POLICY BRIEF

Managing E-Waste in Bangalore

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Electronic waste (e-waste) is one of the fastest growing waste streams in the world. The disposal of electronic products worldwide has intensified in recent years, with 20-50 million tons being generated every year. In most cases, e-waste comprises relatively expensive and generally durable components used for data processing, telecommunications, and entertainment. E-waste generating sources typically include public and private sector companies, hospitals, factories and manufacturing units, retail and commercial establishments, other institutions, and households. Types of e-scrap include both electric and electronic items such as computers, printers, mobile phones, scanning machines, televisions, and medical equipment including scanning machines, microscopes and so forth. Managing the colossal generation of e-waste is fast emerging as one of the major challenges in the urban areas the world over.

Since the 1990s Bangalore has been serving as a major centre for the growth of several manufacturing and hi-tech industries as well as a hub for the software industry. Home to more than 1200 foreign and domestic technology firms, Bangalore figures prominently in the danger list of cities faced with e-waste hazards. However, the estimates on the quantity of e-waste generated in Bangalore vary. E-Parisara estimates that Bangalore produced 8000 tons of computer waste in 2008 and Karnataka State Pollution Control Board (KSPCB) reported approximately 13000 tons of e-waste generation in 2009, excluding household appliances. E-Parisara estimates that Bangalore generates 12000 tons of e-waste per year compared to approximately 330000 tons generated in India, with another 50,000 tons being illegally imported. Manufacturers and assemblers generate about 1800 tons of electronic scrap every year. According to another estimate approximately 1,000 tons of plastics and an equivalent amount of iron, 300 tons of lead, 0.23 tons of mercury, 43 tons of nickel and 350 tons of copper are generated as e-waste in Bangalore, approximately a third of Karnataka's e-waste, and these figures are likely to increase ten-fold by 2020 (EMPRI, 2004).

This policy brief aims to provide insight into the emerging challenges of e-waste generation and management in Bangalore[1]. The brief explores the formal and informal processes of e-waste management, issues and constraints facing stakeholders, the role of key institutions, as well as the policy options available for effective e-waste management.

Flow of E-waste: Informal and Formal Recycling

Formal recycling of e-waste from source to recycling center to disposal site accounts for about 5 percent of the total e-waste generated in Bangalore. Given the limited role of formal recycling due to the relatively small number of formal recycler units, the informal sector plays a significant role in the disposal and treatment of e-waste.

Under informal recycling, the physical flow of e-waste begins with agents, waste dealers and *kabadiwalas* who acquire wastes from the public and private sectors. After segregation, 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 remainder is diverted to the open market. From the mediating waste dealers, the scrap flows to the service industry (as purchase parts for repair and maintenance of old computers). Residual scrap get back into the open market or sold to large waste dealers. At the other end of this chain is a network of dealers operating from large cities like Mumbai and Delhi who acquire scrap from large dealers in Bangalore directly or through the open market.

Informal Recycler segregating E-waste, Goripalya, Bangalore

Some companies store, donate, dispose their e-waste to informal recyclers through open auctions. The informal recycling activity in Bangalore thrives with small and large-scale traders doing brisk business in their backyard recycling units where materials like gold, copper etc are recovered using hazardous chemicals and unsafe methods. Informal recyclers operate in thickly populated clusters in the city, comprising both residential and business establishments (Table 1).

Informal recyclers purchase e-waste in bulk from companies, institutions and households at prices depending on the type of material purchased. For instance, recyclers purchase a non-working computer at approximately Rs.200 and a non-working UPS for Rs.150. Second hand computers are purchased at Rs.1500 and sold between Rs.2000-3000 depending on the configuration. Similarly, profits vary depending on the capital invested. For instance, an investment of Rs.50000 is likely to yield a profit of Rs.5000. Informal recyclers run

small enterprises where they process waste in various combinations. Typically, 25 percent of the total computer scrap collected is reusable. The general trend is to accumulate up to one ton of scrap and later sell to second hand dealers specialized in processing of respective components. Generally, recyclers specialized in certain processes or combination of processes congregate in specific areas. For instance, recyclers in Goripalya are specialized in extraction while those in Nayandahalli and Tilak Nagar areas process plastic waste.

