EMERGING TRENDS IN E-WASTE MANAGEMENT – STATUS AND ISSUES

A CASE STUDY OF BANGALORE CITY

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Abstract

The efficient management of electronic waste (E-Waste) is rapidly emerging as a major challenge. If neglected, it will have a devastating impact on the environment besides serious health issues. This paper provides insights into the status of E-Waste management in Bangalore It is based on intensive fieldwork supported by focus-group discussions, participatory observations and interviews. The paper also documents the management processes of formal/informal institutions, the poor practices that have affected health and urban ecology and the policies for improved E-Waste management.

Introduction

E- Waste is one of the fastest growing waste streams in the world. The discarding of electronic products worldwide has intensified in recent years, with 20-50 million tonnes being generated every year, according to Greenpeace, an international environmental group. Globally, E- Waste is the most commonly used term for denoting electronic waste, though no standard definition is offered for. However, the most widely accepted definition is found in the EU directive on Waste Electrical and Electronic Equipment (WEEE) – "Electrical or electronic equipment which is waste including all components, subassemblies and consumables, which are part of the product at the time of discarding (EU, 2002)." Directive 75/442/EEC, Article 1(a) defines "waste" as "any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force"[2].

The management of the colossal generation of E- Waste is one of the major challenges the world over, especially in urban areas. The presence of valuable and recyclable components in E- Waste attracts the informal and the unorganized sectors involved in waste disposal. Their unsafe and environmentally harmful methods of E- Waste disposal are major environmental and health hazards. Hence, there is a pressing need to address the issue of E- Waste management, particularly in the developing countries. In view of the concentration of IT-industries in developing countries and the rise of the middle class in countries like India and China are just the beginnings of this development (Sinha-Khetriwala *et al*, 2005). In India, only 19,000 metric tonnes of the total E- Waste generated is recycled

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[2] (a) 'Electrical and electronic equipment' or 'EEE' means equipment which is dependent on electrical currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such current and fields falling under the categories set out in Annex IA to Directive 2002/96/EC (WEEE) and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current

due to high refurbishing and reuse of electronic products and poor recycling infrastructure. Currently E-Waste recycling, especially processing, remains concentrated in the informal sector, which, in turn, due to poor processing technologies, contributes largely to pollution and environmental degradation. Nevertheless, if handled properly, recycling of E- Waste will address all the three dimensions of sustainable development, i.e., environmental safety, economic growth and equity (E-Parisaraa, 2009). The increasing "market penetration" in developing countries, "replacement market" in developed countries and "high obsolescence rate" make E- Waste one of the fastest growing waste streams (MoEF, 2008).

Greenpeace estimates that India will triple its E- Waste generation over the next five years with the total E- Waste generation of 1,46,180 tonnes per year. According to the estimates carried out by Toxics Link, India annually generates about $1.5 billion worth of E- Waste. Another survey conducted by the Delhi based International Resources Group (IRG), reveals that India churns out 146,180 tonnes of E- Waste annually with the Indian IT industry contributing 30 per cent of it. More than 60 per cent of the total E- Waste in India is generated by 65 cities. Of the top 10 cities generating E- Waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkota, Ahmedabad, Hyderabad, Pune, Surat and Nagpur (MoEF, 2008). According to the MAIT-GTZ E- Waste assessment study, the annual generation of E- Waste in India works out to 400,000 tonnes annually and 19,000 tonnes are being recycled based on the data by hardware manufacturers (Business Standard, 2012).

The problems associated with E- Waste in India started surfacing after the first phase of economic liberalisation, i.e., after 1990. As is well known, there was a major economic policy shift in 1990 that triggered an increase in consumption (mainly because of the removal of quantitative restrictions on imports). This period also witnessed a shift in the pattern of governance in terms of infrastructure reforms and e-governance through the application of information technology in a big way. The liberalisation and globalisation process also opened up new avenues for the growth of the service sector. India, with its huge pool of skilled personnel in information technology (IT) and information technology enabled services (ITES) became a preferred destination for investments resulting in a boom in the growth of IT companies and BPO agencies. This apart, India also experienced a significantly high rate of growth in the post-liberalisation period that increased purchasing power. The technological revolution made electronic gadgets cheaper and user-friendly. The changes in life styles and the IT boom contributed to a quantum jump in their usage and subsequently to the piling up of E-Waste (WISTA, 2002).

E- Waste is routinely exported by developed countries to developing ones – from Europe, US and Japan to Asian countries – often in violation of the international law. About 80 per cent of the E-Waste generated in the US is exported to India, China and Pakistan (Ghana Business News, 2009). It is estimated that around 50,000 metric tonnes of waste are illegally imported into India. Trading in E-Waste is camouflaged in India, in the form of obtaining 'reusable' equipment or as 'donations' from developed nations. This is convenient and easy because laws to protect workers and the environment are inadequate and not suitably enforced. The developed countries find it more convenient and economical to export E- Waste to the third world countries than managing it themselves because of high environmental and economic costs involved. The Basel Convention on the Control of the Trans-

boundary Movement of Hazardous Wastes and their Disposal was adopted in 1989, which came into force in 1992 with the objective of preventing the economically motivated dumping of hazardous wastes by the rich on poorer countries. However, this was not effectively implemented in India despite a 1997 Supreme Court directive preventing the import of hazardous waste. The Ban Amendment prohibits all export of hazardous wastes, including E- Waste and obsolete ships from developed to developing countries (Misra, 2011).

