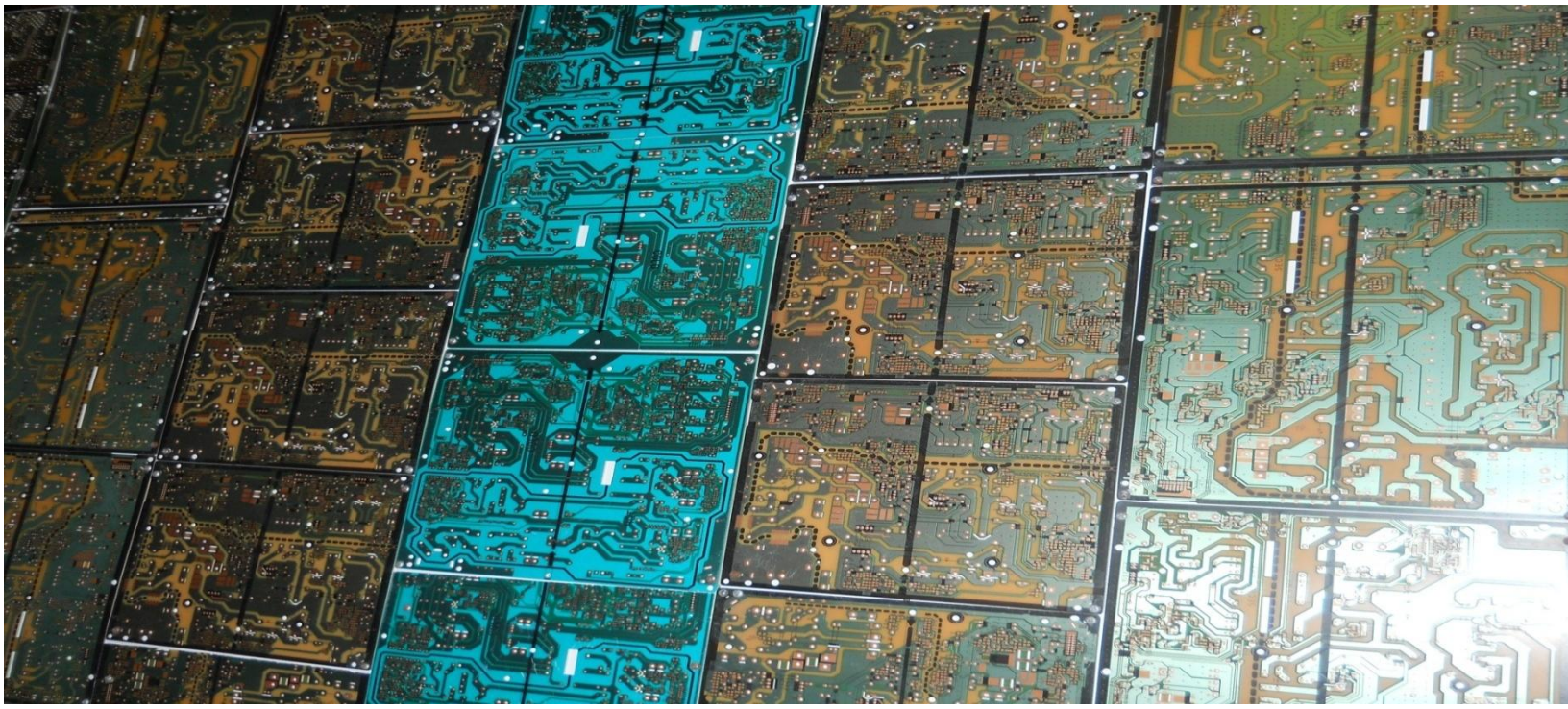
Electronic Waste Management, Consumers' Awareness and Disposal Behaviour in the City of Bangalore



Thesis submitted to the Jawaharlal Nehru University
in partial fulfilment of the requirements for
the award of the Degree of

DOCTOR OF PHILOSOPHY

ANWESHA BORTHAKUR

CENTRE FOR STUDIES IN SCIENCE POLICY
SCHOOL OF SOCIAL SCIENCES
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI – 110067
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CERTIFICATE

This is to certify that the thesis entitled **"Electronic Waste Management, Consumers' Awareness and Disposal Behaviour in the City of Bangalore"** submitted by **Anwesha Borthakur,** at the Centre for Studies in Science Policy, School of Social Sciences, Jawaharlal Nehru University, New Delhi – 110067, India, in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy** is her original work and has not been previously submitted for any other Degree of this or any other University.

We recommend that this thesis be placed before the examiners for evaluation.

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DECLARATION

I declare that the thesis entitled **"Electronic Waste Management, Consumers' Awareness and Disposal Behaviour in the City of Bangalore"** submitted by me in partial fulfilment of the requirements for the award of the Degree of DOCTOR OF PHILOSOPHY at Jawaharlal Nehru University, New Delhi is my own work. The thesis has not been submitted previously in any form for any other degree to this or any other university.

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Dedicated to all the children involved in informal

E-waste recycling activities....

Acknowledgements

At this juncture of my academic life, I remember the essay titled 'My Aim in Life' that we were asked to write as a teenager in high school. My perceived aim, as described in that essay, was to pursue a career in research on a topic of environmental concern and earn a PhD degree! Today I am grateful to a number of individuals who helped me follow my teenage aspiration and arrive at the door-step of realizing it.

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Anwesha

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ABBREVIATIONS

ADS	Advanced Disposal Surcharge
AMC	Annual Maintenance Contract
ARF	Advanced Recycling Fee
ASSOCHAM	Associated Chambers of Commerce and Industry of India
BPM	Business Process Management
CAGR	Compound Annual Growth Rate
CII	Confederation of Indian Industries
CPCB	Central Pollution Control Board
CPU	Central Processing Unit
CRT	Cathode Ray Tube
EAR	Elektro-Altgera¨te Register
ECR	Extended Consumer Responsibility
EEE	Electrical and Electronic Equipments
ELCITA	Electronics City Industrial Township Authority
EMPA	Eidgenössische Materialprüfungs- und ForschungsAnstalt (Swiss Federal Laboratories for Materials Testing and Research)
ENSYDE	Environmental Synergies in Development
EPR	Extended Producer Responsibility
EPSC	Electronics Product Stewardship Canada
EU	European Union
E-waste	Electronic Waste
HCL	Hindustan Computers Limited
HTC	High Tech Computer Corporation
ICT	Information and Communication Technology
IIIT	International Institute of Information Technology
IIT-B	Indian Institute of Management, Bangalore
IISc	Indian Institute of Science
INR	Indian Rupee
IT	Information Technology
IT–BPM	Information Technology – Business Process Management

ISEC	Institute for Social and Economic Change
KSPCB	Karnataka State Pollution Control Board
LCD	Liquid Crystal Display
MAIT	Manufacturers' Association for Information Technology
MoEF	Ministry of Environment and Forest
MPCB	Maharashtra Pollution Control Board
NGO	Non-Governmental Organisation
NIMHANS	National Institute of Mental Health and Neurosciences
NSRCEL	NS Raghavan Center for Entrepreneurial Learning
NTCRS	National Television and Computer Recycling Scheme
OECD	Organization for Economic Corporation and Development
PAH	Poly Aromatic Hydrocarbons
PBDD	Polybrominated dibenzo-dioxin
PBDE	Polybrominated diphenyl ethers
PC	Personal Computer
PCB	Printed Circuit Board
PCBA	Printed circuit board assemblies
PCDD/F	Polychlorinated dibenzo-p-dioxin/furan
POP	Persistent Organic Pollutant
PRO	Producer Responsibility Organizations
PUS	Public Understanding of Science
RCC	Retail Council of Canada
RD	Royal Decree
RoHS	Restriction on use of Hazardous Substances
SRI	Stanford Research Institute
StEP	Solving the E-waste Problem
SWOT	Strength, Weakness, Opportunity, Threat
TCS	Tata Consultancy Services
TIFR	Tata Institute of Fundamental Research
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UNEP	United Nations Environment Program

UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USD	United States Dollars
USEPA	United States Environmental Protection Agency
UNU	United Nations University
WEEE	Waste Electrical and Electronic Equipments

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Chapter 1

Electronic Waste: An Overview

1.1.Introduction

Electronic waste (E-waste) or Waste Electrical and Electronic Equipment (WEEE) signifies a major waste stream in the contemporary global environment. E-waste consists of products that originate from discarded electrical and electronic equipments (EEEs). With an alarming growth rate of 3-5% per year, E-waste is one of the fastest growing waste streams in the world today (Wibowo and Deng 2015). According to the United Nations Environment Program (UNEP), E-waste averages to over 6.8 kg for every living person every year (Perkins, Drisse et al. 2014). Globally, about 30-50 million tonnes of E-waste is disposed off each year (Menikpura, Santo et al. 2014), signifying a disturbing trend and necessitating immediate attention from the scientific community and policymakers.

A joint report by United Nations Environment Programme (UNEP) and United Nations University (UNU) predicts that by the year 2020, a growth of 500% would be observed in India with respect to E-waste from old computers alone as compared to its 2007's level. During the same time, an overwhelming 7 times and 18 times increase in E-waste production would be observed from discarded mobile phones in China and India respectively than their level in 2007 (Schluep, Hagelueken et al. 2009; Lu, Zhang et al. 2015). Likewise, Yu, Williams et al. (2010) forecast that by 2016-2018, obsolete personal computers (PCs) produced in developing countries will surpass that of the developed countries. By the year 2030, E-waste generated from PCs in developing countries will arrive at 400-700 million units, significantly higher than that of the developed countries at 200-300 million units.

The indiscriminate growth of E-waste could be attributed to factors such as societal needs, technological innovations, thriving consumer electronics industry, rapid development and changes in information and communication technologies (ICT), fast

obsolescence rates, replacement of existing EEEs with new models, downward trend in prices of EEEs and so on (Tanskanen 2013; Yu, He et al. 2014; Umair, Bjorklund et al. 2015; Zeng, Song et al. 2015). Today's urban world, in particular, is becoming E-waste hubs with large quantities of E-waste generated in its major cities. Both developed and developing countries have adopted different measures to address their E-waste concerns from diverse prospective. For instance, extended producer responsibility (EPR) is widely practiced in several developed countries such as Japan, Korea and European Union member states in order to responsibly manage their increasing volume of E-waste (Townsend 2011; Manomaivibool and Hong 2014).

Further, in the view of lower labour costs and less stringent environmental regulations, many developed countries are engaged in exporting around 50-80% of their E-waste to the developing countries including countries such as India, China, Bangladesh, Pakistan, Vietnam, West African countries etc. for recycling and disposal purposes (Wu, Leung et al. 2015; Sthiannopkao and Wong 2013). As a consequence, in addition to its domestic generation, developing world is burdened with illegally or legally imported E-waste, causing serious management challenges.

E-waste is a complex stream of waste as it contains both hazardous chemicals and precious metal components. It is a heterogeneous mixture of metals, glass, ceramics and plastics that often consists of a variety of toxic chemicals, including persistent organic pollutants (POPs), heavy metals (such as lead, mercury, cadmium, arsenic, zinc etc) and other potentially harmful substances (Wang, Liu et al. 2015). These E-waste constituents pose serious threats to the human health and ecological environment if not meticulously managed (Zeng, Song et al. 2015; Zheng, Xu et al. 2015). Further, E-waste contains considerable portions of valuable and precious metals such as silver, gold, palladium, copper etc, predominantly from waste printed circuit boards (PCBs). It has been observed that precious metals may occur at concentrations more than tenfold higher in PCBs than in mined minerals (Tsiliyannis 2014; Xiu, Qi et al. 2015).

The presence of valuable or precious metals in significant concentrations earns E-waste the name 'urban mine' (Zhang and Xu 2016). It is attracting increasing research attention due to environmental concerns, market potential and higher growth rate of

waste produced in urban areas (Sun, Xiao et al. 2016). While the hazardous chemical components of E-waste risk the environment, precious metal components, in turn, provide sufficient incentives for lucrative E-waste recycling businesses, flourishing in the developing world. Thus, technological developments to facilitate the proper disposal and treatment of E-waste are not merely an environmental need, but also a significant opportunity to recover and recycle valuable metals and critical materials (Diaz, Lister et al. 2016).

Similar to its compatriots in the developing or emerging world, environment and resource-friendly management of E-waste is a serious concern in contemporary India. The growth of India's electronics market and information technology (IT) sector have been enormous during the last two decades, leading to an increasing penetration of EEEs into the country. According to MoEF (2008), the electronics industry has emerged as the fastest growing segment of Indian industries both in terms of production and exports. Contributing significantly to the country's toxic waste stream, once obsolete all the EEEs currently in-use become E-waste or WEEE. India represents an interesting case of E-waste generation. Complementing to a major characteristic of emerging economies, the amount of waste produced per-capita in this populous country is still reasonably low (Widmer, Oswald-Krapf et al. 2005) and estimated to be a little over 1 kg of E-waste per capita per year (Baldé, Wang et al. 2014).

Nonetheless, in absolute terms, India's market size is larger than that of many high-income countries and domestic demand for consumer durables here has been substantial (Sinha-Khetriwal, Kraeuchi et al. 2005). Consequently, India generates significant volumes of E-waste in absolute terms. Thus, the already existent solid waste management problem in India has been aggravated manifolds with the advent of E-waste. Urban India is responsible for majority of the E-waste generated in the country. A government report suggested that in India, sixty five cities are responsible for generating more than 60% of the total E-waste in the country (MoEF 2008). Among them, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur. Thus, E-waste illustrates primarily an urban problem in Indian context, although the penetration of EEEs is no more restricted to the urban areas alone.

While generation of E-waste in India has observed a significant growth during the last decades, its management practices and policy initiatives are still at an embryonic stage in the country. The diversity in socio-economic, cultural, environmental and several other aspects associated with E-waste management in India construct a scenario with absolute complexity. For instance, E-waste management initiatives in India are influenced by a wide range of key societal factors such as informal competitors, market size, formal take-back systems, availability of E-waste legislations, financing and trust among industrial players and so on (Wang, Huisman et al. 2012). Addressing these factors, effectively and adequately, is a fundamental yet intricate task. In the following sections, the challenges associated with E-waste in India are attempted to address in an adequate detail, both in terms of its diversity and complexity.

1.2.Definitional Frameworks of E-waste

At present there is no standard and clear definition of the expression 'WEEE' or 'E-waste' (Tanskanen 2013; Widmer, Oswald-Krapf et al. 2005). In the absence of a single, specific and globally acceptable definition, several countries have come up with their own interpretations, usages and definitions of the term 'E-waste'. As argued by Tanskanen (2013:1001), "any definition of E-waste needs to consider the aspects of both the product becoming obsolete and the decision of its owner to turn it into waste: electronic products become waste at the time and place when their structure and state are no longer capable of providing the expected performance with respect to the purpose assigned by their owners".

The range of uncertainties and unavailability of consistent information regarding the generation and management of E-waste could be attributed to its perplexing definitional frameworks to a large extent. The European Union's (EU) WEEE Directive[1] offers the most widely approved description and definition of E-waste/ WEEE which incorporates a

[1] Available on: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0019

wide range of electrical and electronic appliances[2]. In the directive, electrical and electronic equipments are divided into ten broad categories with their subsequent sub-categories.

In India, E-waste was first recognized as 'hazardous' in the Hazardous Wastes (Management and Handling) Rules, 2003 where it is briefly covered in Schedule 3 of the Rules[3]. The list of EEEs covered under the e-waste (Management and Handling) Rules, 2011[4] and the recent E-Waste (Management) Rules, 2016[5] are particularly limited. The Indian rules list only two categories of EEEs i.e. 1) information technology and telecommunication equipment and 2) consumer electrical and electronics. Barely 21 varieties of EEEs are included within these two defined categories of E-waste in India. In this thesis, we consider the definition of E-waste or WEEE as provided by the EU because of its wider prospect. The lack of a common, globally acceptable and applicable definition of E-waste complicates the very concept of E-waste itself and makes its assessment and management a complex task. The most comprehensive definition of E-waste or WEEE provided by the EU includes the following ten categories of electrical and electronic appliances (See: Table 1.1).