Table 1: Informal E-waste Processing Enterprises and Disposal Methods in Bangalore

Areas	Ward No	No of Enterprises	Muncipal dustbins	Sewage stream	Open burning	Open drain
Nayandanalli	39	18		+	-	
Kenchenahalli	17	1		+		
Tannery Road	90	16	+			
Hebbal	86	27	+			
Bommanahalli	135	2	+			
Singasandra	191	1	+			
Nagavara and Thanisandra	12	6	+			
Sarakpalya	12	3	+			
Arabic College	12	1	+			
Govindapura and Hegde Nagar	12	2	+			
Rajaji Nagar	99	15	+			
New Guddadahalli	42	2	+			
Old Guddadanalli	42	5		+		
Satellite Town (Bapuji Nagar)	42	3	+			
Rajarajeshwari Nagar	160	3	+			
Sunday Market	30	15	+			
Jolly Mohalla	30	7	+			
Wannarpet	71	1	+			
Neelasandra	69	10	+			
Ashoka Nagar		6	+			
Tilak Nagar	56	6			+	
Goripalya and Padarayanapura	44	22	+	+	+	
Seepings and Thimmaiah Road	79	5	+			
Balaji Nagar	64	10				
New Gurappanapalya	64	1				
Bismilla Nagar	64	2				
J.C Road	46	20	+			+

Source: Manasi et. al 2010

E-waste recycling involves the following steps:

Dismantling and Segregation: The scrap collected or purchased from various sources is segregated into reusable and recyclable components. While the reusable parts are sent to different markets, the recyclable components are dismantled manually and further segregated and sent to respective recycling markets.

Recycling: The segregated reusable waste is tested for suitability by assembling various components into a workable system. Components from multiple computers are assembled to form a new workable computer or cathode ray tubes from colour monitors are used in making colour television sets.

Extraction: Following dismantling, segregation and recycling, metals such as gold, copper, silver, nickel, platinum are extracted in crude forms. The quantity of gold recovered from 50 processors comes to about 3-4g and is sold or used personally for making ornaments.

The price of e-waste varies across formal and informal recyclers. The formal recyclers have waste collected and purchased at a fixed price from various companies. Informal recyclers have no stipulated price fixed as they purchase in bulk and quote based on their experience and may gain or lose in terms of the material purchased. However, the sale prices of materials recovered remain almost the same across various informal recyclers.

Informal recycling units in Bangalore cannot be easily identified as they appear as regular households from the outside. In practice, the entire recycling is carried out in small rooms within their homes with an oven fitted into a hole made in the wall. Within these confines, dealers may adopt crude and unsafe methods for retrieving goods of value. For instance, gold extraction takes place in small rooms with no ventilation. Chips from printed circuit boards containing tiny specks of gold are heated with nitric acid. Following final retrieval using cyanide, the waste is flushed into an open drain outside the unit. Recyclers, many of them women and children, melt computer parts with acids, releasing a smoke-like stream of lead, dioxin and other toxins.

Recyclers and employees mostly fall into the 25-35 year age group. Children below 14 years of age are also hired to collect specific kinds of waste. Women and children also process waste collected from households. Unprocessed e-waste is provided at their doorstep and segregated waste collected back towards the end of the day. Employees are usually paid on daily basis (between Rs.75 and 90 for women, and Rs.100 to 120 for men), while some are hired on a monthly basis (Rs.5000-6000) depending on the e-waste procured. Many of the workers happen to be from the states of Maharashtra, Uttar Pradesh and Bihar. Migrants are preferred as they tend to remain more committed making it easy for employers to manage them by providing basic facilities.

The most commonly adopted method of disposing e-waste in Bangalore involves open burning, particularly electrical wires not useful for any kind of reuse. Focus group discussions with informal recyclers reveal that electrical wires are burnt in fields, graveyards or outside their homes in small quantities. Agricultural fields (near Mandya) are rented for Rs.500 per day for 2-3 days in order to dispose larger quantities (up to 500 kgs). It is estimated that the burning of 50 kgs of wire yields about 30 kg of copper fetching recyclers a price of about Rs.200-220 per kg.

Recyclers in the formal sector receive e-waste from corporations for scientific recycling of waste. There are currently 16 authorized recycling units in Bangalore (Table 2 presents a partial list). The organized recycling companies are equipped to process e-waste at different degrees of excellence. Formal recyclers are expected to abide by rules and regulations in processing e-waste including safety aspects concerning employees. Apart from processing e-waste, formal recyclers are also involved in organizing awareness programs in collaboration with NGOs and schools.