Highly toxic chemicals found in different components of a computer can contaminate soil, groundwater and air, besides affecting workers and the communities living around them. Moreover, workers engaged in computer waste recycling operations are generally exposed to potentially dangerous health hazards because of the fact that at work places health and environmental conditions are compromised. The management of electronic waste has to be assessed within a broader framework of Extended Producer Responsibility and the Precautionary Principle to ensure that future policy responses are more responsive in addressing this issue. At present, E- Waste management cause extreme pollution of nature and hence cause for concern. Several initiatives have been taken by various governments to handle this problem. Apart from governments, many NGOs and private companies are making their best efforts to address this issue. Against this backdrop, the current paper aims to provide insights into the emerging challenges of E- Waste generation and management in Bangalore. The paper is divided into the following sections — regulations concerning E- Waste and the details of the study area and methodology, a situation analysis of E- Waste generation and management, formal and informal recyclers, detailed discussion on the role of institutions in E- Waste management, the possible implications of E- Waste management on urban ecology and the conclusions and suggestions for improving management.

Regulations on E-Waste

Faced with several limitations, a more comprehensive legislation was devised by the Ministry of Environment and Forests and for the first time E- Waste management rules were notified. The E- Waste (Management and Handling) Rules, 2011, make the producers liable for recycling and reducing E-Waste in the country. The rules came into effect on May 1, 2012. The rules fall under the Environment Protection Act. The rules call for the establishment of collection centers, introduction of take-back systems, creating awareness on handling of equipment and use of booklets to ensure segregation at source. Bulk consumers will be responsible for recycling E- Waste and channelising it to authorised collection centers. Records are to be maintained about the E- Waste generated and made available to the State Pollution Control Boards which will be submitted to the Central Pollution Control board annually and then to the government along with the recommendations.

Prior to this, E- Waste or its constituents were considered under the category of “hazardous” and “non hazardous waste”, and were under the purview of The Hazardous Waste Management Rules, 2003, which was an amended version of the Hazardous Waste (Management and Handling) Rules, 2000. It included detailed listing of categories of waste, rules for processes and waste streams in units generating hazardous waste and concentration limits of the constituents in the wastes. The responsibility of identifying sites for the establishment of common treatment, storage and disposal

facilities, procedures relating to the import and export of hazardous waste for recycling and re-export of illegal waste come under the Basel Convention.

Study Area and Methodology

Bangalore, situated in southern India, is one of the top IT destinations in the world. With the liberalisation of the economy in the early 1990s, the computer software industry started booming in Bangalore and increased demand for various support resources. While positive impacts led to significant economic development, it also had a negative impact on lifestyles that exerted immense pressure on resources (energy) and the environment.

Both primary and secondary data were collected for the study. Primary data was collected from key informants and secondary data from Pollution Control Board, NGOs, processing units and formal units. The study was conducted in Bangalore from February to June 2009. Information was collected through interviews with the personnel concerned, and focus group discussions around the E- Waste processing clusters. The study ensured complete coverage and representation of Bangalore. A pilot study was first conducted through questionnaires in core areas where E- Waste was processed like Gowripalya, Nayandahalli, Jolly Mohalla and Sunday Market. Discussions with the informal recyclers provided information on locations of newer E- Waste processing areas (Table 1). With the inputs of the pilot survey, questionnaires were designed keeping in view the specialisation in processing like segregation, collection and extraction of specific components like plastic, CRT tubes etc. However, it was not possible to administer the questionnaires because the respondents (informal recyclers) were reluctant to provide information due to the ban imposed on informal E- Waste recycling by the PCB. The respondents were unable to answer the questions because they had not kept any records of the quantity of waste processed, frequency of health problems experienced etc. With respect to understanding the impact on urban ecology, we identified E- Waste dumping locations and the possible effect it could have on the immediate environment and the health of the people. The impact would be long term and it requires a more detailed study.

E- Waste Management in Bangalore – A Situation Analysis

Bangalore's Mounting E-Waste

Increased E- Waste, one of the recent outcomes of the IT boom, is seen as a major threat to the already deteriorating environment in Bangalore. With little awareness among the majority about the magnitude of the problem, E- Waste has been accumulating almost unhindered as one of the most serious management challenges in the recent times. Experts have cautioned against the potentially harmful impacts of E- Waste and hence the need for its safe disposal. Home to more than 1,200 foreign and domestic technology firms, Bangalore figures prominently in the danger list of cities faced with E-Waste hazard (Habib Beary 2005). As IT firms continue to inundate India's technology hub, Bangalore City is beginning to choke on the E- Waste generated.

E- Waste or Waste from Electronic and Electrical Equipment (WEEE) is no longer a subject for academic discussions at environmental forums. Instead, there is a growing realisation that the issue may assume dangerous proportions over the next few years if left unaddressed. Efforts are being made

to involve the IT companies to make them more responsible. However, with hardly any data available on the number of unregistered companies, tracking them remains a problem. The PCB is taking steps to ensure safe disposal. The Hazardous Waste (Management and Handling) Rule 2003 with major amendments covers various aspects in detail. However, implementation has not been very effective.

E- Waste Generation

There are several estimates on the quantity of E- Waste generated in Bangalore. During discussions, PCB officials reported 13,000 tonnes of E- Waste was generated in 2009, which excluded household appliances. As estimated by E-Parisara, Bangalore generates 12,000 tonnes per year and 330,000 tonnes per year in India with another 50,000 tonnes being illegally imported. The secondary market for old PCs accounts for 40 tonnes per hour while it is 4,000 tonnes per hour for the whole world. Manufacturers and assemblers generate about 1800 tonnes of electronic scrap every year. According to another estimate about 1,000 tonnes of plastics, the same equivalent of iron, 300 tonnes of lead, 0.23 tonnes of mercury, 43 tonnes of nickel and 350 tonnes of copper are generated as E- Waste in Bangalore and this figure might increase ten-fold by 2020 with the city generating one-third of the State's E- Waste.