[2]The major features of this definition include the definition of 'electrical and electronic equipment', its classification into ten categories and its extent as per voltage rating of 1000 volts for alternating current and 1500 volts for direct current (ibid).

[3]Available on: http://envfor.nic.in/legis/hsm/so593e.htm

[4] Available on: http://www.moef.nic.in/downloads/rules-and-regulations/1035e_eng.pdf

[5] Available on: http://www.moef.gov.in/sites/default/files/EWM%20Rules%202016%20english%2023.03.2016.pdf

Table 1.1: Electrical and Electronic Equipments (EEEs) covered under EU's definition of E-waste or WEEE

Sr. No.	E-waste Categories	List of Products Covered
1.	Large household appliances	Large cooling appliances, Refrigerators, Freezers, Other large appliances used for refrigeration, conservation and storage of food, Washing machines, Clothes dryers, Dish washing machines, Cooking, Electric stoves, Electric hot plates, Microwaves, Other large appliances used for cooking and other processing of food, Electric heating appliances, Electric radiators, Other large appliances for heating rooms, beds, seating furniture, Electric fans, Air conditioner appliances, Other fanning, exhaust ventilation and conditioning equipment
2.	Small household appliances	Vacuum cleaners, Carpet sweepers, Other appliances for cleaning, Appliances used for sewing, knitting, weaving and other processing for textiles, Irons and other appliances for ironing, mangling and other care of clothing, Toasters, Fryers, Grinders, coffee machines and equipment for opening or sealing containers or packages, Electric knives, Appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and other body care appliances, Clocks, watches and equipment for the purpose of measuring, indicating or registering time, Scales
3.	IT and telecommunications equipment	Centralised data processing, Mainframes, Minicomputers, Printer units, Personal computers (CPU, mouse, screen and keyboard included),

		Laptop computers (CPU, mouse, screen and keyboard included), Notebook computers, Notepad computers, Printers, Copying equipment, Electrical and electronic typewriters, Pocket and desk calculators and other products and equipment for the collection, storage, processing, presentation or communication of information by electronic means, User terminals and systems, Facsimile, Telex, Telephones, Pay telephones, Cordless telephones, Cellular telephones, Answering systems, And other products or equipment of transmitting sound, images or other information by telecommunications
4.	Consumer equipment	Radio sets, Television sets, Video cameras, Video recorders, Hi-fi recorders, Audio amplifiers, Musical instruments, And other products or equipment for the purpose of recording or reproducing sound or images, including signals or other technologies for the distribution of sound and image than by telecommunications
5.	Lighting equipment	Luminaires for fluorescent lamps with the exception of luminaires in households, Straight fluorescent lamps, Compact fluorescent lamps, High intensity discharge lamps, including pressure sodium lamps and metal halide lamps, Low pressure sodium lamps, Other lighting or equipment for the purpose of spreading or controlling light with the exception of filament

		bulbs
6.	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	Drills, Saws, Sewing machines, Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, folding, bending or similar processing of wood, metal and other materials, Tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses, Tools for welding, soldering or similar use, Equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means, Tools for mowing or other gardening activities
7.	Toys, leisure and sports equipment	Electric trains or car racing sets, Hand-held video game consoles, Video games, Computers for biking, diving, running, rowing, etc., Sports equipment with electric or electronic components, Coin slot machines
8.	Medical devices (with the exception of all implanted and infected products)	Radiotherapy equipment, Cardiology, Dialysis, Pulmonary ventilators, Nuclear medicine, Laboratory equipment for *in-vitro* diagnosis, Analysers, Freezers, Fertilization tests, Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability
9.	Monitoring and control instruments	Smoke detector, Heating regulators, Thermostats, Measuring, weighing or adjusting appliances for household or as laboratory equipment, Other monitoring and control instruments used in industrial installations (e.g. in control panels)
10.	Automatic dispensers	Automatic dispensers for hot drinks, Automatic dispensers for hot or cold bottles or cans,

		Automatic dispensers for solid products, Automatic dispensers for money, All appliances which deliver automatically all kind of products

Source: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0019

Recently, the new category eleven is added to the existing ten categories that provides for any product with any electrical function (for instance, a gas cooker with an electric clock or light) to be brought into the scope of this directive from 23 July, 2019.

1.3.Problems of E-waste in India

1.3.1. Rapid Growth of E-waste

The growth of population in urban India from 11.4% in 1901 to 31.16% in 2011 contributed to an alarmingly increasing amount of waste production (Yadav, Karmakar et al. 2016). Further, the second half of twentieth century witnessed the rise of a consumption-based economy around the globe (Aras, Korugan et al. 2015). As one of the largest and the most flourishing segment of this growth story, electronics industry (Zeng and Li 2016) results in a massive volume of EEEs being produced, used and consumed worldwide since the 1980s (Song, Li et al. 2016). According to the Confederation of Indian Industries (CII 2011), Indian electronics industry has a market size of approximately USD 65 billion and is expected to reach USD 400 billion by the year 2020 (Agrawal, Singh et al. 2014). The outcome is the large quantity of E-waste being produced in the country. Emerging economies like India has the fastest growing markets for EEEs and thus, are large generators of E-waste (Widmer, Oswald-Krapf et al. 2005).

Today, E-waste in India is an important waste stream both in terms of its volume and toxicity (Dwivedy and Mittal 2012). For instance, approximately 41-152 million units of computers will become obsolete in India by 2020 (Dwivedy and Mittal 2010a) causing serious management challenges and environmental/human health apprehensions. India

domestically produces 480,000 tonnes of E-waste per annum ((Kaushal and Nema 2013). The Associated Chambers of Commerce and Industry of India (ASSOCHAM) has put this figure at 1.85 million tonnes in 2016 with the city of Mumbai, Delhi-NCR and Bangalore generating 120,000 tonnes, 98,000 tonnes and 92,000 tonnes respectively[6]. Ten states and sixty-five cities in India produce more than 70% and 60% of the total E-waste generated in the country respectively (MoEF 2008). Maharashtra ranks first in the list of E-waste generating states in the country followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab. Among the cities, Mumbai ranks first followed by Delhi and Bangalore.

Further, India has been one of the major destinations of E-waste from the developed countries with an estimated 50,000 tonnes of E-waste imported every year into the country (Agoramoorthy and Chakraborty 2012). Inadequate recycling infrastructures and the possibility of environmental pollution in the industrialized countries (Nnorom, Ohakwe et al. 2009) together with the low labour costs and lenient environmental laws in the industrializing countries encourage the developed world to export their end-of-life electronic products to the developing world (Peeters, Vanegas et al. 2015). According to the Central Pollution Control Board (CPCB) of India, every year 146,000 tonnes of E-waste is recycled in the country (Shinkuma and Managi 2010). A report by Toxics Link (2004) stated that at the recycling units in New Delhi itself, 70% of the total E-waste collected was actually exported or dumped by developed countries.

Planning for cost-effective E-waste handling and treatment measures necessitate information on the generation, flow and disposal of E-waste which aids in the estimation of the extent and potential consequences of mishandling of the same (Lau, Chung et al. 2013). However, the available data on generation of E-waste is both poor and inadequate (Rubin, de Castro et al. 2014). Although a number of methods have been deployed for E-waste estimation, majority of them fail to meticulously address the same. Lu, Liu et al. (2015) argue that constant technological innovation coupled with frequent product replacement lead to acute fluctuations of E-waste generation. Further, the accuracy of E-

[6] See: http://www.assocham.org/newsdetail.php?id=5642

waste estimation depends largely on the average lifespan of electronic and electrical devices and consumers' disposal tendency in a particular country (Ozturk 2015).

The diverse end-use points and dissimilar consumers' behaviour thus intensify the complications associated with E-waste estimation (Yedla 2016). Nevertheless, although the estimation of the quantities of E-waste generated in India varies from one agency to the other, the sizes of all these estimates are equally large (Premalatha, Tabassum-Abbasi et al. 2014). Accordingly, it is evident that E-waste is a significant toxic waste stream in India by virtue of its own domestic generation and illegal import and hence, its proper management is essential for sustainable development in India.

1.3.2. Management of E-waste

India's E-waste dilemma has its own specific characteristics and calls for adequate addressing from the research and policy community (Borthakur and Govind 2017). For instance, one of the important aspects associated with E-waste in India is its older age than its counterparts in the developed countries. It is because E-waste is often viewed as a commodity in India with some inherent values, causing reluctance among the people to dispose it off immediately (Sinha 2008). Thus, obsolete electronics often find second- and even third-hand users in the country farther down the income chain (Sinha-Khetriwal, Kraeuchi et al. 2005). On a positive note, such kind of consumer behaviour delays the entry of E-waste to the toxic waste stream and facilitates in conserving resources and pollution abatement.

In India, door-to-door scrap collectors (known locally as 'kawariwalas') pay consumers a positive price for their obsolete electronics. In the country, E-waste collectors/dealers, dismantlers, and recyclers operate in a well-established network in the informal sector (Manomaivibool 2009). Thus, India's E-waste recycling has been primarily a market driven industry (Dwivedy, Suchde et al. 2015) dominated by a number of informal actors. More than 90% of the E-waste in India is processed in this informal sector involving a large number of people (Pandey and Govind 2014), especially urban poor women and children.

While most developed countries are effectively managing their E-waste by "formulating effective legislations, developing recycling infrastructures, and strictly adhering to the principle of EPR to command electronic manufacturers and importers to take-back used electronic products" (Afroz, Masud et al. 2013: 185), countries like India are distressed with the problem of an ineffective and inadequate E-waste management system. For instance, EPR, as one of the mechanisms highlighted by the European Union's WEEE Directive, has been instrumental in Europe in shifting waste management focuses towards the direction of recycling with decreasing impact from the disposal of obsolete electronics (Niza, Santos et al. 2014). On the contrary, despite EPR being a major policy approach in both e-waste (Management and Handling) Rules, 2011 and E-waste (Management) Rules, 2016 in India, it is yet to be implemented effectively.

It is important to recognize that India's E-waste management system is complex. Therefore, it is essential to understand its diverse socio-cultural, economic, environmental and other associated attributions for developing a sustainable management option.

1.3.3. Social and Economic Implications of E-Waste

Due to the social and economic disparities in the developing countries compared to their counterparts in the developed world, many people lack the use of new EEEs (Wath, Vaidya et al. 2010). There is also a considerable price difference involved between the new and used EEEs. As a result, the demands for secondhand EEEs are relatively high in India. Thus, India has very lucrative secondhand markets for reusable products. Repair, component reuse, recondition and refurbishing shops are common features in the country (Manomaivibool 2009). Devious organisations in several rich countries use 'donations' of obsolete electronic equipments as a loophole in the Basel Convention[7] to export both functioning and non-functioning EEEs to countries like India (Ladou and Lovegrove 2008).

[7] See: http://www.basel.int/theconvention/overview/tabid/1271/default.aspx

Old yet functional EEEs are often shipped to developing countries by well-meaning donors in the West (Robinson 2009). In India, the existing recycling workshops absorb these old EEEs where E-waste is treated with least regard to the worker's occupational health and safety measures. Owing to the high demand for secondhand EEEs and low initial investment required for starting a collection, dismantling, sorting, or a recovery facility (Sinha 2004), E-waste recycling business is becoming very attractive to small entrepreneurs. For E-waste recycling facility owners in India, rather than creating environmental or social awareness, the financial profit is the main objective (Wath, Vaidya et al. 2010). Consequently, a significant number of urban poor people are involved in the E-waste recycling business with least knowledge about the harmful effects of improper E-waste recycling activities on their health and environment. The involvement of a large number of women and children in these recycling activities further aggravate the problems associated with E-waste management in India.

Nevertheless, the E-waste recycling units in India have great potential for generating employment. Recovering reusable components or materials from discarded EEEs act as a source of income for the economically deprived people (Wath, Vaidya et al. 2010). An entire new economic sector revolving around trading, repairing, and regaining materials from redundant electronic devices is growing in the country (Streicher-Porte, Widmer et al. 2005). As almost everything ranging from the collection, dismantling, sorting-segregation, and recovery of E-waste are mostly done manually in India, this business provides significant employment opportunities (Baud, Grafakos et al. 2001) in several cities, especially to the urban low-skilled people.

It has been estimated that in Delhi alone, the number of unskilled workers involved in recycling and recovering operations are at least 10,000 (EMPA 2004). With the intense growth of E-waste during the last few years, this number could be expected to increase considerably in the recent past. Thus, it is imperative to explore the opportunities and challenges associated with the current E-waste management in India while formulating E-waste management policies in the country. Nevertheless, although the present system provides a living for the urban poor, its risk to human and the local environment cannot be overlooked.

1.3.4. Health and Environmental Implications of E-Waste

E-waste contains more than 1000 different substances which fall under 'hazardous' and 'non-hazardous' categories (MoEF 2008). When EEEs are placed in landfills or incinerated, they pose both environmental and health risks due to the hazardous materials that they contain (Needhidasan, Samuel et al. 2014). Toxic heavy metals are constantly released into the environment from unregulated E-waste recycling activities. A number of researchers have indicated that a wide variety of heavy metals and polyhalogenated organics (including polychlorinated biphenyls and polybrominated diphenyl ethers (PBDEs)) are released from E-waste (Yu-Gong, Tian et al. 2016; Huang, Bao et al. 2016; Chen, Zhang et al. 2016; Ghosh, Ghosh et al. 2015; Ren, Xiao et al. 2014; Kiddee, Naidu et al. 2013). Most of the these chemicals are persistent in nature and have a great potential to accumulate and magnify in the vital organs of human and animal bodies.

The workers in the E-waste recycling units and local residents residing in the vicinity of E-waste recycling sites are exposed to these perilous chemicals present in E-waste mostly through inhalation, dust ingestion, dermal exposure and dietary intake (Tang, Cheng et al. 2015; Labunska, Abdallah et al. 2015). Unfortunately, unaware of the potential E-waste hazards, a large number of people in developing countries are engaged in unsafe handling and management of E-waste (Menikpura, Santo et al. 2014).

Another significant concern associated with informal recycling activities in countries such as India is that mostly, E-waste processing sites are located in abandoned fields near arable lands in the vicinity of major Indian cities, facilitating heavy metal penetration through soil and providing plants sufficient opportunity to absorb the same (Pradhan and Kumar 2014). As a result, there is a greater probability of E-waste toxicants entering the food chain, bioaccumulate or biomagnify ('bioaccumulation' and 'biomagnification') in the process and may cause irreversible damages to health.

Informal E-waste recycling activities coupled with its environmental and health apprehensions are therefore one of the serious concerns encountered by several cities in a number of developing or emerging economies. Most of these E-waste recycling areas are potential sites for uncontrolled and unmonitored air, water and soil pollution (Grant,

Goldizen et al. 2013). Absence of health and safety measures and involvement of women and children in the recycling businesses have the potential to further amplify the problem of E-waste in India.

1.4.Regulations of E-waste in India

For the first twenty years of the economic liberalization in India, which ensured increasing penetration of EEEs into the market due to the evolution of the IT and electronics sector, E-waste observed no significant hindrance in its expansion. For most part of these years, it was an unnoticeable and silent stream of waste observing a remarkable growth in the country. The e-waste (management and handling) Rules, 2011 was the first legal initiative formed to exclusively address the E-waste management concerns in India. Thus, although the IT revolution started in India way back in the early 1990s, a proper legislation related to E-waste was being introduced almost after 20 years, in 2011 (Borthakur 2015).