A survey reveals 226 informal enterprises located in 27 wards as against 16 formal recycling units in Bangalore (Manasi et. al 2010). While accurate

An informal recycler segregating e-waste, Padarayanapura, Bangalore

Table 2: Formal Recycling Units in Bangalore

Organization	Types of e-waste collected	Source of collection	Process involved	Metals extracted
E-Parisara	Computer scrap: All types of electrical and electronic appliances	IT companies, Government organizations and NGOs	Manual dismantling, segregation, shredding, crushing, pulverizing and density separation	Gold, silver, palladium and lead
Ash Recyclers	Only computer scrap	Rag pickers and e waste collection agents	Manual dismantling, segregation and metal extraction	Gold, platinum and copper
Nishanth Technologies	Computers, laptops, landline phones	IT companies	Collection, segregation and dismantling manually	–
K.G Nandini Enterprises	Computer scrap, Cell phones, Printers Electrical cables, motors & transformers	IT companies	Shredding, Delaminating, Screening, Fluid bed separation	–
E-Warrd	Electronic items	IT companies and Watch factory	Dismantling; Segregation	–
Attero	Electronic goods	Households and IT companies	Collection, Dismantling, Mechanical separation	Various

estimates on the impact of e-waste recycling on health are difficult to obtain, it is clear that informal workers work under very unhygienic conditions with no safety precautions. In 20 of the 27 wards, recyclers dump processed e-waste into municipal dustbins, while the rest, resort to open burning and dumping in sewage drains (Table 1). Thus, there is an urgent need for appropriate regulations to address the impact of e-waste disposal on human health and the environment.

Role of Institutions in E-Waste Management

The government, industry, users and non-government organizations have started taking notice of the growing hazards of e-waste disposal alongside a growing consensus that recycling and resource recovery need to be environmentally friendly. Several organizations at different levels of government as well as corporations and NGOs have taken up various initiatives in managing e-waste. In India, Ministry of Environment and Forests (MoEF) in association with the Central Pollution Control Board (CPCB) developed 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 coordination with Manufacturers Association for Information Technology (MAIT) framed the rules and submitted them 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 final safe disposal of e-waste. An overview of initiatives undertaken in Bangalore is presented in Table 3.

The Central Pollution Control Board is an autonomous organization under the MoEF and the apex organization in India for prevention and control of pollution. The CPCB plays an important role in drafting guidelines, advising the MoEF on policy issues, conducting field tests and coordinating the activities of the state pollution control boards. The role of KSPCB is to enforce legislation and coordinate with other agencies in e-waste management. The government has formed a WEEE (European community directive) task force, comprising the CPCB, the MoEF, Ministry of Communication and Information Technology, Industry associations, NGOs and some independent experts. For instance, the goals of the Indo-German-Swiss e-waste initiative, a joint project involving India, Switzerland, and Germany, is to establish a clean e-waste channel aimed at (a) a convenient collection and disposal system for large and small consumers to transfer all their e-waste safely; (b) a voluntary system for producers to care for their products post their useful life; (c) a financially secure system that makes environmentally and socially responsible e-waste recycling viable. The initiative also aims to work towards (a) reducing risks to the population and pollution of the environment resulting from unsafe e-waste handling; (b) focusing on knowledge transfer and upgrading skills of all the stakeholders involved through trainings and seminars; (c) targeting the existing informal recyclers for their maximum but safe participation in future e-waste management by facilitating their growth and integration with the formal structure.

Conclusion and Policy Options

There is a lack of awareness among manufacturers and consumers alike about the potential hazards of unsafe e-waste disposal. The roles and responsibilities regarding management of e-waste are unclear and ill-defined. The only legislation in place relates to Hazardous Waste Management and Handling Rules (Amended Rules 2003), that lists e-waste under Schedule 2 (list A and B) and restricts the import and export of e-waste. The Guidelines for Environmentally Sound Management of E-waste are relevant as they address several issues concerning e-waste management, the need for delineating specific methods for managing streams of e-waste, and an integrated e-waste recycling and treatment facility. The Guidelines also recommend greater powers for the State

Table 3: City Based Initiatives

Organization Involved	Objective	Initiatives and Activities
ELCIA	Provide an environment friendly e-waste management system for companies	• Established the Clean e-waste Channel and Data assessment to define the capacity of Clean e-waste Channel. Estimate quantity and type of e-waste generated by companies
EWA	Identify sustainable and eco-friendly solutions to the problem of electronic waste	• Providing trainings for informal sectors recyclers on eco-friendly procedures • Formation of Eco–Bird which includes 11 recycling units from the unorganized sector • Formation of E-WARDD, an association of informal e waste recyclers in the process of being upgraded as formal recyclers
Wipro Infotech, WeP Peripherals Ltd (IT firms)	Undertake initiatives for improved management through EPR	• Identify suitable disposal mechanisms and technically competent disposal agencies • Introduce and promote environment-friendly products like green toner, green printer, green printer program
Saahas (NGO)	E-waste collection, awareness creation and act as a link between producers and formal recyclers.	• Established e-waste collection points in various areas of Bangalore • Undertake safe collection, disposal of e-waste and other hazardous waste from households • Create awareness on environmental issues by working along with educational institutions and corporate offices
Formal Recyclers	To promote safe processing and disposal of e-waste	• Recycling process involving non-incineration technology-manual dismantling, segregation, shredding, crushing, pulverizing and density separation

Burning e-waste on open sites: Hosur Road, Bangalore

Pollution Control Boards to prescribe specific and stringent rules depending on the local conditions.