Discussions with the officials of the Karnataka State Pollution Control Board revealed that the quantity of waste generated is based on the obsolescence rate of computers in the IT industries. E-Waste generating sources include IT companies, public and private sectors, hospitals, factories, commercial establishments, computer retailers, manufacturers, and households.

Flow of E- Waste

One of the major constraints involved in disposing E- Waste is the absence of scientific landfills. In the absence of scientific and formal E- Waste management mechanisms and policy guidelines, the user-industries that have custom-bonded electronic equipment, such as computers, are forced to dispose obsolete computers to illegal traders. The disposal and treatment of E- Waste is a distinct production chain and cannot be treated solely as disposing waste because it involves both re-use and recycling. However, the character of the production chain differs in the formal to the informal sectors. The formal sector is constrained by regulations, either governmental or international modes of self-regulation (ISO 14001 standards). Three factors are of major interest First, sources of E- Waste are both domestic and international and E- Waste is imported, even though it is illegal, unless 1) the purpose is direct reuse, or 2) E- Waste is handled in an environmentally sound way (Basel-convention, Toxic Link, note that E-Waste has only been classified as hazardous by law in India since 2008 (E-Parisaraa 2009). Second, formal E- Waste treatment plants are new in the Indian context (E-Parisaraa was established in 2004-2005) which explain the third significant fact that 95 per cent of the E- Waste is handled by informal recyclers (E-Parisaraa 2009, Sinha-Khetriwala 2005). Thus, the formalisation of E- Waste management in India has just begun. This process faces the dynamics and dilemmas generally associated with what some researchers have conceptualised as the "informal" economy.

The informal sector is generally characterised by the lack of social and environmental awareness and responsibility, low wages, a multiplicity of health risks and is mainly driven by

decentralisation and outsourcing of production (Portes *et. al.* 1989). Thus, informalisation is a way for large companies, both domestic and international, to exploit what one could denote as "labour arbitrage" (low wages and avoidance of social security provisions imposed by labour unions or governments) and "regulatory arbitrage" (avoidance of environmental regulation, pollution control etc.). Nevertheless, if you apply a bottom-up perspective, the interpretation of the informal sector changes: In developing countries, E- Waste recycling is a lucrative business, which provides livelihood for a large number of people. Thus, the question is whether these people have any real alternatives to informal recycling, or are they stuck with environmental and health hazards out of economic necessity (Portes et. al. 1989). This stipulates that government intervention in the informal E- Waste sector should be carefully designed to address livelihood and environmental problems.

The current dynamics and infrastructure of the E- Waste sector are barriers to such interventions and need to be taken into consideration: First, E-Parisaraa receives E- Waste from large companies only due to domestic and international compulsions. Large international companies (IBM, Intel etc.,) often have to comply with demands from stakeholders to document their corporate social and environmental responsibility. Hence, they follow certain standards of self-regulation. A formal recycling unit like E-Parisaraa in a developing country with an ISO 14001 certification is thus ideal for their purpose in terms of legitimising the disposal. Formal disposal of E- Waste become mandatory in Karnataka recently and has reduced the flow of E- Waste to the informal sector. However, the law faces some constraints with respect to the capacity of the formal sector to absorb large quantities of E- Waste and the multiple ways to circumvent such regulations. This is actually achieved through "business as usual", donation of used equipment to schools or NGO's or disposal for reuse. In India, you are paid to dispose E- Waste because there is a much larger market for reuse and recycling and the price offered is higher in the informal sector than in the formal sector, whereas in Europe you have to pay for the disposal of E- Waste (E-Parisaraa 2009). Eventually, the equipment might end up in general households, which do not face any constraints in disposing in the absence of any kind of waste collection infrastructure. The informal recyclers are readily available for getting rid of such E- Waste. Thus, in the current situation, it is difficult to ignore the role of the informal sector in E- Waste management.

Formal Disposal Site – Treatment Storage and Disposal Facility

The Pollution Control Board, in association with GTZ, a German Engineering Firm, has set up an E-Waste disposal landfill site, with an investment of ` 55 crores, at Dobbaspet about 50 kms from Bangalore near Tumkur road. The landfill has been operating since February 2009, despite encountering opposition from activists, local residents and politicians fearing a hazardous impact on health and environment. The landfill knows as a 'Treatment Storage and Disposal Facility' (TSDF) is spread over 93 acres with a potential storage capacity of 40,000 tonnes of industrial and biomedical waste every year and actual storage capacity of 8,00,000 tonnes – enough to last for two decades. Industries registered with Karnataka (more than 2,000) have to pay between ` 1,500 and ` 2,500 for each tonne of waste to use the TSDF. More than 8,000 tonnes of hazardous waste has been sent to the site and companies like BHEL, Volvo and Toyota have used this facility.