The e-waste (management and handling) Rules, 2011 primarily emphasized on the Extended Producer Responsibility (EPR) model for effective channelization of E-waste to the registered collectors/dismantlers/recyclers. The Organization for Economic Cooperation and Development (OECD) defined EPR as "a policy approach under which producers are given a significant responsibility – financial and/or physical – for the treatment or disposal of post-consumer products"[8]. Within the purview of the 2011 rules, producers of EEEs or any other person/agency/association can set up collection centers intended for the collection of E-waste. This means that the EPR is not the sole responsibility of the producers and there are scopes of loopholes to avoid the burden of E-waste management by them.

Thus, principles of EPR here have the potential to be desecrated by not maintaining the exclusivity of producer's responsibility towards collecting the E-waste produced from their products. Nevertheless, the provisions of the 2011 rules could not be effectively

[8] See: http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

implemented as the growth in the number of registered E-waste recyclers could not keep pace with the increasing generation of E-waste in the country. Therefore, the government of India came up with the recent E-Waste (Management) Rules, 2016.

The E-Waste (Management) Rules, 2016 provides a number of stringent yet insightful amendments to the previous rules. For instance, the collection of E-waste is now exclusively made a producer's responsibility, which can set up collection centre or point or even can arrange buy back mechanism for such collection (MAIT 2016). If the responsibility of collection of E-waste is provided to a dealer on behalf of the producer, it requires the dealer to collect the E-waste by "providing the consumer a box, bin or a demarcated area to deposit e-waste, or through take back system and send the e-waste so collected to collection centre or dismantler or recycler as designated by producer" (MoEF, 2016: 7). But eventually producers are the ones who are entirely accountable for the waste produced by their obsolete EEEs.

India is also a signatory of the 'Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal', known commonly as the 'Basel Convention' which came into effect in 1992[9]. The primary objective of the convention is to restrict the 'toxic trade', i.e. the cross-border movement or export of hazardous waste (including E-waste) mostly from the industrialized to the industrializing countries. Describing the original aim and current unfortunate state of affair of the Basel convention, Lepawsky (2015:152) writes:

— "The Basel Convention is a key international agreement regulating international transboundary shipments of hazardous waste. The Convention came into force in 1992 and includes 175 signatories at the time of writing. In the e-waste literature the Convention is often referred to as international law that makes it illegal to dump hazardous waste, including e-waste, from rich, 'developed' countries to poor, 'developing' countries. This is certainly the spirit of the Convention but a careful consideration of its provisions suggests a murkier picture. [...] the trade of e-waste is growing. Since 1996, total trade has more than doubled from almost 500 million kg to over 1 billion kg. What is surprising is how the geography of this trade is organised and breaks down regionally."

[9] See: http://www.basel.int/theconvention/overview/tabid/1271/default.aspx

Thus, the convention is subjected to major challenges associated with its successful implementation both from the developed and developing countries. The success of any rules or legislations, nevertheless, depends on peoples' cooperation for its successful implementation upto the grassroots level. Considering the rapid diffusion of EEEs in every strata of the society in both urban and rural India, today the challenge within the realm of the policy community lies in the successful implementation of the E-waste (Management) Rules, 2016. This requires adequate awareness among the diverse 'bulk' and 'individual' consumers about the disastrous health and environmental consequences of irresponsible disposal of E-waste.

Peoples' consumption and disposal behaviour have been studied widely by a number of researchers such as Bortoleto, Kurisu et al. (2012), Milovantseva and Saphores (2013), Zabkar and Hosta (2013), Ercan and Bilen (2014), Botetzagias, Dima et al. (2015), Tian, Wu et al. (2015), Yla-Mella, Keiski et al. (2015), Dasgupta, Southerton et al. (2016), Islam, Abdullah et al. (2016) etc. Many of them have pointed out that peoples' awareness, their education level and income have a considerable influence on their consumption as well as disposal behaviour. A number of such studies have used the concept of conspicuous consumption and the theory of planned behaviour (TPB) to analyse their results. A brief description of these two conceptual frameworks, with an aim to use them in the context of our study, has been provided in the following section.

1.5.The Conceptual Framework

The conceptual framework underlying this work uses elements that stem from the Theory of Planned Behaviour (TPB) and Conspicuous Consumption. Considering these two concepts having distinct yet interrelated linkages, we attempt to develop a framework towards 'Public Understandings of E-waste and its Disposal' in the context of India.

1.5.1. Conspicuous Consumption

The concept of 'conspicuous consumption' was first introduced by Thorstein Veblen (1899) in his celebrated treatise 'The Theory of the Leisure Class'. According to this

idea, individuals signal or advertise their wealth through their consumption behaviour with an aim to achieve greater social status. Veblen's theory is rooted on the argument that individuals who place their wealth 'in evidence' are rewarded with privileged treatments by their social contacts (Bagwell and Bernheim 1996). Veblenian conspicuous consumption is evident in two dimensions: 'invidious comparison' and 'pecuniary emulation'. 'Invidious comparison' is intended to exhibit one's status to be higher than the others. Here, the higher class individuals, in particular, seek to distinguish themselves from the lower class individuals (Palma, Ness et al. 2017). 'Pecuniary emulation', alternatively, reflects the exercise by the lower class individuals of imitating the consumption standards of those whom they perceive to possess a higher status than them. Accordingly, here, the lower class individuals are engaged in purchasing prestige or status goods with the intent of emerging as members of the perceived higher class (Palma, Ness et al. 2017).

While one set of consumers may perhaps purchase goods to indicate their affiliation in a group of higher status, the other set of consumers may also conspicuously consume goods or services in order to merely avoid the manifestation of being a part of the lower class (Geiger-Oneto, Gelb et al. 2013). Rauscher (1997:36) argues that in the contemporary times, it might be "more appropriate to adopt Veblen's (1899) point of view and to argue that conspicuous consumption rather than the accumulation of wealth is the major source of social status".

Today, a considerable body of empirical evidences proposes that people are concerned about their relative consumption — a potential indication for status quest (Aronsson and Johansson-Stenman 2013). For instance, Veblen's effect is said to manifest itself when consumers reveal an enthusiasm to pay a higher price for a functionally equivalent product (Bagwell and Bernheim 1996). Veblen's work was primarily concentrated on wealthy individuals of rich economies (affluent American people) and accordingly, several early works on the topic argued that conspicuous consumption is restricted to the developed countries' upper classes. However, a considerable number of empirical observations refuted this argument in the due course of time. For instance, the exceedingly conspicuous nature of ceremonial expenditures in

terms of dowry and wedding celebrations in India and burial practices in South Africa (Linssen, van Kempen et al. 2011) indicate an increasing quest for social status in these developing countries.

With a higher income growth in India ever since the economic liberalization in 1991 and subsequent rise of income inequality in the country, the concerns associated with conspicuous consumption become a matter of great significance from marketing and policy perspectives (Jaikumar and Sarin 2015). Nevertheless, despite the theoretical attention 'conspicuous consumption' has received over the years, the concept is yet to be adequately addressed in the context of emerging economies like India. Therefore, we attempt to evaluate its influence on *an individual's EEEs purchasing behaviour* and its subsequent impacts on E-waste generation.

1.5.2. The Theory of Planned Behaviour (TPB)

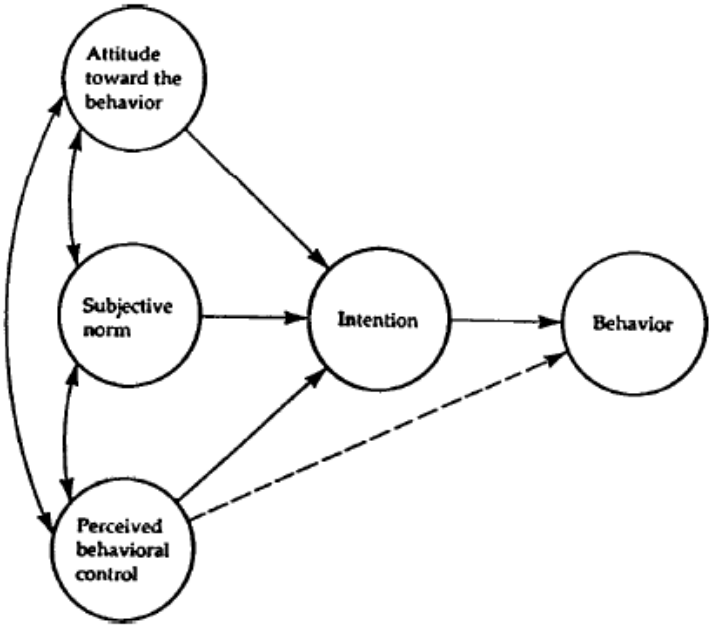
The Theory of Planned Behaviour (TPB) is one of the most widely used and influential social science frameworks for the prediction and understanding of particular behaviours in specified contexts. It is a dominant psychological theory (Botetzagias, Dima et al. 2015) for systematically identify the factors that have the potential to influence consumers' waste disposal behaviour and awareness. Originally proposed by Ajzen (1991), the TPB is an extension of the 'Theory of Reasoned Action (TRA)' by inclusion of an additional variable in the form of *perceived behavioural control*. Previous to the TPB, the TRA suggested that *attitude* and *subjective norms* influence the intention of an individual to perform a certain kind of behaviour.

Nevertheless, the core of the theory remains the same i.e. individuals are more likely to perform the behaviours that they feel positive toward (Barber, 2011). As stated by Ajzen (1991: 181), "a central factor in the theory of planned behaviour is the individual's intention to perform a given behaviour. Intentions are assumed to capture the motivational factors that influence a behaviour; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform

the behaviour". However, the final outcome as their intention has the potential to be frequently constrained by their perceived behavioural control (See: Figure 1.1).

The TPB has been a widely used framework for investigating waste disposal or recycling behaviours across diverse study samples (Zhang, Huang et al. 2015). For instance, Echegaray and Hansstein (2017), Yla-Mella, Keiski et al. (2015), Botetzagias, Dima et al. (2015), Pakpour, Zeidi et al. (2014), Ghani, Rusli et al. (2013), Tudor, Barr et al. (2007), Hansmann, Bernasconi et al. (2006) etc have used the TPB as a theoretical framework to study diverse waste management behaviours in different contexts. Accordingly, we attempted to evaluate *an individual's E-waste disposal behaviour* through the framework of the TPB.

Figure 1.1: Theory of Planned Behaviour (TPB)



Source: Ajzen 1991

A number of authors have argued that the theory does not explain individual's behaviour in adequate detail and thus, suggested the inclusion of additional variables within the model (Tonglet, Phillips et al. 2004). Addressing the 'sufficiency' of the TPB, Ajzen (1991:199) too had offered the scope of insertion of further explanatory variables,

provided that these variables can be revealed to have a considerable and distinct contribution to the theory. Accordingly, it has been observed that the majority of the researches utilizing the TPB as a theoretical framework especially in the context of recycling behaviour have attempted to integrate additional predictors (Botetzagias, Dima et al. 2015). In this thesis, we have attempted to integrate the concept of conspicuous consumption with the TPB and develop a framework of 'Public Understandings of E-waste and its Disposal' in Indian context.

1.5.3. Towards 'Public Understandings of E-waste and its Disposal'

In this thesis, the problems associated with E-waste management in India are tried to be evaluated from its roots. Thus, it is essential to assess an individual's behaviour both in terms of *consumption* and *disposal* of EEEs. Accordingly, two conceptual frameworks, having potential to facilitate us assessing these two different dimensions of E-waste, have been selected. While the framework of 'conspicuous consumption' could guide us evaluate an individual's EEEs *consumption* patterns, the TPB could assist us in assessing an individual's E-waste *disposal* behaviour. Subsequently, we have attempted to devise a research model in terms of a new conceptual framework entitled 'Public Understandings of E-waste and its Disposal' through which a comprehensive essence of E-waste management challenges and opportunities could be figured out in Indian context.

While devising the new framework, we considered the fact that peoples' actual EEEs consumption may be influenced by two factors: 1) Functional needs and 2) Conspicuous consumption. The TPB assists us in determining the reasons or intentions that shape consumers' waste disposal behavioural pattern in terms of attitudes, subjective norms and perceived behavioural control. Regulatory measures and awareness of the public also impact E-waste disposal behaviour. Together, conspicuous consumption and the TPB contribute towards the framework of 'Public Understandings of E-waste and its Disposal' especially in the context of India. The detail of the framework along with its practical implementations is provided in the Chapter 6 of this thesis.

1.6.Gap in the Existing Literature

Understanding consumers' awareness and disposal behaviour is central in improving any E-waste collection initiative (Saphores, Ogunseitan et al. 2012) and its overall sustainable management. The current literature on E-waste management in terms of consumers' awareness and attitudes towards E-waste disposal primarily comprises of literatures investigating the experiences of disposal behaviour which is nothing but the factors that persuade the decision of the consumers whether to store, donate, sell, discard, or recycle an electronic product (Dindarian, Gibson et al. 2012). In depth researches on the topic have attracted insufficient attention (Song, Wang et al. 2012). A bibliometric analysis of the E-waste literatures published during the period between 1994 and 2014 provides the rationale for undertaking this study.

The literature search was carried out through a number of structured keyword searches. Two major databases were primarily searched for relevant publications: 'Scopus' and 'Web of Science'. Over 22,700 peer-reviewed journals are indexed in 'Scopus', while 'Web of Science' indexes around 12,000 peer-reviewed journals. These two databases index majority of the journals bringing out E-waste and related researches from publishers such as Elsevier, Springer, Sage, Taylor and Francis, Emerald, Wiley and so on. In both the databases, we used keywords such as 'E-waste' or 'Electronic Waste' or 'WEEE' or 'Waste Electrical and Electronic Equipment' in order to document researches on our topic of interest. The coverage of Scopus is significantly higher than that of the Web of Science as it is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings[10]. Accordingly, we decided to concentrate our search in Scopus in order to make our study more comprehensive.

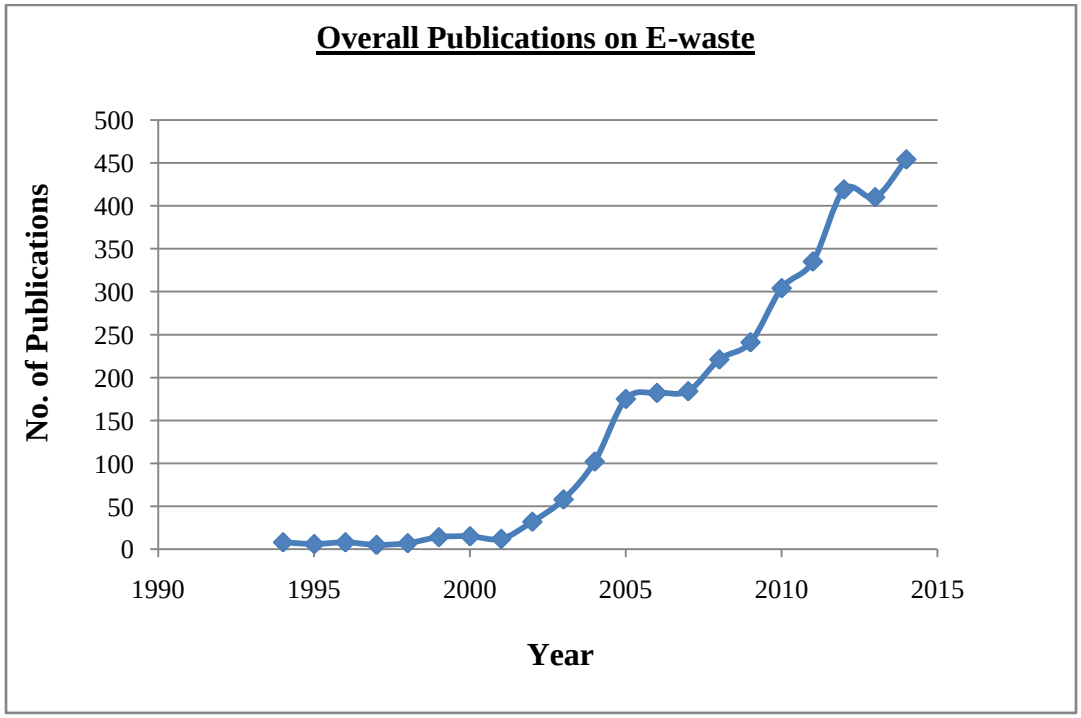
The bibliometric analysis on the trends in global E-waste research shows a large gap in literature. For instance, the analysis with 'Scopus' database using different search queries provided some thought provoking outputs. A general investigation in 'Scopus' using a broad search query on 'E-waste' reports 3192 research documents published

[10] https://www.elsevier.com/solutions/scopus

during the 20 years period, from 1994 to 2014 (See: Figure 1.2). The literatures on E-waste in India have been limited to reviews on the current status of E-waste recycling/disposal, estimation of E-waste quantities, and benchmarking the European Union's E-waste management systems with focus on India (Dwivedy and Mittal 2012).