Several options for sustainable e-waste management exist:

Reuse: Reuse is already in practice. Increasing a product's lifespan with adequate precautions could further strengthen it. There are many companies and non-profit organizations that promote the reuse of discarded computers at schools and work places. Specific manufacturers pay recyclers for processing their consumer products at statewide collection events. A formal system is required for promoting the reuse of electronic waste with awareness as part of the working system.

Recycle: Recycling hazardous products has more negative implications for health and environment. 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): The aim of EPR is to encourage producers to prevent pollution and reduce resource and energy use in each stage of the product life span by changing product design and processing technology. This includes the choice of materials, the manufacturing process, and the use and disposal of products. However, product take-back needs to go hand-in-hand with mandatory legislation.

Governance: Government institutions need to take the lead in systematizing e-waste management. It is important that a regulatory authority is set up exclusively to manage hazardous waste apart from formulating e-waste policy and legislation. Any company, institution, organization established in India should be subjected to specific mandatory terms and conditions concerning e-waste disposal. Fostering partnerships with manufacturers and retailers by creating an enabling environment is essential for a scientific and cost-effective disposal of e-waste. Establishing necessary infrastructure for collection of domestic e-waste and fees from manufacturers and consumers for the disposal of toxic materials should be subsidized by recycling and disposal industries along with incentive schemes for garbage collectors and general 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 informal sector. The programs should also be made available to students in the form of a certificate course like any other skill training. Research and Development to develop and standardize of hazardous waste management, environmental monitoring, and the regulation of hazardous waste disposal needs to be promoted.

Awareness Creation: Awareness of health and environmental impact of e-waste as well as current disposal methods need to be promoted through participatory governance models. Labeling all computer monitors, television sets and other household/industrial electronic devices stating hazardous contents must be enforced in order to identify environmental hazards and ensure proper e-waste disposal.

Formalizing the Informal Sector: Informal recyclers should be trained in e waste processing and provided with authorization. Procedures and duration involved in obtaining authorization should be made simple. Getting informal recyclers to build an action plan under the guidance of the government and companies is essential. Although informal recyclers are keen on becoming authorized recyclers, they are ignorant of the procedures and find it difficult to access the KSPCB. Additionally, the precondition for becoming a formal recycler is to own land in an industrial area. As most of the informal recyclers are poor, they find it difficult to meet the stipulated requirements of the government. However several informal recyclers were willing to work in a common recycling treatment if set up by the PCB and trained accordingly.

Regulations: Governments should be responsible for developing an adequate system of laws, controls and administrative procedures for hazardous waste management. A comprehensive law encompassing e-waste regulations, management and appropriate disposal of hazardous wastes is required. Such a law should empower the agency 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.
- Standardize methodologies for different processes involved during recycling; CPCB should specify such methodologies relevant and applicable to Indian conditions and also permissible limits for dissolved heavy metals in the atmosphere.
- Control risks from the manufacture, processing, distribution, use and disposal of electronic wastes.
- Encourage beneficial reuse of e-waste and business activities that use waste; set up programs so as to promote recycling among citizens and businesses.
- Sensitize e-waste generators on reuse/recycling options.

To sum up, presently e-waste management in Bangalore is largely unorganized as well as in the initial stages of formalization. Given the rapid increase in e-waste generation and inappropriate disposal methods such as land filling and open air burning by informal recyclers, the consequences for Bangalore are likely to be severe if e-waste disposal is not tackled early and effectively. Consequently, there is an urgent need for ensuring that appropriate regulations are in place to address the various aspects of e-waste management. Documenting important aspects of e-waste management and the attendant health and environmental impact in Bangalore form a basis for formulating, assessing, and implementing further measures relevant for e-waste processing.

[1] For the complete report see S. Manasi, Bibhu Prasad Nayak and N. Latha. (2010). *Eco-threats of E-Waste: A Case Study of Bangalore City*. Institute for Social and Economic Change.

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