Recyclers

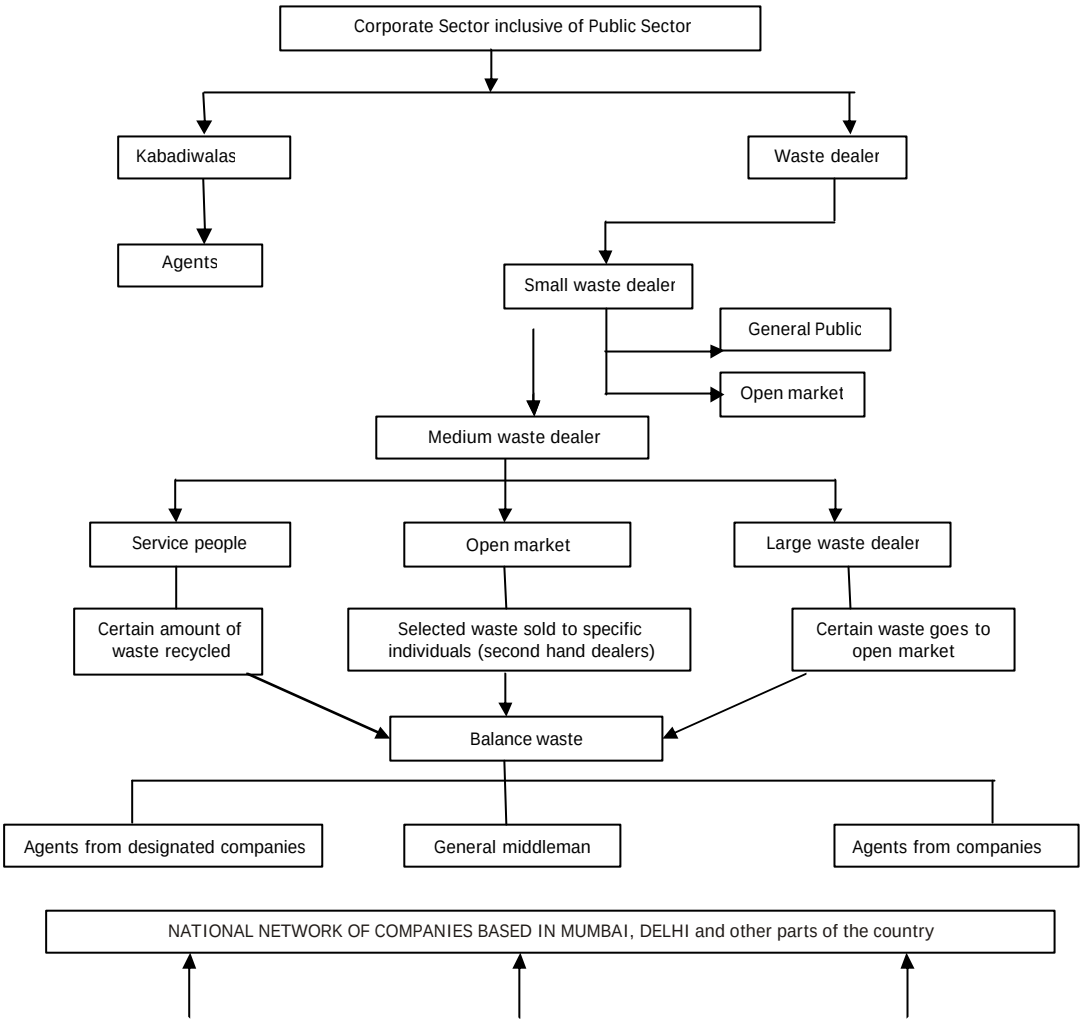
Informal E- Waste Recycling in Bangalore

Informal E- Waste recycling is carried out in certain pockets of Bangalore that are highly congested, densely populated by minority communities with low-income. Recyclers are engaged in various forms of partnerships in the E- Waste business. It could be a single individual or partnerships at various levels based on the financial investments. For instance, they pool their investments to purchase E- Waste from companies, process it and share the profits or set up individual businesses by establishing small business enterprises, employing labour for processing the E- Waste.

The informal recycling process has several levels of management. The physical flow of E-Waste begins with agents, waste dealers and even ordinary Kabadiwalas who acquire computer systems from the public and private sectors. After segregation, both agents and small waste dealers sell the waste to the mediating waste dealers. Small waste dealers sell some of the waste to the public as second hand goods while the remaining is diverted to the open market. From the mediating waste dealers, the scrap flows to the service industry as parts for repair and maintenance of old computers. Again, some residuals in the service industry get back into the open market while the rest is sold to large waste dealers. From the large waste dealers it is channeled in three ways: (1) recycling of certain parts (2) selected waste sold to specific individuals and (3) certain parts come back to the open market. At the other end of this chain, there is a network of dealers operating from large cities like Mumbai and Delhi through agents, intermediaries and company agents. All of them approach large dealers in Bangalore to acquire scrap directly or through the open market. The process can be better understood in the form of a flow chart.

There are a very few (earlier 6, now 16) formal recycling units in Bangalore. Some companies store, donate, dispose their E Waste to informal recyclers through open auctions. The informal recycling activity is unorganised with small and large-scale dealers doing brisk business in their backyard recycling units where materials like gold, copper etc., are recovered using dangerous chemicals and non-scientific processes. The informal recyclers mainly operate in seven major congested and thickly populated clusters in the city, comprising both residential and business areas. People working in the informal E- Waste sector are struggling to be recognized as formal sectors because their livelihoods are dependent on this trade (E-Nam, 2008).