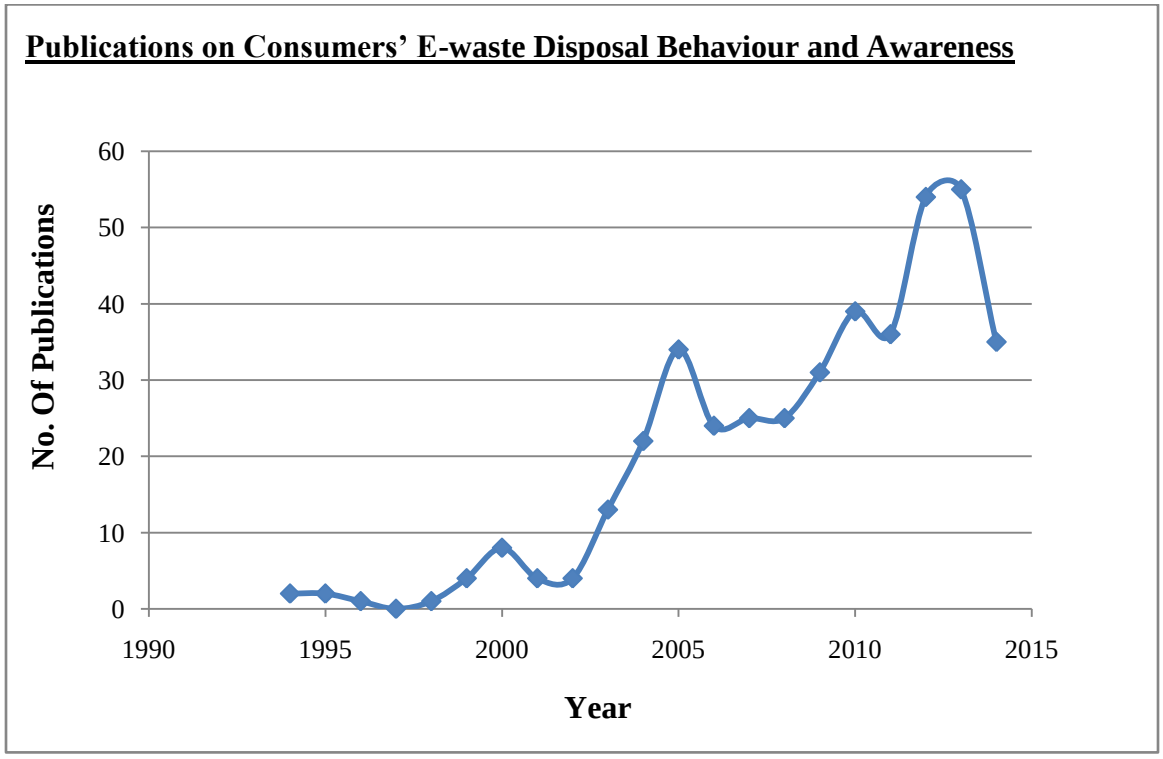
Nevertheless, a specific search using the query on 'E-waste' with 'consumer' or 'awareness' shows 419 research papers published during the same period (See: Figure 1.3). It has been observed that although the words 'consumer' and 'awareness' appears in the title, abstract or keywords of a number of papers on E-waste, the overall issues addressed in those papers do not serve our purpose of identifying researches on consumers' E-waste disposal behaviour and awareness. After a thorough investigation of the individual papers, only 52 papers are found to have satisfactorily dealt with consumers' E-waste awareness and disposal behaviour in diverse countries. The detail of this finding is provided in Chapter 3 of this thesis.

Figure 1.2: Growth of overall publications on 'E-waste' from 1994 to 2014



Source: Scopus 2015

Figure 1.3: Growth of publications on 'Consumers' E-waste Disposal Behaviour and Awareness' from 1994 to 2014



Source: Scopus 2015

We have observed that there are few current studies on public perception and awareness of E-waste and how socio-cultural factors shape their consumption and disposal behavioural patterns of electrical and electronic equipments in India. Studies identifying the major challenges associated with the E-waste management system in the country are reasonably low. Similarly although there have been a number of studies enlisting the key stakeholders in the E-waste trade value chain including the evaluation of social, health and environmental impacts associated with their disposal, there is a dearth of empirical researches examining the consequences of the patterns of such disposal behaviour by the concerned stakeholders (Dwivedy and Mittal 2012). This study attempts to fill up certain parts of this gap in research by conducting an empirical study in the city of Bangalore with the following objectives.

1.7.Objectives

1. To analyse the current E-waste management practices in India.
2. To identify and analyse the influential factors affecting the E-waste management system in India.
3. To explore publics' current E-waste disposal behaviour and its implications in the overall E-waste management system (with special reference to Bangalore).
4. To study the publics' perceptions and awareness on E-waste in India (with special reference to Bangalore).
5. To analyse the policy frameworks for sustainable E-waste management in India.
6. To develop a conceptual framework to analyse publics' understandings of E-waste.

1.8.Research Questions

1. What are the current E-waste management practices in India?
2. What kinds of E-waste disposal practices are adopted by different stakeholders in India?
3. What are the global practices for E-waste management? What could India learn from the global experiences?
4. What are the major influential factors shaping consumers' E-waste disposal behaviours in India in terms of different environmental, socio-cultural and economic considerations?
5. How does public perceive E-waste? Does their awareness shape their consumption and disposal behaviour?
6. How could we ensure the compliance of consumers' behaviour with the existing policy frameworks on E-waste in India?
7. How publics' understandings of E-waste could be conceptualized?

1.9.Universe of the Study

The study was carried out with an aim to construct an E-waste management profile of India, especially emphasising on consumers' disposal behaviour and awareness. Bangalore (now officially known as 'Bengaluru'), a city popularly known as the 'Silicon Valley of India', was considered for the empirical study. The intent was to assess the E-waste management strategies, disposal behaviour and public awareness among diverse consumer stakeholders in the city.

The rationale for considering Bangalore for the study purpose has been manifold. Bangalore has a preeminent position as the nation's leading IT employer and exporter (Ha, Agusa et al. 2009). An estimated 30,000 to 40,000 computers become obsolete every year from the IT industry in Bangalore alone (Needhidasan, Samuel et al. 2014). Home to more than 1200 foreign and domestic technology firms, Bangalore figures significantly in the danger list of cities faced with an E-waste hazard (Pinto 2008). Further, the city is among India's prominent educational and commercial hubs. Bangalore district has a literacy rate of 87.67% (Census 2011). Studies such as Li, Liu et al. (2012) suggest that high educational level is one of the most significant factors in raising the potential of a household's cooperation on responsible E-waste management.

Further Bangalore has been a pioneering city to undertake certain initiatives towards sustainable E-waste management in India. For instance, E-Parisaraa Pvt. Ltd, India's first government authorized E-waste recycler, started its operations from September 2005 in Bangalore. Bangalore is the capital of Karnataka State in Southern India and is the third most populous city in the country (Ha, Agusa et al. 2009). Thus, as a rapidly emerging city, it has a significant user base of EEEs. Further, unlike many other Indian cities handling primarily illegally/legally imported E-waste, Bangalore handles more of domestically produced E-waste (Sthiannopkao and Wong 2013). Bangalore ranks among the top ten (placed third in the ranking) Indian cities that are repository of E-waste (MoEF 2008). By looking at the city profile of Bangalore, it could be concluded that it has a sizable users of electronic and electrical appliances and thus, has the potential to serve as a model for evaluating the issues associated with E-waste management in the country.

The following consumer stakeholders were selected for the purpose of our study. These stakeholders are some of the major contributors to the quantity of E-waste generated in the country (Rajya Sabha Secretariat 2011; MoEF 2008; MoEF 2016).

- Households
- Information Technology (IT) and Electronics Sector
- Banking Sector (representing public and private sector)
- Educational Institutes

The E-waste (Management) Rules, 2016 distinguishes between two types of EEE users – 'consumer' (signifying any person using EEEs. In this thesis, we are using the term 'individual consumer' to represent this section of people) and 'bulk consumer'[11]. IT, Banking Sector and Educational Institutes are considered 'bulk consumers' of EEEs and thus, are the 'bulk producers' of E-waste in India. Individuals at the household level constitute 'consumers' or 'individual consumers' of E-waste. Thus, through this study, we attempt to address the E-waste disposal behaviour and public awareness associated with both these categories of consumers.

1.10. The Study Sample

In order to generate primary data on consumers' E-waste disposal behaviour and awareness and assess the overall E-waste management practices in the city of Bangalore, 300 questionnaires were distributed among purposively selected respondents at the household level. These respondents essentially represent 'individual consumers' of electrical and electronic equipments. The rest three sectors, namely 1) Information Technology (IT) and Electronics Sector, 2) Banking Sector (representing public and private sector) and 3) Educational Institutes, represent 'bulk consumers' of EEEs in the city of Bangalore.

[11] Available at: http://www.moef.gov.in/sites/default/files/EWM%20Rules%202016%20english%2023.03.2016.pdf

The IT major Wipro and a landmark company in the electronics sector (name withheld on request of the interviewee) were considered as key representatives from the IT and Electronics sector. The study was carried out in ten banks with five representatives from major public sector banks (i.e. Canara Bank, The State Bank of Mysore, Bank of India, Indian Bank, The South Indian Bank), three representatives from private sector banks (i.e. HDFC Bank, ICICI Bank, Kotak Mahindra Bank) and two from the cooperative banks (i.e. Karnataka Bank, Apex Bank). The headquarters of Canara Bank and the State Bank of Mysore situated in Bangalore were visited for the study purpose. Indian Institute of Management, Bangalore (IIM-B) was considered as a key representative from the educational sector in the city. The detail of the study sample has been provided in the subsequent chapters (Chapter 4 and Chapter 5).

1.11. Research Methods

Both primary and secondary sources of data were evaluated to assess various E-waste related issues such as its generation, management practices, disposal behaviour, public perception/awareness and so on. Secondary sources include journal and newspaper articles, books, annual reports of various key representatives, blogs, other internet resources etc. An empirical study was carried out in the city of Bangalore to evaluate the existing E-waste management structures, consumers' disposal behaviour and associated awareness. For 'individual consumers', electronic waste with respect to obsolete 'computers' and 'mobile phones' were considered as the representatives of E-waste while for the 'bulk consumers', obsolete computers alone were considered.

Structured online questionnaire survey (through the survey portal 'Survey Monkey') and semi-structured informal face-to-face interview methods were carried out with 'individual consumers' at the household level in order to assess their E-waste disposal behaviour and awareness. The mode of data collection from the 'bulk consumers' was primarily semi-structured informal interviews. Together, these two approaches helped us in gathering purposeful information. Both open and close-ended questions were included

in the online survey. For the interview method, basic questionnaires were formulated for interviews as per the requirement of our research interest and the respective sector concerned. A common questionnaire was formulated for the IT and electronics, banking and educational sector, whereas a different questionnaire was formulated for the households for the online survey.

The questions for the online survey for individual consumers at households were structured. Here we first identified the key informants and through them, we approached other potential respondents who participated in our study and provided relevant information. It was a kind of respondent-driven snowball sampling where we relied on each respondent to drive the next set of respondents. However, in the case of face-to-face interviews (which was the major mode of data collection from the bulk consumers); all questions were not designed or phrased in advance. Some of the questions were shaped during the interview, letting both the interviewer and the person being interviewed the flexibility to explore in detail or discuss issues.

While interviewing, the questions were also modified according to the response of the person being interviewed and need of the sector concerned. Thus, semi structured questionnaire method was selected to collect data because it provides the interviewer flexibility to add, modify and omit questions during the time of the interview. As E-waste management in India is a reasonably unexplored area of research, such kind of flexibility is indispensable for gathering reliable and purposeful data.

The interviews were primarily informal and carried out with relevant stakeholders such as the IT professionals and administrative staffs of academic institutes/banks, individuals at the households etc to have their responses on E-waste management practices in their respective institute. Informal or conversational interviews allow the interviewer to converse and probe emerging concerns, or ask questions in a naturalistic manner on atypical events. The nature of such kind of interview technique is ‘casual’ and thus, it has the potential to be helpful in drawing highly candid accounts from the respondents (Reeves, Kuper et al. 2008). Overall the study was essentially qualitative in

nature with an aim to express the voices of the associated stakeholders. Further detail about the research methods applied and associated challenges have been described in the subsequent chapters (Chapter 4 and Chapter 5).

There had been a few challenges that we had to encounter towards collecting relevant information. For instance, during the direct approaches for acquiring relevant information from the banks (especially the headquarters) and educational institutes, getting permission to enter the vicinity of such institutes and meeting the concerned representative having knowledge about their E-waste management procedures were major challenges. Language was another barrier in conveying the purpose of our visit to the concerned authority through the security stuffs present at the gate who mostly spoke the vernacular language. Further complicating our challenges, barring a few, there was an inherent reluctance among the representatives from each sector towards providing necessary information on their E-waste management practices. Even after repeated attempts through visits, E-mail, phone calls etc, a good number of major IT and electronics companies, educational institutes and popular public and private sector banks did not either reply back or disclose any information on their E-waste management practices.

1.12. Scope and Limitations of the Study

E-waste is reasonably a novel area of academic research in Indian context. Research information on the topic is still far from adequate in the country. Therefore, it has been a challenge to gather adequate information from scientific literature on E-waste management in Indian context. Further, the field study in Bangalore posed several challenges towards collecting purposeful information. Firstly, it had been a challenge to convince people to fill up the questionnaire related to our study in the fast paced city. Due to inadequate interest and awareness on E-waste and its associated concerns, a number of people directly showed their disinterestedness on the topic and was not willing to cooperate both during the online survey and on-site interviews.

A lack of transparency was observed in all the sectors towards providing relevant information on their E-waste management practices. This is particularly true for the 'bulk consumers' of EEEs. Even repeated attempts did not result in gathering purposeful information from a number of IT and electronics companies, banks and educational institutes. We argue that if such ambiguity exists across these bulk producers of E-waste, it is rather intricate to formulate effective E-waste management strategies and policy initiatives.

1.13. Chapter Schemes

Chapter 1: *Electronic Waste: An Overview*: This introductory chapter provides an overview on the current debates on E-waste. The basic aim is to problematize E-waste in Indian context. A brief description of the conceptual framework along with the objectives of the study and the research design are discussed. The sample of our study and tools and techniques used for collection of data are also explained in this chapter.

