulatory process. The issues of governance have always been a limiting factor in effective implementation of rules and it would be utmost importance to embed necessary drivers for accountability, transparency and sustainability into any regulation or policies on waste.

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