Flow Chart 1: Informal E- Waste recycling process in Bangalore

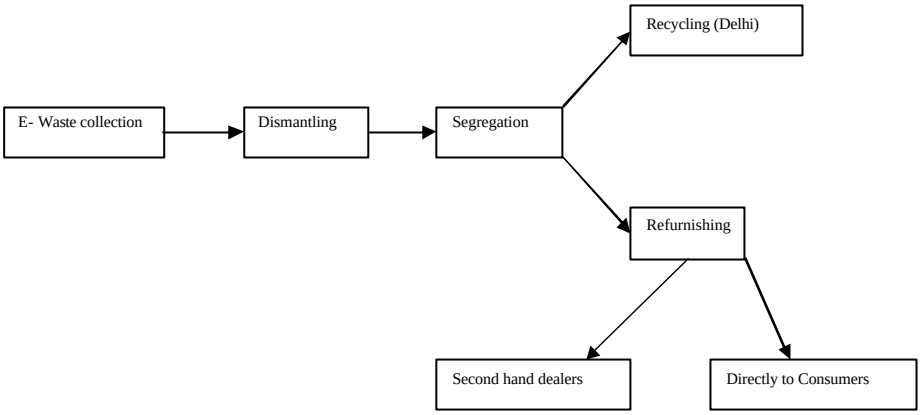


Informal E- Waste Recycling Process - Traders

The recyclers run small units (area of 4x4 sq feet for small enterprises and 20x20 sq feet for large enterprises) where they process waste in various combinations (Table 10). Usually, 25 per cent of the computer scrap collected is reusable. The general trend is that they accumulate waste up to 1 tonne and later sell to second hand dealers specialising in processing the respective components. Generally, recyclers specialising in certain processes or combination of processes congregate in specific areas For instance, some recyclers collect only wires and sell them to large-scale dealers, recyclers in Gowripalya specialise in extraction and recyclers in Nayandahalli and Tilak Nagar process plastic waste. All these aspects have been documented in detail for various areas.

E- Waste recycling involves the following steps:

Flow Chart 1: E- Waste Processing



Employment

Recyclers (the ones who invest) and employees mostly belong to the age group 25-35 years. However, children are also engaged in the recycling process to do simple chores like collecting specific kinds of waste while women are employed for processing waste at households. Labourers are usually paid on a daily basis (between ` 75 and 90 for women and ` 100 and 120 for men per day) but a few are hired on a monthly basis (` 5000 to 6000) depending on the E- Waste procured. Although informal recyclers are keen on becoming authorised recyclers, they are ignorant of the procedures and access to the Karnataka State Pollution Control Board. To become a formal recycler, one has to own land in an industrial area. As most of the informal recyclers are economically poor, they find it difficult to meet such stipulated requirements.

Monetary Benefits

Informal recyclers purchase E- Waste in bulk from companies, institutions and households. Prices depend on the type of material purchased and sold accordingly. The price mechanisms of E- Waste trading vary across formal and informal recyclers. The formal recyclers have categories across waste collected and purchased at a fixed price from various companies, whereas informal recyclers have no stipulated price because they purchase in bulk and sell by making guesstimates. However, the selling price of materials recovered remains almost the same across informal recyclers, indicating that recyclers have a better future in E- Waste business.

Formal Recyclers

Formal recycling of E- Waste from source to recycling centre and finally to the disposal site accounts for hardly 5 per cent of the total E- Waste generated. The authorised dealers receive E- Waste from corporates for scientific recycling. There were six authorised recycling units existing in Bangalore during

the time of the study but currently there are 16. The organised recycling companies are equipped to process E- Waste at different degrees of excellence. However, it is very important that the formal recycling be in place to ensure accountability. The processes can always be refined. Apart from processing E- Waste, formal recyclers are also involved in awareness programmes in collaboration with NGOs and schools. The formal recyclers are supposed to abide by rules and regulations in processing E-Waste including safety of employees.

Institutions' Role in E- Waste Management

The roles and responsibilities are still unclear in managing E- Waste and until such time, the blame-game will continue. Most consumers of electronic waste are unaware of the effect on health and the environment. Large corporate offices and households have not given much attention to what happens to E- Waste after it is sold as scrap. The general view of the industry is that the government should regulate scrap trade through authorised dealers. However, there is the larger issue of Extended Producer Responsibility (EPR) where producers have to take up the responsibility of safe disposal of their products after they have reached the end of their shelf life. This is the internationally accepted practice and is regulated by appropriate legislation in all parts of the world. In India, however, both multinational and domestic companies seem unwilling to embrace this practice.

The IT industry and other generators of E- Waste have yet to comprehend fully their role in dealing with the problems related to the disposal of E- Waste. Although the IT industry is aware of the problems concerning disposal of E- Waste, most of the companies consider donating of computers as the most convenient option in this regard. Thus, it is evident that collection and recycling processes need to be strengthened and systematised.

As mentioned earlier, the present legislation does not seem to be effective in addressing these problems adequately. The government, industry, users and NGOs have started taking notice of the growing hazards of E- Waste disposal alongside a growing consensus that recycling and resource recovery used to be environmental-friendly. Several organisations have taken up various initiatives in managing E- Waste. An overview of their aims and functioning highlights their efforts and further requirements to strengthen the institutional structure of E- Waste management.

Indo-German-Swiss E- Waste initiative involving several partners – Ministry for Environment and Forests, Central Pollution Control Board, BMZ, German Technical Cooperation, SECO and EMPA – is a case in point with respect to co-ordinated management of E- Waste. Further, the Ministry of Environment and Forests is the nodal agency in the administrative structure of the central government for planning, promoting, co-ordinating and overseeing the implementation of environmental and forestry programmes. The Ministry is also the nodal agency in India for the United Nations Environment Programme (UNEP). The Central Pollution Control Board (CPCB) is an autonomous organisation under the Ministry of Environment and Forests, the apex organisation in India for the prevention and control of pollution. Among the many functions of the CPCB, is drafting guidelines, advising the MoEF on policy issues, conducting field tests and co-ordinating the activities of the State Pollution Control Boards.