Chapter 2: *Generation and Management of E-waste in India*: The chapter maps out the current state-of-affairs associated with the generation of E-waste in India and its management challenges. Emerging issues of concern such as illegal import of E-waste and informal recycling sector are addressed in detail in this chapter. The chapter identifies the key stakeholders involved in the generation and management processes.

Chapter 3: *Global Trends in Consumers' E-waste Disposal Behaviour and Awareness*: This chapter is an attempt to review two key elements greatly accountable for influencing sustainable E-waste management initiatives: Consumers' E-waste 1) 'Disposal Behaviour' and 2) 'Awareness'. We have attempted to perform an extensive review on the topic in the global context. We especially emphasize on the complexities in India's E-waste management system due to the consumers' wide-ranging disposal practices and preferences. The chapter is an attempt to understand the global scenario and figure out what India could learn from the diverse global experiences.

Chapter 4: ***E-waste Disposal Behaviour and Awareness of Household Consumers in the City of Bangalore*****:** This chapter focuses on consumers in terms of 'individual consumers' of EEEs. It discusses the empirical study carried out in the city of Bangalore on individual household consumers. Diverse E-waste disposal behaviours at the households in Bangalore are documented. Variations of disposal behaviours and associated awareness with respect to the respondent's age, gender, education and income level are analysed in detail.

Chapter 5: ***E-waste Management and Bulk Consumers: An Empirical Worldview*****:** This chapter focuses on the 'bulk consumers' of EEEs and thus, 'bulk producers' of E-waste. The chapter evaluates the E-waste disposal practices and preferences at the IT and Electronics, Banking and Education Sector in Bangalore. The diversity in their disposal behaviour and associated challenges are identified and analysed.

Chapter 6: ***'Public Understandings of E-waste and Its Disposal' in India: Developing a Conceptual Framework*****:** This chapter is a journey towards developing a new conceptual framework of 'public understandings of E-waste and its disposal' in the context of India. The empirical study carried out in the city of Bangalore with 'individual consumers' is considered to validate the relevance of the new conceptual framework. By developing this comprehensive framework, we primarily try to analyse publics' perceptions on purchase of EEEs, disposal of E-waste and the determinants of their E-waste disposal behaviour.

Chapter 7: ***Conclusions*****:** This chapter discusses the key findings of the entire study and concludes the study by providing insights for future scope of research.

Chapter 2

Generation and Management of E-waste in India

2.1.Introduction

Waste management remains a major apprehension for the contemporary society as both the quantity and complexity of waste continue to amplify rapidly (Ordonez, Harder et al. 2015). Large amounts of E-waste have been continuously and rapidly piling up in a number of emerging economies during the last decades, both from the rising domestic consumption and imports (Wang, Huisman et al. 2012). Especially since 2000, E-waste has become a major global apprehension in terms of considerations for resource recycling and environmental improvement (Zeng, Yang et al. 2017). A considerable portion of the E-waste generated globally is not documented and addressed in a controlled manner for potential recovery of materials (Tansel 2017).

Complementing the global scenario, environment and resource-friendly management of E-waste is a serious concern in contemporary India. The already existent solid waste management problem in the country has been aggravated manifolds with the advent of domestically generated and illegally/legally imported E-waste. With a potential for an annual growth exceeding 800,000 tonnes, another 50,000 tonnes of E-waste is dumped into India every year (Agoramoorthy and Chakraborty 2012) causing serious environmental and human health hazards. Waste represents an enormous loss of material and energy resources (Yla-Mella, Poikela et al. 2014) which calls for effective management strategies involving sustainable consumption and pollution prevention measures.

As observed by Rubin, de Castro et al. (2014), the fast progression of technology in combination with strong incentives for consumption marks the rapid obsolescence of a broad range of products. This results in an increasing generation of waste from electronic and electrical products than other consumer goods. It is because consumers now-a-days prefer replacing their electronic goods and gadgets (which is often easier and cheaper) rather than taking broken electronics to a repair shop. For instance, Paiano, Lagioia et al.

(2013) argue that even though, mobile phones have potential lifespans of approximately ten years, fashion trends and technological obsolescence (both of which are often planned by the manufacturers) together with effective marketing strategies by mobile network providers, declining prices of mobile phones and specific tariff options/offers encourage consumers to change their phones at regular intervals. This results in the usable life of these devices to decrease to only 12-24 months. With the advancements in research and development on information technology, aspects of E-waste management including collection, recycling and treatment are gradually receiving increasing global attention (Lu, Zhang et al. 2015) as the obsolescence has become a major cause of concern in the contemporary world.

This chapter evaluates the current E-waste scenario in India with respect to its generation and management. Both domestic generation and illegal import of E-waste are addressed. Existing E-waste management challenges in India have been assessed taking into account the current E-waste disposal practices/preferences, dominance of the informal recycling sector, stakeholders' involvements etc.

2.2.Sources of E-waste in India: Domestic Generation and Illegal Import

As one of the fastest growing global manufacturing activities, turnover associated with the production of electrical and electronic equipments (EEEs) exceeds even that of car manufacturers (Buekens and Yang 2014). However, the question related to how much E-waste is actually generated with respect to its source of generation and eventual destination is often complicated to comprehend. The E-waste dilemma, particularly in the developing countries, is further aggravated by the existing system of collecting information in which secondary and waste products are by and large hidden in the national statistics of production, sale and trade-in goods (Nnorom and Osibanjo 2008). Thus, E-waste's position both as 'waste' and 'secondary' product hinders its factual assessment.

Nevertheless, it had been estimated that, globally, the volume of E-waste generated was expected to reach 93.5 million tonnes in 2016 from 41.5 million tonnes in 2011 at a

Compound Annual Growth Rate (CAGR) of 17.6% from 2011 to 2016 (Yu, He et al. 2014). Signifying major economic benefit, during the same time, the whole profit of E-waste market was expected to rise to 20.25 billion US dollars in 2016 from 9.15 billion US dollars in 2011 at a CAGR of 17.22% (Yu, He et al. 2014). In European Union countries, for instance, E-waste increases by 16-28% every five years with a growth rate three times faster than the municipal solid waste (Rahmani, Nabizadeh et al. 2014).

The situation in India is equally worrisome. Dwivedy and Mittal (2010b) suggested that the amount of E-waste in India observes a growth rate of 7% to 10% per year. It is estimated that the country annually produces 480,000 tonnes of E-waste (Kaushal and Nema 2013). ASSOCHAM put this value at 1.85 million tonnes in 2016. Thus, although these estimations may vary from one source to the other, the sizes of all are equally large. Widmer, Oswald-Krapf et al. (2005) observed that while the per-capita E-waste production in India is reasonably low, the total absolute quantity of E-waste generated is huge because of the large population size and increasing domestic demands for EEEs in the country. MoEF (2008) maintained that ten states in India are responsible for the generation of 70% of the total E-waste in the country.

It has been observed that the process of urbanization has significant influence on the E-waste generation, although rural areas in India also produce considerable volume of E-waste due to the diffusion of EEEs to the farthest part of the country. As a still emerging process, urbanization in Indian cities demands a fast-paced life which, in turn, encourages increasing use of several EEEs for greater comfort and accessibility. However, all these EEEs have their respective lifespan and become obsolete after a specific period of time. The functional life of EEEs observes an ever-decreasing trend due to the emergence of an innovative, lucrative and attractive electronics market. In the absence of a proper disposal mechanism, once obsolete, these EEEs are mostly concentrated in the informal recycling centers in urban slums causing serious environmental and human health concerns.

Table 2.1 documents the major research articles addressing the generation and forecasting of E-waste and their respective location of study.

Table 2.1: Research articles on generation and forecasting of E-waste

Serial No.	Reference	Location of Study
1.	Ikhlayel, M. (2016)	Jordan
2.	Cao, J. et al (2016)	China
3.	Breivik, K. et al (2016)	Global
4.	Yedla, S. (2016)	Global
5.	Duan, H. et al (2016)	China
6.	Song, Q. et al (2016)	China
7.	Petridis, N.E. et al (2016)	Western and Eastern Europe, Asia/Pacific, Japan/Australia/New Zealand
8.	Li, B. et al (2015)	Global
9.	Borthakur, A (2015)	India
10.	Li, J. H et al (2015)	China
11.	Kalmykova, Y. et al (2015)	Sweden
12.	Saidan, M., Tarawneh, A. (2015)	Jordan
13.	Rodrigues A. C. et al. (2015)	Brazil
14.	Ozturk (2015)	Turkey
15.	Lu, Y. C. et al. (2015)	China
16.	Alavi, N. et al. (2015)	Iran
17.	Perez-Belis, B., Ibanez-Fores, B.V. (2015)	Global
18.	Shumon, M.R.H. et al (2014)	Malaysia/Global
19.	Jang, Y.-C. et al (2014)	Korea
20.	Rahmani, M. R. et al. (2014)	Iran
21.	Breivik, K. et al. (2014)	Global
22.	Schumacher, K. A. et al. (2014)	The USA
23.	Premalatha, M. et al. (2014)	Global/India
24.	Andarani, P., Goto, N. (2014)	Indonesia
25.	Habuer, J. et al. (2014)	China
26.	Bigum, M. C. et al. (2013)	Denmark
27.	Kim, S. et al. (2013)	South Korea
28.	Wang, F. et al. (2013)	Global
29.	Araujo, M. G. et al. (2012)	Brazil
30.	Chung, S.S. (2012)	China
31.	Zhang, L. et al. (2012)	China
32.	Kahhat, R., Williams, E. (2012)	The USA
33.	Polak, M., Drapalova, L. (2012)	Czech Republic
34.	Fraige, F. Y. et al. (2012)	Jordan
35.	de Oliveira, C. R. (2012)	Global/Brazil
36.	Sole, M. et al. (2012)	Spain
37.	Ongondo, F. O. et al. (2011)	Global

38.	Chung, S. S. et al. (2011)	Hong Kong
39.	Wager, P. A. et al. (2011)	Switzerland
40.	Gutierrez, E. et al. (2011)	Spain
41.	Zhang, L. et al. (2011)	China
42.	Dwivedy, M., Mittal, R. K. (2010 a)	India
43.	Dwivedy, M., Mittal, R. K. (2010 b)	India
44.	Jang, Y-C. (2010)	Korea
45.	Yu, J. L. et al. (2010)	Global
46.	Steubing, B. et al. (2010)	Chile
47.	Odhiambo, B.D. (2009)	Kenya
48.	Babbitt, C.W et al (2009)	The USA
49.	Robinson, B. H. (2009)	Global
50.	Yang, Y., Williams, E. (2009)	The USA
51.	Ivanus, R. C. (2009)	Romania
52.	Yang, J. X. et al. (2008)	China
53.	Osibanjo, O. et al. (2008)	Nigeria
54.	Kang, H. Y., Schoenung, J. M. (2006)	The USA
55.	Liu, X. B. et al. (2006)	China
56.	Li, J. et al (2006)	China

2.2.1. Domestic Generation of E-waste in India

After the first phase of economic liberalization i.e. after 1990, problems associated with E-waste started evolving in India (Wath, Dutt et al. 2011). The Information Technology (IT) sector, a major driver of change in the Indian economy, has been one of the largest contributors to the E-waste stream in the contemporary India (Needhidasan, Samuel et al. 2014). As put forth by Reddy (2015:166), "the celebratory narrative around IT locates in the development of the IT sector a signature moment in India's postcolonial modernity, namely its imminent passage from a developing nation to a world economic power entering the time of global capital". At the same time, its input to the country's E-waste stream cannot be ignored.

Likewise, the firm competition in the market in terms of quality, brands, services and prices offered between different foreign and Indian companies stimulated the growth of consumer durable and electronic industry in India (Wath, Dutt et al. 2011). In due course, all these progresses have been responsible for contributing significantly to the country's E-waste generation during the last two decades. Heeks, Subramanian et al. (2014)

observed that local organizational consumers of information and communication technology (ICT) create the majority of E-waste in India. As India's Information Technology – Business Process Management (IT-BPM) sector has the potential for a projected growth of $300 Billion by 2020[12]; it is evident that the problem of E-waste (in the form of ICT equipments) from the IT sector will continue unabated in the near future. The single most dominant component of ICT related E-waste from the IT sector is computers (including Personal computers, Laptop computers, Notebook computers, and Notepad computers) and associated hardware.

The major reason for the exceptionally high substitution and desertion rate of computers from the IT sector could be attributed to the launch of new and modified versions of software every few months. Many a times, the older hardware is not compatible with the new software, thus, forcing the companies to accept newer hardware at regular intervals (Borthakur 2014). As a consequence, an estimated 30,000 to 40,000 computers become obsolete every year from the IT industry in Bangalore alone (Needhidasan, Samuel et al. 2014). Reddy (2015) estimated that 30 per cent of the computers used in Bangalore's IT sector become obsolete every year and that 8000 tonnes of toxic E-waste are generated per annum (as of the year 2005). By 2009, this volume had risen to over 14,000 tonnes and the figure rose to an astounding 37,000 tonnes by 2013. In the year 2016, ASSOCHAM estimated the figure to be 92,000 tonnes.

Bangalore, famously known as the 'Silicon Valley of India', is today the third-largest producer of E-waste in India, after Mumbai and Delhi. Home to more than 1200 foreign and domestic technology firms, Bangalore figures prominently among the Indian cities faced with intense E-waste associated hazards (Needhidasan, Samuel et al. 2014). Likewise, in the city of Pune (another IT hub of the country) significant portion of E-waste is generated from key stakeholders such as IT industries, banking sector, educational institutes and households (Borthakur 2014).

[12] http://www.makeinindia.com/sector/it-and-bpm

The state-wise distribution of E-waste generation in India is provided in Table 2.2 as of the year 2005. Nevertheless, the quantity is expected to rise significantly during the last decade as E-waste has become a major waste stream in the country today.

Table 2.2: State-wise generation of E-waste in India as of the year 2005

Serial No.	State/Union Territory	E-waste Generated (Tonnes)	Serial No.	State/Union Territory	E-waste Generated (Tonnes)
1.	Andaman and Nicobar	92.2	19.	Lakshadweep	7.4
2.	Andhra Pradesh	12, 780.3	20.	Madhya Pradesh	7,800.6
3.	Arunachal Pradesh	131.7	21.	Maharashtra	20,270.6
4.	Assam	2,176.7	22.	Manipur	231.7
5.	Bihar	3,055.6	23.	Meghalaya	211.6
6.	Chandigarh	359.7	24.	Mizoram	79.6
7.	Chattisgarh	2,149.9	25.	Nagaland	145.1
8.	Dadra and Nagar Haveli	29.4	26.	Orissa	2,937.8
9.	Daman and Diu	40.8	27.	Puducherry	284.2
10.	Delhi	9,729.2	28.	Punjab	6,958.5
11.	Goa	427.4	29.	Rajasthan	6,326.9
12.	Gujarat	8,994.3	30.	Sikkim	78.1
13.	Haryana	4,506.9	31.	Tamil Nadu	13,486.2
14.	Himachal Pradesh	1,595.1	32.	Tripura	378.3
15.	Jammu and Kashmir	1,521.5	33.	Uttar Pradesh	10,381.1
16.	Jharkhand	2,021.6	34.	Uttarakhand	1,641.1
17.	Karnataka	9,118.7	35.	West Bengal	10,059.4
18.	Kerala	6,171.8		Total	146,180.7

Source: Adopted from Wath, Dutt et al. (2011)

As one of the fastest growing economies in the world, India's domestic demand for consumer durables has been enormous (Sinha-Khetriwal, Kraeuchi et al. 2005) especially during the last two decades. Consequently, the amount of EEEs placed on the Indian

market has been increasing every year (Manomaivibool 2009). Government reports suggest that the country's already vast consumer-base of EEEs has the potential to achieve a consumer electronics market of $29 Billion by the year 2020[13]. The lucrative market of EEEs coupled with the ever-decreasing lifespan of consumer durables is a major concern in India. At the household level in the city of Pune, for instance, it has been observed that people tend to exchange their older EEEs with new ones at a faster rate. This tendency is more during the festive seasons when lots of offers (in terms of exchange offers and discount on purchase of new EEEs) come up regularly (Borthakur 2014), both in the retail stores and online e-commerce sites.

