E-Waste, Chemical Toxicity, and Legislation in India

Prashant Mehta
National Law University Jodhpur, India

INTRODUCTION

The industrial revolution was a period of dynamic change and dramatic innovation in the history of human society (Ayers, 1999). Across the world, societies are constantly reinventing to manage revolutionary changes that have radically transformed the lifestyle of people. Some of these changes are subtle and barely noticeable, while other changes are blatant and abrupt, like advances in Information and Communication Technology (ICT) and widespread use of Electrical and Electronics Equipment (EEE), which has made human civilization to grow in a more efficient manner.

Following economic liberalization in 1991, the Indian ICT industry has been one of the major drivers of economic progress both in terms of volume and applications. It has assumed the role of providing a forceful leverage to the socio, economic, and technological growth of a developing society (Joseph, 2007). However consumption and production processes of these complex electronic devices are unsustainable, pose a serious challenge to environment and human health, making e-waste one of the largest growing waste streams (Lundgren, 2012a). With waste market getting increasingly global, such waste is illegally exported to crude e-waste recycling hotspots in Asian countries, such as China, India, and Pakistan, and in some African countries, like Ghana and Nigeria (Castillo, 2011). Such illegal trade in e-waste is camouflaged and conducted under the pretext of obtaining 'reusable' equipment or 'donations' from developed nations.

E-waste comprises of ICT and EEE products that are not fit for their originally intended use. It includes computers, its accessories (monitors, printers, keyboards, and central processing units), typewriters, mobile phones and chargers, remotes, compact discs, headphones, batteries, LCD/Plasma TVs, air conditioners, refrigerators, and other household appliances (Lalchandani, 2010). The increasing 'market penetration' in the developing countries, 'replacement market' in the developed countries (Borthakur & Sinha, 2013), coupled with rapid developments, innovation, miniaturization, and replacement resulted into higher rate of obsolescence of electronics products. It is estimated that in 2014 world-wide 41.8 million metric tonnes (Mt) e-waste was generated and most of it was not collected and treated in environmentally sound manner (Baldé, Wang, Kuehr, & Huisman, 2015). Most of this either end up with municipal waste in landfills or unauthorized recycling yard (Greenpeace Press Report, 2008).

As noted by UNEP in 2005, "Every year, 20 to 50 million tonnes of e-waste is generated world-wide, which could bring serious risks to human health and the environment" (Schwarzer, Giuliani, Kluser, & Peduzzi, 2005). Even though there is no clear data on the quantity of e-waste generated and disposed of each year in India, it is estimated 70 percent of e-waste handled in India is imported. It also estimates that between the years of 2007-2020, domestic television e-waste will double, computer e-waste is expected to increase five-fold, while cell phones will increase eighteen times (Disabled World, 2015). Thus knowledge society of 21st century is creating its own toxic footprint which is most debated issue amongst the environmentalists, environment regulators, world-wide environment forums, governmental, and non-governmental agencies, and policy makers.

BACKGROUND OF STUDY

Solid waste management, which is already a mammoth task in India, is becoming more complicated by the invasion of e-waste, which has complex characteristics as it differs chemically and physically from urban or industrial waste. Each wave of technology creates a set of waste previously unknown by humans (Sikdar & Vaniya, 2014) making e-waste management a big issue in both developed and developing countries.

The current practices of e-waste management in developing countries suffer from a many drawbacks such as informal recycling, inadequate legislation, low public awareness of the hazardous nature of e-waste, use of obsolete methods, and inadequate emphasis on the employee's protection (Cobbing, 2008), is jeopardizing people's health and environment (Smith, Sonnenfeld, & Naguib Pellow, 2006a).

Having reviewed literature from various other studies conducted in India and abroad, and understanding the magnitude of this problem, it is time for India to critically review its management of e-waste, to work towards a strategy to create the necessary infrastructure, and mechanisms to support sustainable and environmentally friendly e-waste management besides sensitizing consumers, waste recyclers, and future decision makers on issues like e-waste characteristics, its trans-boundary movement recycling technology, social, and environmental considerations, and toxic effect on health.

DEFINITION OF E-WASTE

Even though there is no standard definition for e-waste, some of the reported definitions of e-waste in literature are mentioned below:

According to the Basel Convention, "Wastes are substances or objects, which are disposed of or are intended to be disposed of, or are required to be disposed of by the provisions of national laws" (Text of Basel Convention, 2014).

According to Basel Action Network (BAN), "E-waste includes a wide and developing range of electronic appliances ranging from large household appliances, such as refrigerators, air-conditioners, cell phones, stereo systems, and consumable electronic items to computers discarded by their users" (Puckett, Byster, Westervelt, Gutierrez, Davis, Hussain, & Dutta, 2002), (Gaidajis, Angelakoglou, & Aktsoglou, 2010).

As per European Directive 2002/96/EC, "Waste electrical and electronic equipment (WEEE), including all components, subassemblies, and consumables, which are part of the product at the time of discarding" (European Parliament, 2003, January 27), (Jain, 2008), (European Parliament, 2012, July 4).

As per European Directive 75/442/EEC, Article I(a), "Any substance or object which the holder discards or is required to discard in compliance with the national legislative provisions". Further it includes all components, subassemblies, and consumables which are part of the product at the time of discarding (Borthakur & Singh, 2012).

According to Organisation for Economic Co-operation and Development (OECD), "Any household appliance consuming electricity and reaching its life cycle end", also referred as composite waste (OECD, 2007).

These differences in definitions, of what constitutes e-waste, have the potential to create disparities in both the quantification of e-waste generation and the identification of e-waste flows across nations. The lack of a precise definition of e-waste is one of the key issues that need to be addressed on an international level (Lundgren, 2012b).

COMPONENTS OF E-WASTE

E-waste is classified as hazardous waste (Tsydenova & Bengtsson, 2011a), and it imposes many challenges on the recycling industry (Smith, Sonnenfeld, & Naguib Pellow, 2006b). Modern electronics can contain up to 60 different elements;

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