The German Federal Ministry for Economic Co-operation and Development (BMZ) develops the guidelines and concepts of Germany's development policy. It determines the long-term strategies for co-operation with different participants and defines the rules for their execution. This principal task results in the development of common projects with the partner countries at the international level while the GTZ (German Technical Co-operation) is an international co-operative enterprise for sustainable development with worldwide operations. Advisory Services in Environmental Management (ASEM) is a joint programme of the GTZ and the Indian MoEF focuses on urban and industrial environmental management and sustainable development.

The SECO is the Swiss Confederation's Competence Centre for all core issues relating to economic policy, and in 2003, it initiated the Knowledge Partnerships programme in E- Waste for developing and transition countries. The EMPA is an independent, neutral institution for multidisciplinary research on sustainable materials and systems engineering. Within the EMPA, the competence center for electronic waste recycling is part of the technology and society laboratory that analyses the impact of technological developments on the society and environment. The EMPA is the technical control body for E- Waste recyclers in Switzerland contracted by the two system operators – SWICO Recycling Guarantee (SWICO) and Swiss Foundation for Waste Management (SENS) – for regular audits of recycling facilities. E- Waste recycling is one of EMPA's research topics, both at the material flows and components levels.

The role of the KSPCB, as is known, is to enforce laws, acts and with E- Waste as an emerging issue. It is working in co-ordination with other agencies in E- Waste management. The KSPCB received its first application in 2005 for re-cycling E- Waste in Karnataka and was the first to give such authorisation to E-Parisara followed by other formal recyclers.

WEEE Task Force - The government formed a WEEE (European Community directive) task force comprising the CPCB (Central Pollution Control Board), the Ministry of Environment and Forests, Ministry of IT and Electronics, industry associations, NGOs and some independent experts. The Indo-German-Swiss E- Waste initiative is a joint project involving India, Switzerland and Germany. The vision of this initiative is to establish a clean E- Waste channel aimed at establishing (a) a convenient collection and disposal system for large and small consumers to transfer all E- Waste safely, (b) a voluntary system for producers concerned over the care of their products post their useful life and (c) a financially secure system that makes environmentally and socially responsible E- Waste recycling viable. The initiative also aims to (a) reduce risks to the population and the environment from unsafe handling of E-Waste; (b) focus on knowledge transfer and skills upgradation of all the stakeholders through trainings and seminars and (c) target the informal recyclers to ensure safe participation in future E- Waste management and facilitate their growth and integration within the formal structure.

The Electronics City Industries' Association (ELCIA) was formed by the industries located in the Electronics City in 1992. It is the umbrella organisation representing all the companies operating in the Electronics City Bangalore. The main objective of ELCIA is to provide an E- Waste management system for safe disposal besides organizing waste sensitization programs.

E- Waste agency (EWA) is a nodal agency for E- Waste management in Bangalore formed by IT companies, NGOs and the KSPCB with the main objective of curtailing unregulated dumping of E-

Waste in Bangalore. The EWA constitutes representatives from the IT sector such as Nasscom, MAIT and STPI, the State and Central Pollution Control Boards, various formal recyclers and NGOs. Currently, the EWA, with the support from the Indo-German-Swiss E- Waste Initiative, is engaged in training groups from the informal sector in eco-friendly management of E- Waste with the objective of making them authorised recyclers.

Initiatives

State Government Initiatives

Various initiatives have been taken to introduce policies and guidelines for managing E- Waste. In India, the Ministry of Environment and Forests in association with the Central Pollution Control Board drafted guidelines for environmentally sound management of E- Waste in March 2008. Several NGOs and civil society groups like Green Peace, Toxics Link and GTZ in co-ordination with the Manufacturers Association for Information Technology (MAIT) framed the rules and submitted to the Ministry of Environment and Forests. Under the new E- Waste (Management and Handling) Rules, manufacturers of electronic gadgets will be 'personally' responsible for the safe disposal of E- Waste. Eighteen electronic brands have started implementing plans on toxic chemical phase-out and 'take-back' of old and end-of-life products in India. http://www.thaindian.com/newsportal/business/india-prepares-strictest-rules-on-disposing-of-E- Waste_100234233.html

In Bangalore, WeP Peripherals Limited in association with Saahas, an NGO and E-Parisara, has launched an E- Waste collection drive at various locations in the city. WeP also has set up the Social Development Trust with a contribution from its net profit and has taken initiatives to address the growing threat of E- Waste disposal by consciously introducing and promoting environment-friendly products like green toners and printers.

Pressures of E- Waste on Urban Ecology

Bangalore's urban ecology has been under great stress due to various forms of pollution. With the problem of E- Waste increasing at a rapid rate, the effects could be serious. After a summary of the probable impact of E- Waste on ecology, in this section, we have documented the inappropriate disposal methods adopted by informal recyclers in Bangalore. Given the fact that it requires more time to understand the impact on urban ecology, it is not possible to identify the exact evidence without lab testing of samples of air, water and soil. However, discussions with respondents reveal that Bangalore is in for serious problems if E- Waste disposal if not tackled early and effectively.

Electronic components contain several toxic substances that adversely affect environment and human health. The hazards get more serious if E- Waste components are not recycled properly and the most common methods of disposal are acid baths, landfills and open-air incineration. When E- Waste is dumped in landfills, the toxic substances present in them breakdown and ingress into the soil and groundwater.