The attractive offers on EEEs allure consumers to purchase newer products while their older ones are still functional and have the potential to serve the owner for another few more years. Such a trend of ever-increasing consumption of EEEs whilst decreasing user life of the same is a common characteristic, particularly of urban India. Hence, considerable quantities of EEEs become obsolete while still fully functional, contributing to the country's domestic E-waste generation in the process. Thus, it is certain that, similar to the IT-BPM sector, E-waste from consumer durables will observe a continuous growth in the coming decades. This calls for immediate policy attention towards sustainable management of E-waste in the country.

2.2.2. Issues Concerning Import of E-waste in India

Import of E-waste from the developed to the developing countries signifies one of the most fundamental waste management associated problems in present-day Asia. Sthiannopkao and Wong (2013) approximated that 70% of the E-waste processed or disposed of in India originate abroad, with Delhi being its primary destination. Cities like Bangalore handles more of domestically produced E-waste. It has been observed that in addition to the importation of E-waste from Europe and the US, there is also a flow of E-waste material within the Asian region, for instance, from Japan to South-East Asia (de

[13] http://www.makeinindia.com/sector/electronic-systems

Oliveira, Bernardes et al. 2012). India has been a popular destination for such importation activities since long, with this trade chiefly fuelled by the presence of a large informal E-waste recycling sector within the country.

At present the main E-waste disposal mechanism followed by most developed countries is export to the developing world in the name of 'bridging the digital divide' (Nnorom and Osibanjo 2008). Locating the loopholes in the Basel Convention[14], a number of developed countries are constantly transporting their E-waste to the developing countries without much hurdle. As argued by Tong, Li et al. (2015: 32), "the localisation of imported waste recycling from North to South is driven by the demand for low-cost raw materials to alleviate domestic shortages and by the need to promote labour intensive industries that generate employment opportunities for unskilled labour". Although the justifications provided by the developed world in favour of this 'toxic trade' looks convincing, many studies question the actual purpose behind the same. For instance, Pradhan and Kumar (2014) and Agoramoorthy (2006) argued that inexpensive labour and weak environmental law enforcement are essentially the primary reasons behind shipping of millions of tonnes of E-waste to developing countries (such as India, China, Bangladesh and Pakistan) in the name of recycling.

Import of E-waste contributes significantly to the growth of the informal recycling sector especially in urban India where a lot of urban poor are involved in primitive E-waste recycling by adopting perilous means to extract various E-waste components for economic benefit. As argued by Needhidasan, Samuel et al. (2014:4), "over 1 million poor people in India are involved in the manual recycling operations of E-waste and most of the people working in this recycling sector are the urban poor with very low literacy levels and hence very little awareness regarding the hazards of E-waste toxins". Involvement of a large number of women and children in such recycling activities further intensifies the problems associated with E-waste recycling activities in the country (Borthakur 2015).

[14] The Basel Convention is a key piece of law governing the international toxic waste trade. The spirit of the Convention is to prohibit the dumping of hazardous waste from developed countries to developing countries. See: Lepawsky, J. 2015. Are we living in a post-Basel world? *Area,* 47**,** 7-15.

A report by Toxics Link (2004) revealed that considerable portion of the total E-waste collected by the recycling units in New Delhi is essentially exported or dumped by developed countries. Recycling in India is financially profitable for the developed world. The cost of recycling of a single computer in the United States, for instance, is USD 20 while the same could be recycled in India for only USD 2, suggestive of a net saving of USD 18 if the computer is exported to India (Chatterjee and Kumar 2009). Agoramoorthy and Chakraborty (2012) have revealed that around 50,000 tonnes of E-waste is dumped into India by the developed countries every year. Consequently, domestic generation and illegal import together contribute to the total volume of E-waste generated in the country.

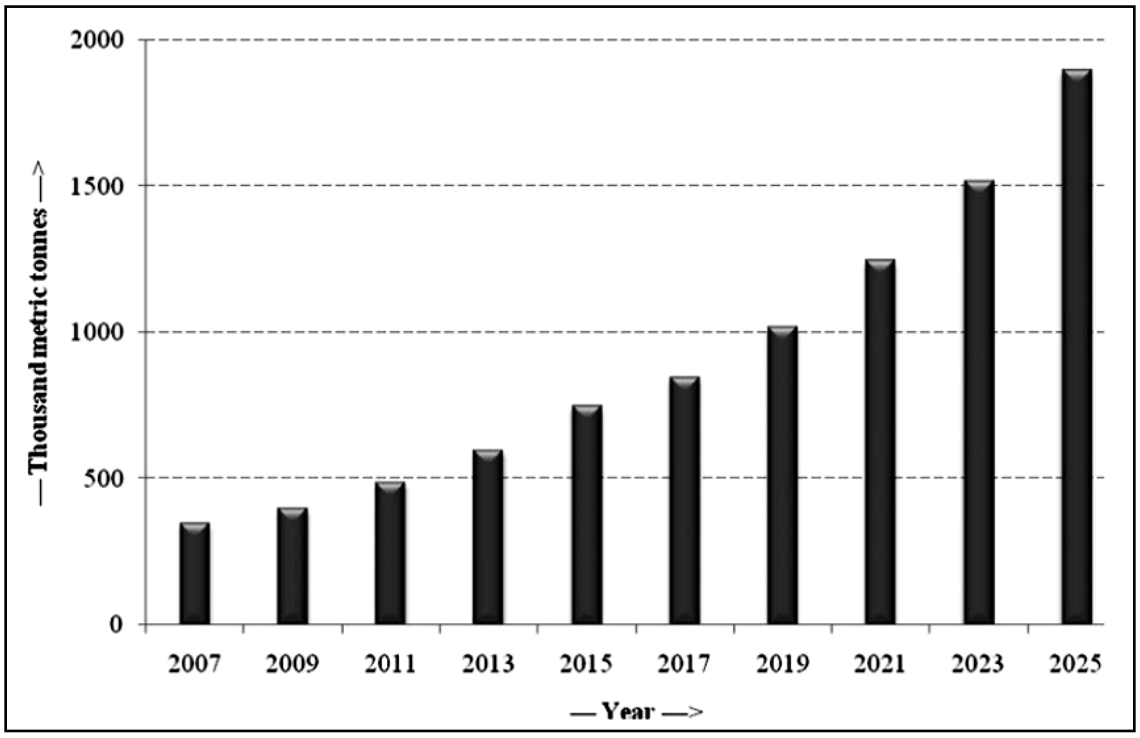
2.2.3. Forecasting the Future Generation of E-waste in India

Robinson (2009) argued that electrical and electronic items are essential for the functioning of all but the most primitive economies. Therefore, the recent trends in E-waste generation signify a process in which the global production of E-waste observes consecutive changes with the growth of economies and innovation potential. Premalatha, Tabassum-Abbasi et al. (2014) stated that the shorter the lifespan of an electrical or electronic item, the greater its proportion in a given pile of E-waste. For instance, mobile phones and personal computers (PCs), having an average lifespan of two to three years, constitute a greater proportion of E-waste than television sets, refrigerators, washing machines, ovens etc having lifespan of approximately 10 years or more.

A joint report by United Nations Environment Programme (UNEP) and United Nations University (UNU) predicts that by the year 2020, E-waste from old computers alone would observe a growth of 500 % in India, and E-waste from discarded mobile phones would be about 18 times higher than the 2007 level in the country (Lu, Zhang et al. 2015). Considering the still inadequate E-waste management options in India, such growths are rather alarming. Yu, Williams et al. (2010) forecasted that by the year 2030, the numbers of obsolete PCs in developing world at 400-700 million units will be double than that of the developed regions at 200-300 million units.

Further, mobile phones in general and smartphones in particular experience a constantly growing market share in the present Indian scenario. As illustrated by Suckling and Lee (2015:1182), "mobile phone represents a unique incursion of technology into the life of consumers, providing a level of integration and interaction with a wider social and technological sphere possibly unequalled by any other technology". This persistently evolving integration of mobile phones as an integral part of consumers' day to day activities contributes to its immense growth during the last two decades. Overall, it could be affirmed that the growth of E-waste in India has the potential to continue uncontested in the coming decades. Indian EEEs market is still evolving and it is still far from saturation. Thus, with the advent of new technologies, considerable portions of older EEEs (both non-functional and functional) will become obsolete and continue to contribute to the country's emerging E-waste stream. The proposed generation of E-waste till the year 2025 is illustrated in Figure 2.1.

Figure 2.1: Generation and Forecasting of E-waste in India



Source: Premalatha, Tabassum-Abbasi et al. 2014

2.3.Management of E-waste in India and Associated Challenges

E-waste is a complex category of waste which calls for its special collection, handling and disposal attention. E-waste contains considerable portions of hazardous chemical toxicants and precious metals. While precious metal components (including gold and silver) present in E-waste provide significant incentives for recycling, hazardous chemical toxicants (mainly in the form of persistent organic pollutants and heavy metals) pose serious threats to the human health and environment if not carefully managed. Many studies carried out in Indian cities report potentially high level of pollutants from E-waste dumping sites and its recycling activities. The study by Subramanian, Kunisue et al. (2015), for instance, suggested that carcinogenic and environmentally perilous Poly Aromatic Hydrocarbons (PAHs) present in the road dust of New Delhi and Bangalore in India seems to be a serious matter of concern. This could be attributed to solid waste and E-waste dumping sites which act as prominent sources of pollution from chemical toxicants in Indian metropolis.

Up to diverse extents, several countries and regions across the globe have implemented – 1) green engineering, 2) improved collection and recycling, and 3) increased reuse – as three main approaches as endeavours towards the alleviation of growing E-waste concerns (Milovantseva and Fitzpatrick 2015). However, in the Indian context, such approaches may not be entirely purposeful and triumphant due to factors such as the current E-waste disposal practices and preferences influenced by low environmental awareness, dominance of a large informal E-waste recycling sector involving a large number of urban poor, financial concerns associated with green engineering adoption and so on.

2.3.1. Current E-Waste Disposal Practices and Preferences in India

Considering the present global scenario, it is certain that the number of electronic devices used per capita will continue to increase in the coming decades (Sepulveda, Schluep et al. 2010) and India is not an exception to this trend. Indian cities, in particular, have observed a significant growth of E-waste in the last few years due to a lucrative and

alluring consumer electronics market. The first major problem associated with E-waste management in India is its ever-increasing quantity, and second is its critically significant scientific and environment-friendly disposal practices (Wath, Vaidya et al. 2010). However, it has been observed that E-waste management practices in the country are largely rudimentary with an omnipresent lack of sincere interest among its citizens towards implementation of sustainable E-waste management initiatives. Awareness on improper disposal of E-waste and associated environmental and human health consequences is still inadequate in India which signifies an alarming trend in a country laden with intense E-waste pollution problems from domestic generation and illegal/legal import.

Having observed India's E-waste disposal practices and preferences, Sinha-Khetriwal, Kraeuchi et al. (2005) argued that although environmental concerns seem not to be as relevant in the country as many other more critically significant concerns, Indians are culturally loathe to waste. This ensures that EEEs often find second-hand and even third-hand users farther down the income chain, thus delaying the entry of E-waste into the toxic waste stream. Thus, on a positive note, in a populous country like India such practices of handing over used EEEs are encouraging from an environmental sustainability perspective. Nevertheless, it is estimated that in India, 75% of obsolete electronic items are stored due to uncertainty of how to manage them appropriately (Ramachandra and Varghese 2004).

A study carried out in the IT hub of Pune confirms large volume of obsolete EEEs stored unattended for several years at various banks, businesses, educational institutes, households and so on (Borthakur 2014). Further, India's E-waste management system encompasses some peculiar characteristics. For instance, unlike its Western counterparts, in India it is the waste collectors who pay consumers a positive price for their obsolete electrical and electronic appliances (Sinha-Khetriwal, Kraeuchi et al. 2005). A common practice of E-waste disposal in the country is either through auction or by selling it to the scrap dealers (kawariwalas) which in turn are sold to the recyclers in the informal sector (Raghupathy and Chaturvedi 2013). Such disposal behaviour encourages the growth of a large informal E-waste recycling sector in the country.

2.3.2. Dominance of the Informal E-waste Recycling Sector

Although India is second only to China in processing of E-waste (Sthiannopkao and Wong 2013), most of the E-waste recycling activities in the country are carried out in the informal or unorganized sector that have undesirable impacts on the environment and human health (Raghupathy and Chaturvedi 2013). E-waste is one of the most complicated categories of waste and its labour intensive recycling attribute makes its environmentally sound management practices expensive in countries with high labour costs (Breivik, Armitage et al. 2014). Therefore, availability of cheap labour acts as an incentive for developed countries to send their E-waste to the developing world. Marginalized populations, especially in the industrializing countries, bear the brunt of improper E-waste management practices as most E-waste recyclers here, in either the formal or informal sector, are poor and less educated as compared to the respective population average (Perkins, Drisse et al. 2014).

An estimation by the International Labour Organization suggests that, because of their small, nimble fingers that can easily dismantle discarded EEEs, children are considered ideal E-waste workers; encouraging increasing involvement of them in E-waste recycling activities (Perkins, Drisse et al. 2014). In particular, slums in urban India have become E-waste recycling hubs with substantial recycling activities regularly being carried out in those areas without appropriate health and safety measures. E-waste recycling offers a source of income for people with limited academic qualifications and economic opportunities. India has observed an entirely new business– or market–driven flourishing E-waste recycling system (Sinha-Khetriwal, Kraeuchi et al. 2005) coming about without any government intervention (Widmer, Oswald-Krapf et al. 2005). Bangalore, for instance, is fast emerging as a home to E-waste entrepreneurs and informal recyclers who are engaged in disassembling and recycling of obsolete EEEs.

According to the environmental NGO Saahas's study, Bangalore has a massive informal E-waste recycling sector comprising of 150 E-waste recyclers and 250 scrap dealers (Reddy 2015). Thus, the informal E-waste recycling sector in the city provides ample employment opportunities to a large number of people consisting mainly of urban poor migrants. It has been estimated that approximately 1000 tonnes of plastics, 350

tonnes of copper, 0.23 tonnes of mercury, 300 tonnes of lead and 43 tonnes of nickel are annually generated in Bangalore from E-waste recycling activities (Needhidasan, Samuel et al. 2014).

Further, Mandoli industrial area in Delhi has a prominent position as one of the major informal E-waste recycling sites in India. It comprises of around 60-80 mid-scale and household-sized industries engaged in recycling of printed circuit boards, cathode ray tubes (CRTs), cables, batteries etc (Pradhan and Kumar 2014). Pradhan and Kumar (2014:7915) further states, "the informal recycling operations are ongoing here about 10-12 years ago, and now, around 700-1,000 workers are engaged in whole recycling process starting from collection of E-waste to extraction and sale of metals". These informal E-waste recycling areas are sites for uncontrolled emission of potentially hazardous chemical toxicants. The study by Ha, Agusa et al. (2009), for instance, found increasing concentrations of trace elements such as copper, cadmium, zinc, tin, indium, lead, mercury and bismuth in soil from E-waste recycling sites in the city of Bangalore with the level of copper, mercury, antimony and lead exceeding the screening values proposed by US Environmental Protection Agency (USEPA).

2.4.Formal vs. Informal E-waste Recycling: A SWOT Analysis

The Strength, Weakness, Opportunity, Threat (SWOT) methodology was originally developed by the Stanford Research Institute (SRI) in the 1960s[15] and involves an analysis of the current and future situation of a particular issue. We attempted to carry out a SWOT analysis in order to identify a number of strengths, weaknesses, opportunities and threats associated with the informal and formal E-waste management sector in India (See: Table 2.3).

[15] See: http://www.isu.edu/acadaff/swot/

Table 2.3: SWOT Analysis

SWOT Analysis	Informal Sector	Formal Sector
Strengths	1. Skilled in identifying materials with potential value. 2. Well-established practice. 3. Excellent networking and wide spread collection system. 4. Toxic, yet efficient methods of recycling. 5. Employment generation. 6. Growing influx of unskilled, semi or uneducated workers. 7. Willingness of consumers to dispose their E-waste in the informal sector. 8. Unabated growth of E-waste.	1. Government support and regulation. 2. Potential for establishment of high-tech recycling facilities with increased efficiency. 3. High precision and accuracy in extraction of materials including precious metals. 4. Health and safety measures including insurances for workers. 5. Environment and Resource Friendly. 6. Unabated growth of E-waste.
Weaknesses	1. Primitive recycling methods to extract certain hazardous component from E-waste. 2. Low efficiency in extraction of metals including precious metals. 3. Severe pollution and human health problems.	1. Still in its infancy. 2. Captures only 3-5% of the total E-waste generated in India. 3. Restricted collection network. 4. Subjected to shortage of sufficient input materials due to the diversion of E- waste to informal sector.

Opportunities	1. Growing volume of E- waste. 2. Labour intensive. 3. Availability of cheap labour. 4. Traditional expertise of informal recyclers could be helpful in efficient recycling. 5. Cost-effective recycling skills. 6. Networks among informal recyclers. 7. Entrepreneurship opportunities. 8. Flexible regulation.	1. Growing volume of E- waste. 2. Entrepreneurship opportunities. 3. Government's promotional schemes to aid the sector. 4. Availability of cheap and skilled labour. 5. Modern and efficient recycling facilities to extract maximum benefits. 6. Lesser pollution and human health issues. 7. Compliance with environmental laws.

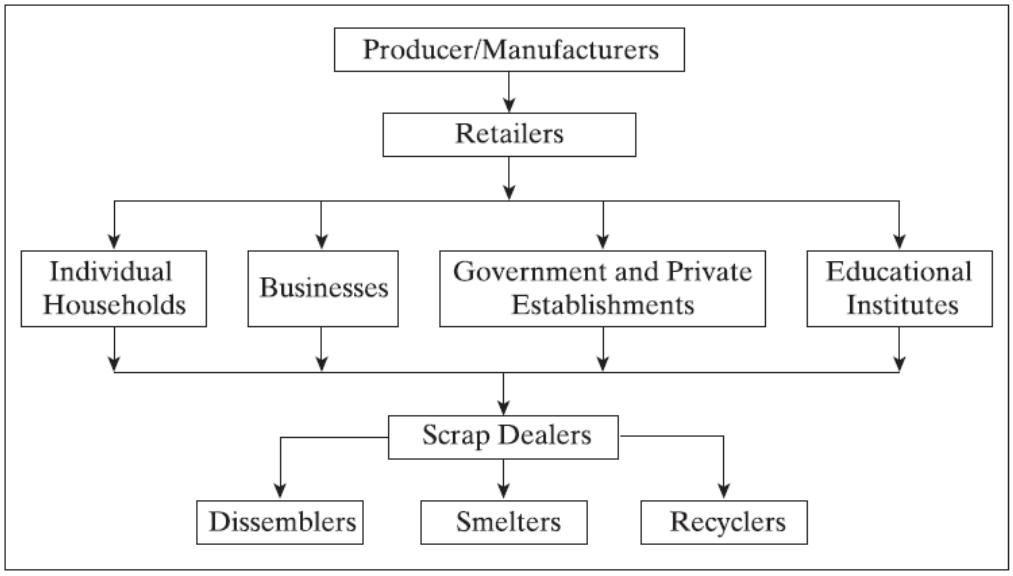
Threats	1. Uncontrolled emission of pollutants. 2. Involvement of women and children without any health and safety measures. 3. No insurance benefits to workers. 4. Control and concentration of the business by a few powerful hands. 5. Emergence of competitors in the recycling sector.	1. Cut down employment opportunities. 2. Disruption in the traditional waste management processes involving local scrap dealers or 'kawariwalas'. 3. Emergence of competitors in the recycling sector. 4. Changing composition of E-waste. 5. Strict government regulations in the form of labour laws, child labour laws, minimum wages among others.

	6. Restriction in the import of E-waste. 7. Changing composition of E-waste.	6. Rising cost related to strict compliance such as insurance benefits to workers.

2.5.Involvement of Key Stakeholders

Identification of the key stakeholders is an essential step towards addressing the E-waste apprehensions both at the local and global scale. Recognition of the stakeholders and evaluation of their E-waste generation and management potentials aid in addressing the problems associated with E-waste from its roots. Figure 2.2 shows the involvement of different stakeholders along the E-waste flow particularly in Indian context. A large proportion of E-waste is generated and subsequently managed in their own respective ways by these various stakeholders at each level of the flow. Assessing the quantities of E-waste generated and managed at each level is essential in order to formulate an E-waste inventory and policy plan in the country.

Figure 2.2: Involvement of Different Stakeholders along the E-Waste Flow in India



Source: Borthakur 2012

Our primary focus of concern in this thesis is the 'consumers' in terms of both 'individual' and 'bulk' consumers. These consumers mainly comprise of IT industries, public and private sector establishments, hospitals, research and educational institutes, households, businesses and corporate offices, etc. who are increasingly dependent on EEEs and thus they are the major contributors to the E-waste stream in the country (Borthakur 2015).

2.6.Discussion

Electronics industry, today, is one of the world's largest and fastest growing manufacturing sectors. Influenced by the enormous consumer demands, the growth of this industry is expected to continue unabated in the coming decades. Therefore, it is certain that the amount of E-waste produced both at the global and local scale will continue to observe an unprecedented growth in the near future. Complementing the global scenario, apparently, E-waste in India is anticipated to observe an exponential growth in the coming years because of the increasing infiltration of EEEs in every stratum of society. Government reports already suggest that electronics industry in India is the fastest growing segment among Indian industries in terms of both production and export. The omnipresent urge to build a digitally empowered India in the form of an 'information' or 'smart' society will further promote the EEEs surge in the country. With increasing technological innovations and attractive market strategies by the electronics giants, many EEEs are expected to become obsolete while in their functional lives.

Our experiences in some major Indian cities justify this trend. For instance, IT sector in major Indian cities such as Pune and Bangalore contributes to majority of the E-waste generated because of its particularly high desertion rate. As one of the foremost industrial sector in contemporary global environment, IT sector observes introduction of newer and modified versions of software every few months. In most of the cases, older hardware is observed to be not compatible with the new software which forces this sector to opt for new hardware at regular intervals. Such practices result in considerable portion of E-waste generated from this sector with studies illustrate that approximately 30,000 to

40,000 computers become obsolete every year from the IT industry in Bangalore alone. Moreover, considering the illegal import of E-waste into India from the developed world, in fact, significant volume of toxic E-waste finds its way to some of the poorest communities in the country where it becomes a source for uncontrolled emission of pollutants. Thus, domestic generation plus illegal import contribute to the total volume of E-waste generated in India.

Nevertheless, it has been observed that the initiatives undertaken in India to manage its E-waste, in an environment-friendly and resource-friendly manner, are still rudimentary and not able to offer satisfactory results. We have observed that E-waste management practices in India possess some peculiar characteristics which need to be considered while formulating any E-waste management strategy and associated policy initiatives in the country. For instance, E-waste is considered as 'resources' by a large group of people involved in informal recycling activities in India who are engaged in the extraction of precious metals and other valuable components from E-waste. Even the regular urban consumers of electronics consider E-waste to have some value and thus, are reluctant to dispose it off immediately. Consequently, large volumes of E-waste are observed to be stored in Indian households, banking sector, educational institutes, IT industries, business houses etc.

It could be postulated that only with some kind of financial compensations; consumers in India are willing to discard their obsolete electronics. This contributes to the growth of a large informal recycling sector in the country where, unlike several developed countries, E-waste collectors or scrap dealers (popularly known as 'Kawariwalas') pay consumers a positive price for their obsolete electronics. Especially, the presence of a large numbers of reclaimable precious metals in electronic devices has been promoting the rapid growth of E-waste recycling industries in the recent decades (Fu, Zhang et al. 2013).

2.7.Conclusions

E-waste in India has a number of economic, social, cultural, environmental and human health implications. Recycling in India, for instance, is driven by economic necessity associated with poverty which encourages a large number of urban poor people to be a part of the recycling industry. Thus, recycling of E-waste in India provides employment opportunities to unskilled or low skilled people. However, informal E-waste recycling practices involve rudimentary extraction techniques and thus, release hazardous pollutants. Accordingly, we may conclude that E-waste has multifaceted distinctiveness in the Indian context. Considering these atypical characteristics, our experience calls for E-waste management strategies in India based on its diverse socio-cultural, economic, political, ethical, health and environmental aspects.

Our experience also calls for stringent policy instruments that should be implemented in order to address and control the E-waste crisis from its roots. The e-waste (Management and Handling) Rules, 2011 (which came into effect from 1st May, 2012) was an appreciated first step in this regard. This rule, however, was implemented almost after 20 years since the IT revolution began in India during the early 1990s. Posing a great challenge, considerable portion of E-waste had already been generated by the time E-waste rules are enforced in the country. In continuance with the previous rule, the very recent E-Waste (Management) Rules, 2016 (came into force from the 1st October, 2016) is another welcoming step towards ensuring responsible management of E-waste in India.

Further, certain market-based policy initiatives have potential to instigate appropriate E-waste disposal behaviour among diverse consumers. It is essential to adequately explore policy instruments such as Advance Recycling or Disposal Fee, Deposit-Refund System, Tax Credits, Virgin Material Taxes, Pay-as-you-throw and so on for maximizing the sustainable E-waste management prospective in India (Borthakur 2016). The only challenge lies in aligning these initiatives to fit into the native characteristics of the country.

Awareness and knowledge on consequences of irresponsible disposal of E-waste on the environment and human health should be prioritized as a major management and

policy component. It is also essential to stimulate and enhance public awareness through publicity and education in order to facilitate purchase and use of products that are produced with and ultimately generate little hazardous waste (Buekens and Yang 2014). Considering its unprecedented potential for growth in the coming decades, time has arrived for ensuring sustainable and responsible disposal of E-waste among its diverse stakeholders in India. Otherwise disastrous consequences are inevitable.

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Chapter 3

Global Trends in Consumers' E-waste Disposal Behaviour and Awareness

3.1.Introduction

Electronic Waste (E-waste) or Waste Electrical and Electronic Equipments (WEEE) has become a major concern in the contemporary world. The rapid growth of E-waste is influenced by fast technological progresses and innovations, rapid changes in information and communication technologies (ICT), economic growth, electrical and electronic equipments (EEEs) becoming a major component of our day-to-day life, increasing versatility of most electronic devices, and the downward trend in prices (Yoshida, Terazono et al. 2016; Umair, Bjorklund et al. 2015; Yla-Mella, Poikela et al. 2014). For instance, about 5.6 billion mobile phones were in-use in the world as of 2012 (Schnoor 2012) with the potential for further growth in the near future. Moreover, the rapid advance in technology, consumer demand/attitudes and strong incentives for consumption bring about a drastically reduced lifespan and faster replacement rates of most EEEs, the consequence of which is the rising quantity of E-waste (Gu, Wu et al. 2016; Thavalingam and Karunasena 2016; Ozkir, Efendigil et al. 2015; Paiano, Lagioia et al. 2013; Rubin, de Castro et al. 2014).

E-waste represents 1-3% of global municipal waste production of 1636 million tonnes per year (Mallawarachchi and Karunasena 2012) with a potential to increase by 3-5% every year (Agamuthu, Kasapo et al. 2015). According to Khetriwal, Kraeuchi et al. (2009), the deficits in previous studies directly addressing policy makers' concerns makes E-waste management a difficult task. For instance, publics' awareness and their active participation are essential for the success of E-waste management initiatives. While many studies on E-waste issues have been published in the last decade, only a few of them addresses publics' E-waste disposal behaviour and awareness. There is little

understanding on how the awareness level affects the disposal behaviour and sustainable management of E-waste in a particular country or community.

In India, although local organizational consumers of ICT (in the form of 'bulk' consumers of EEEs) create the majority of E-waste (MoEF 2008), the factors determining their E-waste decisions (such as when EEEs turn into E-waste, and whether or not it is sent for recycling) are not well understood (Heeks, Subramanian et al. 2014). It is imperative to comprehend consumers' knowledge and awareness levels on their EEEs as they are the ones who eventually become the producers of E-waste in a particular commune (Kwatra, Pandey et al. 2014). Xu, Wang et al. (2014) suggest that legal advocacy, environmental knowledge, consumers' behavioural attitude, their subjective norms, perceived behavioural control and previous recycling experiences directly influence E-waste management activities in a particular city. From this perspective, it is unlikely to have a comprehensive E-waste management initiative without the contribution of 'consumers' who form an integral part of an E-waste management system.

Thus, this chapter is an attempt to look into consumers' E-waste disposal behaviour and associated awareness in a global context with special emphasis on India. We try to problematize this issue by addressing queries such as: What are the different modes of E-waste disposal practiced by the consumers of diverse countries? Do consumer's awareness level and disposal pattern differ from one country to another? Do differences exist only 'between' the developed and developing countries or variations also persist 'within' the developed or developing nations? What are the different factors that affect the consumers' behaviour towards E-waste disposal? Does awareness level among consumers shapes their disposal behaviour? What are the different ways or means consumers usually adopt to minimise the problems of E-waste? Is there any socio-cultural/gender difference in E-waste disposal behaviour? In order to answer these questions, we have analysed the available literatures on issues related E-waste disposal behaviour and awareness in different countries.

3.2.Global Trends in E-waste Research

A glimpse of the literatures published during the period between 1994 and 2014 best clarifies the reason behind our consideration of this topic. A bibliometric analysis on the trends in global E-waste Research was carried out with 'Scopus' database using different search queries. It has been observed that consumers' E-waste disposal behaviour and awareness have been an ignored area of E-waste research for a long period of time. The topic has gained research interest and momentum only recently with a number of publications coming up from diverse research groups.

A general investigation in 'Scopus' using a broad search query on 'E-waste' reports 3192 research documents published during the period of 20 years, from 1994 to 2014. It has been observed that researches on E-waste has experienced a considerable growth in the last decade with the trend appear to continue in the near future. Whereas a specific search using the query on E-waste with 'Consumer' or 'Awareness' shows 419 research papers published during the same period. The purpose of using the word 'consumer' instead of phrases such as 'consumer disposal' is to, first, have a wider range of papers so that no paper on the topic is left behind. This broad array of papers is subsequently narrowed down. Therefore, these 419 papers are further individually verified in order to check the authenticity related to our topic of concern by reading at least the abstract (and the full text whenever felt essential) of each paper.

It has been observed that although the words 'consumer' and 'awareness' appears in the title, abstract or keywords of a number of papers on E-waste, the overall issues addressed in those papers do not serve our purpose of identifying researches on consumers' E-waste disposal behaviour and awareness. After thorough investigation of the individual papers, only 52 papers are found to have satisfactorily dealt with consumers' E-waste awareness and disposal behaviour in diverse countries (See: Table 3.1 which has been undated till 2016 with 67 research publications). Thus, a relative lack of adequate research interest on the topic has been observed as compared to other E-waste issues such as recycling of E-waste, chemical analysis and pollution studies, microbiological studies, lifecycle assessment, health impact studies of E-waste constituents and so on. Such an inadequate consideration on this important aspect of E-

waste management has been a motivation for us to explore the consumers' E-waste disposal behaviour and awareness on a global scale with special focus on India.