The informal recycling units in Bangalore cannot be easily identified because most of them are regular households where the entire process is carried out in small rooms exposing family members to

toxic fumes. The impact on health remains unraveled with hardly any research being done on the extent of the damage to human health.

In Bangalore, scrap dealers adopt crude methods for of retrieving goods of value. Apart from exposing themselves to toxic fumes, they also damage the environment in different ways For instance, gold extraction takes place in small rooms with no ventilation. The chips from printed circuit boards containing tiny specs of gold are heated with nitric acid. The final retrieval is done using cyanide, which is flushed into the open drain outside the unit. This process poses several severe risks to human health and the environment. A very basic machine is used to crush television monitors and casing units. Recyclers, many of them women and children, melt computer parts with acids, releasing a smoke-like stream of lead, dioxins and other toxins.

Burning of E- Waste, particularly electrical wires that cannot be reused, is the most commonly adopted method of disposal in Bangalore. During focus group discussions, informal recyclers revealed that the electrical wires were burnt in the open fields, graveyards or outside their houses in small quantities and large quantities were pooled (up to 500 kgs), for burning in agricultural fields on the outskirts of the city (near Mandya). Farmers are paid them ` 500 per day for using their land. It is estimated that the burning of 50kgs of wire yields about 30kg of copper fetching them a high price of about ` 200-220 per kg. See Table 4 for methods of E- Waste disposal in Bangalore.

Table 1: E- Waste recycling areas and dumping methods followed by informal recyclers in Bangalore

Sl.no.	Areas	Ward no.	No of Enterprises	Municipal dustbins	Sewage stream	Open burning	Open drain
1	Nayandalli	39	18		+	+	
2	Kenchenahalli	17	1		+		
3	Tannery road	90	16	+			
4	Hebbal	96	27	+			
5	Bommanalli	135	2	+			
6	Singasandra	191	1	+			
7	Nagavara and Thanisandra	12	6	+			
8	Saraypalya	12	3	+			
9	Arabic college	12	1	+			
10	Govindapura and Hegde nagar	12	2	+			
11	Rajajinagar	99	15	+			
12	New Guddahalli	42	2	+			
13	Old Guddahalli	42	5		+		
14	Satellite town (Bapuji nagar)	42	3	+			
15	Rajarajeshwari nagar	160	3	+			
16	Sunday market	30	15	+			
17	Jolly moholla	30	7	+			
18	Wannarpet	71	1	+			
19	Neelasandra	69	10	+			
20	Ashoka nagar		6	+			
21	Tilak nagar	58	6			+	
22	Gowripalya and Padarayanapura	44	22	+	+	+	
23	Seppings and Thimmaiah road	79	5	+			
24	Balajinagar	64	10				
25	New Gurappanpalya	64	1				
26	Bismillanagar	64	2				
27	J.C road	46	20	+			+
			220				

Source: Based on discussions with respondents during field visits

Conclusions and Policy Options

To sum up, E- Waste management in Bangalore is largely unorganised and in the initial stages of working towards proper management. No accurate estimates are available on the quantity of E- Waste generated and recycled, given the magnitude of the problem and poor accountability. The study was initiated with ambitious objectives but it subsequently faced several bottlenecks in accessing the required information and data. However, the study documented various important aspects of E- Waste management in Bangalore that are expected to add to the knowledge and database besides recommend

measures relevant for E- Waste processing. The findings have also thrown up new research issues, which are of critical importance to E- Waste management. For instance, no studies have been conducted to explore the dimension of the impact on the health of informal workers engaged in E-Waste processing. Similarly, there is hardly any empirical evidence to explain substantially the impacts of E- Waste on the urban environment. Adoption of crude recycling methods with no concern for environmental impact reflects on the reality. There is less awareness among manufacturers and consumers alike about the potential hazards of unsafe E- Waste disposal. An increase in exported E-Waste is exempted from basic customs duty and is convenient for import of computers under the EXIM Policy 2000. The roles and responsibilities are unclear with regard to managing E- Waste and need to be properly defined. The E- Waste (Management and Handling) Rules, 2011 is an important step in regulating E- Waste. The earlier legislations, like Hazardous Waste Management and Handling Rules (Amended Rules 2003), which while listing E- Waste under Schedule 2 (List A and B), merely impose restrictions on import and export of E- Waste. The Guidelines for Environmentally Sound Management of E- Waste developed by the Ministry of Environment and Forests in 2008 are of high relevance in terms of addressing several issues concerning E- Waste management. However, it also mentions that the need for working out specific ways of managing E- Waste. For instance, the problem of CFL disposal is a major threat in cities. It also provides guidelines for integrated E- Waste recycling and treatment facilities, indicating that it would be more relevant to prescribe specific and stringent rules by the State PCBs depending on the local conditions. Given this scenario, there is an urgent need to ensure appropriate regulations are in place to address the various aspects of E- Waste management.

Options for Improved Management

We came across many options discussed in various reports dealing with the issue of E- Waste management. However, it is important that these options be implemented. There is a definite scope for working on these options for sustainable management of E- Waste in order to avoid imminent threats to ecology and human health in Bangalore. Besides the general recommendations discussed, it would be useful to create institutional arrangements to improve the management of the various processes of generation, collection, transportation and disposal of E- Waste.

- **Regulations** - Governments should be responsible for developing adequate laws, controls and administrative procedures for hazardous waste management. The latest E- Waste Management Rules 2012 has covered several important aspects. However, a comprehensive legislation, including E- Waste regulations and management and proper disposal of hazardous wastes, is required. Such a law should empower the agencies to control, supervise and regulate the relevant activities of government departments. Under this law, the agency concerned should
    - Collect basic information on the materials from manufacturers, processors and importers and maintain an inventory of these materials. The information should include toxicity and potential harmful effects.
    - Identify potentially harmful substances and make it mandatory on the part of the industry to test them for adverse health and environmental effects.

- Standardise methodologies for different processes involved during recycling; The CPCB should specify relevant methodologies applicable to Indian conditions (regardless of any State) and permissible limits for dissolved heavy metals in the atmosphere because metals involved in E-Waste recycling happen to be mostly heavy.
- Control risks from manufacture, processing, distribution, use and disposal of electronic wastes.
- Encourage beneficial reuse of E- Waste and business activities that use E- Waste, set up programmes to promote citizens and businesses to recycle.
- Sensitise E- Waste generators on reuse/recycling options.

- **Governance:** Managing of E- Waste should be the joint responsibility of all the stakeholders. In Bangalore several institutions have come forward to work towards integrated management of E-Waste, however, government institutions should play a major role in streamlining management. It is important that a regulatory authority be set up exclusively to manage hazardous waste besides formulating E- Waste policy and legislation. Any company, institution, organisation established should be subjected to certain terms and conditions concerning E- Waste disposal, which should be made mandatory. Fostering partnerships with manufacturers and retailers by creating an enabling environment is essential for disposing E- Waste scientifically at reasonable costs. The establishment of necessary infrastructure for collection of domestic E- Waste has been confined to NGOs, which needs to be further streamlined. Fees from manufacturers/consumers for the disposal of toxic materials should be subsidised by recycling and disposal industries along with incentive schemes for garbage collectors and public for collecting and handing over E- Waste. At present, formulating and regulating occupational health safety norms related to E- Waste recycling are mainly confined to the formal sector. The programmes should also be made available for students in the form of a certificate course like any other skill training. Research and Development in respect of developing and standardising of hazardous waste management, environmental monitoring and the regulation of hazardous waste-disposal through periodic environmental audits needs to be planned.
- **Creation of Awareness** - Participatory governance models need to be promoted to generate awareness of the impact of the current practices on health and the environment. Awareness programmes for children and the public on the impact E- Waste need to be effectively implemented. Further, labeling of all computer monitors, television sets and other household/industrial electronic devices with hazardous contents should be mandatory to identify environmental hazards and ensure proper management and disposal of E- Waste. So far, awareness levels have been very low, almost absent among the informal processors of E- Waste and the civilians. The efforts in this regard have to be intensified to protect the health of the environment and the people.
- **Formalising the Informal Sector** - E waste processing is a source of livelihood for many of the poor families. They should be formally trained in E- Waste processing and authorized to do so. Procedures and duration involved in obtaining such training and authorisation should be as simple as possible. Getting them together to build an action plan under the guidance of the government and companies is essential. Further, alternative sources of livelihood should be made viable to

reduce the "social necessity" of informal recycling and disposal of E- Waste. In this context, it is also relevant to carry out a situation analysis of the constraints faced by the Customs Department across different harbours of India because harbours are one of the main sources of informal recycling.

- **Reuse:** Reuse is already in practice. However, increasing a product's lifespan with adequate precautions could further strengthen it. Many companies and non-profit organisations have been promoting the reuse of discarded computers in schools and work places. Manufacturers like Sony, Panasonic and Sharp pay certain recyclers to process their products that consumers buy at statewide collection events. In short, a formal system should be evolved to promote the reuse of electronic waste with creation of awareness as a part of the working system.
- **Recycle:** Recycling of hazardous products has a negative impact on health and the environment, including neighborhood communities. In this context, it would be more relevant to redesign the products besides encouraging sustainable product designs using non-hazardous materials.
- **Extended Producer Responsibility (EPR)** – EPR aims to encourage producers to prevent pollution and reduce the use of resources and energy in every stage of the product's life span by effecting changes in product design and processing technology. This includes upstream impacts arising from the choice of materials and the manufacturing process as well as the downstream impacts like the usage and disposal of products. This should facilitate research and development activities in the companies to find sustainable technologies and materials. This could probably increase the price of electronic equipment because companies might pass on additional costs to consumers and thereby lower the demand for such products. However, product take-back needs to go hand-in-hand with mandatory legislation for phasing out e-toxics.
- **Incineration:** Although incineration is an option, it is not considered a safe method of disposal of E- Waste because it pollutes the atmosphere with heavy metals such as lead, cadmium and mercury and ash. Mercury in the atmosphere can bioaccumulate in the food chain, particularly fish – a major route of exposure for the public. If products contain PVC plastic, highly toxic dioxins and furans are released. Incineration is the largest point sources of dioxins in the US and Canada. It is one of the largest point sources of heavy metal contamination of the atmosphere globally. Smelting can pose dangers similar to incineration. California and Massachusetts have banned the dumping of computer monitors into the landfills and incinerators.
- **Landfill**: It considered as the safest and effective option but has its negative impacts. In Bangalore, we have the first landfill with safety measures in place. It is argued by many that even the best landfills are not completely secure always and that a certain amount of chemical and metal leaching might occur, hence proper care should be taken. Choosing the landfill site is an issue when land resources are a constraint. Hence, adequate efforts should be taken to minimise the waste that would reach the landfill site.

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