Table 3.1: Research articles on consumers' E-waste disposal behaviour and awareness

	Reference	Aspect Addressed		Location
		Consumer Disposal Behaviour	Public Awareness	
1.	Wang, Z.et al (2016)	•		China
2.	Nowakowski, P. (2016)	•	•	Poland
3.	Islam, M.T. et al (2016)	•	•	Bangladesh
4.	Echegaray, F. (2016)		•	Brazil
5.	Botelho, A. et al (2016)	•		Portugal
6.	Sabbaghi, M. et al (2016)	•		Global
7.	Chugh, R.et al (2016)		•	India
8.	Cao, J et al (2016)		•	China
9.	Mashhadi, A.R et al (2016)	•	•	Global
10.	Thavalingam, V., Karunasena, G. (2016)	•	•	Sri Lanka
11.	Dixit, S., Badgaiyan, A.J. (2016)	•		India
12.	Ylä-Mella, J. et al (2015)	•	•	Finland
13.	Pérez-Belis, V. et al (2015)	•		Spain
14.	Dixit, S., Vaish, A. (2015)	•		India
15.	Sabbaghi, M.et al (2015)	•		China
16.	Tsamo, C (2014)	•	•	Cameroon
17.	Yu, L. et al (2014)		•	China
18.	Ylä – Mella, J. et al (2014)	•		Finland
19.	Kwatra, S. et al (2014)	•	•	India
20.	Xu, F. et al (2014)	•		China
21.	Ercan, O., Bilen, K. (2014)		•	Turkey
22.	Zhong, H. et al (2014)	•		China
23.	Massawe, E. et al (2014)	•		USA
24.	Shumon, M.R.H., Ahmed, S.(2013)	•		Malaysia

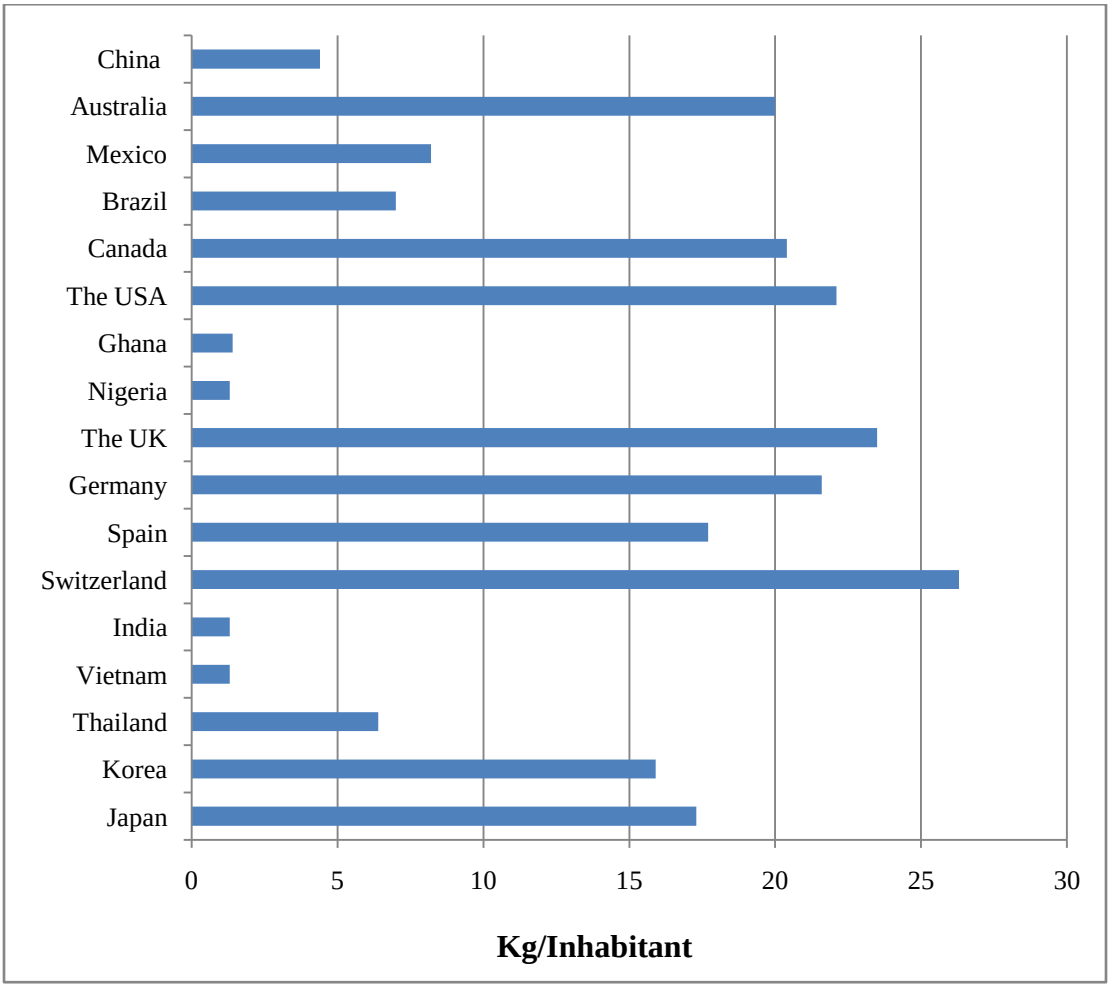
25.	Cruz-Sotelo, S.E.et al (2013)	•		Mexico and Spain
26.	Edumadze, J.K.E.et al (2013)	•	•	Ghana
27.	Tocho, J.A., Waema, T.M. (2013)	•	•	Kenya
28.	Chibunna, J.B. et al (2013)	•	•	Malaysia
29.	Dixit, S., Vaish, A. (2013)	•		India
30.	Ciocoiu, N. et al. (2013)	•		Romania
31.	Kaushal, R.K., Nema, A.K. (2013)	•		India
32.	Milovantseva, N., Saphores, J.D. (2013)	•		USA
33.	Dwivedy, M., Mittal, R.K. (2013)	•	•	India
34.	Anuj, M.et al (2013)	•		India
35.	Afroz, R. et al (2013)	•	•	Malaysia
36.	Ho, S.T. et al (2013)	•		Malaysia
37.	Hanafi, J.et al (2013)	•		Indonesia
38.	Achillas, C. et al (2012)		•	Greece
39.	Subramanian, L.et al (2012)	•		India
40.	Li, J. et al (2012)	•		China
41.	Lee, H.M. , Sundin, E, (2012)		•	Sweden
42.	Song, Q.et al (2012)	•		Macau
43.	Dindarian, A. et al (2012)	•		UK
44.	Agarwal, G. et al (2012)	•		India
45.	Rode, S. (2012)	•		India
46.	Fraige, F.Y. et al (2012)	•	•	Jordan
47.	Chen, L.F., Yee, H.W. (2011)		•	Malaysia
48.	Hanafi, J. et al (2011)	•		Indonesia
49.	Koloseni, D., Shimba, F. (2011)	•		Tanzania
50.	Gutiérrez, E. et al (2011)	•		Spain
51.	Ciocoiu, C.N. et al (2011)	•		Romania
52.	Lozano, S. et al (2010)	•		Spain
53.	Jang, Y.C., Kim, M. (2010)	•		Korea
54.	Ansari, N.L. et al (2010)	•	•	Bangladesh
55.	Gutiérrez, E. et al (2010)	•		Spain
56.	Kahhat, R.F., Williams,	•		Peru

	E.D. (2010)			
57.	Davis, G., Herat, S. (2010)		•	Australia
58.	Nnorom, I.C. et al (2009)	•	•	Nigeria
59.	Kunacheva, C.et al (2009)		•	Thailand
60.	Davis, G., Wolski, M. (2009)	•		Australia
61.	Tanskanen, P., Butler, E. (2007)	•		Finland and US
62.	Abeliotis, K. et al (2006)		•	Greece
63.	Papaoikonomou, A. et al (2006)		•	Greece
64.	Huang, P. et al (2006)	•	•	China
65.	Peralta, G.L., Fontanos, P.M. (2006)	•		Philippines
66.	Cairns, C.N. (2005)	•		USA
67.	Darby, L., Obara, L.(2005)	•	•	UK

3.3. Consumers' E-waste *Disposal Behaviour and Awareness*: Evidences from Some Countries

It is essential to identify consumers' E-waste disposal behaviour in a particular country in order to spot relevant weaknesses existing in the system which facilitates in designing management solutions and awareness-raising campaigns (Perez-Belis, Bovea et al. 2015). Most European or North American consumers who recycle believe that they are reversing or at least mitigating environmental degradation by recycling their goods (Dauvergne and LeBaron 2013). However, with financial profits playing a major part, incentives for participating in recycling activities in developing economies like India and China are entirely different from that of developed countries. Thus, scenarios vary across countries and it is essential to assess consumers' disposal behaviour and awareness in individual countries in order to address the global E-waste crisis adequately and effectively. Figure 3.1 illustrates the domestic E-waste generation of the different countries that we have considered for this review purpose.

Figure 3.1: Domestic E-waste Generation in Different Countries in the Year 2014



Source: Baldé, Wang et al. 2014

3.3.1. The Asian Context

3.3.1.1.China

A preferable disposal habit among the Chinese consumers is to sell their obsolete electronic appliances due to the 'norms of viewing these products as tradable properties and the prosperity of second-hand markets' (Chi, Wang et al. 2014:91). The study by Li, Liu et al. (2012) on the behaviours of urban residents towards discarding E-waste in households in Baoding, China reveals that most often E-waste is sold to the hawkers omnipresent in the area from where these obsolete electronics are directed into the

secondhand marketplace to be refurbished, and eventually resold. This is a common practice in the whole country (Chi, Wang et al. 2014) with collection and recovery enterprises its key actors (Mo, Wen et al. 2009). Accounting for 52% of total disposals, 'malfunction' is observed to be the major reason for discarding of EEEs.

Unlike European and North American countries where products once discarded are considered 'waste' having no value, 'waste' is considered very valuable in China. Consequently a large informal and formal waste processing market exists in the country with aims to 'capture any value that is present in what people and companies throw away' (Veenstra, Wang et al. 2010:451). A general reluctance exist among Chinese consumers to pay for disposal services and waste recycling or for extra consumer responsibility, particularly when consumers can be financially benefitted by selling their out-of-use EEEs (Hicks, Dietmar et al. 2005).

3.3.1.2.Japan

The legal situation in Japan on E-waste is analogous to the conditions in the European Union to a certain extent (Zoeteman, Krikke et al. 2010). From the year 2001, policymakers in Japan propagated a comprehensive array of laws, rules and regulations to convert E-waste into resources (Oguchi, Kameya et al. 2008; Kirby and Lora-Wainwright 2015). The Home Appliance Recycling Law (2001), for instance, allows consumers to return their obsolete EEEs to manufacturers for recycling (Oguchi, Sakanakura et al. 2012). E-waste is largely collected by retailer shops from the consumers and subsequently transported to selected stockyards. In other cases, consumers directly get their E-waste to the designated stockyards or to the municipalities close-by, where, municipalities are accountable for the transportation of E-waste to the stockyards (Menikpura, Santo et al. 2014). All these initiatives result in Japan being only second to the EU in absolute volumes of E-waste recycled, achieving a 70% recovery of households' E-waste generation (Zoeteman, Krikke et al. 2010).

Nevertheless, one of the major reasons behind half of the out-of-use home appliances in Japan being exported as secondhand items was observed to be the fact that the

consumers are obliged to pay the recycling and transportation costs when they discard their obsolete electronics. Consumers can avoid paying the recycling and transportation expenses if they sell their obsolete home appliances to exporters (Shinkuma and Huong 2009). Such recyclable resource's outflow can weaken Japan's domestic system for recycling (Sugimura and Murakami 2016).

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3.3.1.3.Korea

Consumers in Korea are responsible for the collection fee of their E-waste and have two options: (1) paying no collection fee if the consumer decides to buy a new replacement product, in this case the retailers, producers or suppliers collect the E-waste (Jang 2010), or (2) paying a collection fee to the local government collection system (Kahhat, Kim et al. 2008). Some municipalities or local governments initiated the collection of E-waste from households at designated areas or curb side collection containers or door-to-door free of charge (Kim, Jang et al. 2013). On a weekly basis, local E-waste transporters, contracted and authorised by the local governments, collect E-waste and dispatch it either to private E-waste recycling facilities, off-site treatment facilities, producer recycling centres, or local reuse centres.

There are approximately 60 E-waste storage centers across the country established by several importers and manufacturers of consumer EEEs (Jang 2010). Nevertheless, some obsolete electronics are often viewed as potentially valuable resources by residents in Korea and thus, many of them are stored at the household level. An estimated 28 million obsolete and used mobile phones were kept stored in Korean households as of the end of 2006 (Jang 2010).

3.3.1.4.Thailand

Complementing a major characteristic of emerging economies in Asia, in Thailand too, more than half of the households simply keep stored their end-of-life EEEs at home in the absence of a proper collection mechanism. 11% of the population dispose of E-

waste together with other waste and 35% perform some sorts of source-separation wherein unused EEEs are sold, given away, or traded in (Manomaivibool and Vassanadumrongdee 2011). The primary reason for many Thais keeping their obsolete electronics in storage is their perception of its remaining value (Manomaivibool and Vassanadumrongdee 2012). 'Donation' is a significant channel for disposal of obsolete items which complements the Buddhist concept of good deeds and thus, largely practiced across the country (Manomaivibool and Vassanadumrongdee 2011).

3.3.1.5.Vietnam

Nguyen, Yamasue et al. (2009) observed that owing to the difficult past of the country as a war-torn nation, people in Vietnam traditionally keep their E-waste (which they consider valuable) at home. As a consequence, there is a delay in obsolete EEEs entering the E-waste stream and the amount of waste generated has always been quite small. In Vietnam, the producers have responsibility only for the E-waste from the production line but not for the appliances discarded by consumers. In the country, apart from a few announcements or declarations, presently no laws, rules and regulations exist to exclusively deal with E-waste (Pariatamby and Victor 2013), contributing largely to the success of the informal handling system.

3.3.2. The European Context

3.3.2.1.Switzerland

Switzerland is the earliest country in the world to establish a formal management system for E-waste and today, is a leading country in E-waste collection (Duygan and Meylan 2015). The pioneering Swiss E-waste management system is based on the principles of EPR—both operationally and legally (Sinha-Khetriwal, Kraeuchi et al. 2005), placing the financial and physical responsibilities for the eco-friendly E-waste recycling, treatment and disposal processes on EEE manufacturers and exporters (Wath, Vaidya et al. 2010). The fundamental reason for the success of E-waste management initiatives in the country has been its responsible, environmentally conscious and law

abiding consumers who return their discarded appliances to the designated retail-outlets or collection points or directly transport E-waste to the recyclers at regular intervals.

Further, SENS and SWICO (as the two Producer Responsibility Organizations in Switzerland), are the core of Swiss E-waste take-back system (Hischier, Wager et al. 2005) with over 90% of the E-waste from private consumers is collected and treated under the control of one of these two take back schemes (Savi, Kasser et al. 2013). Financed by an Advanced Recycling Fee (ARF) that the consumers pay while purchasing their EEEs, comprehensive take-back and recycling systems have been established by both SENS and SWICO (Hischier, Wager et al. 2005). ARF is more of a consumer rather than a shareholder sponsored system, where a buyer is considerably keener on paying a small cost at the time of purchase of a product than paying for the discarding of an item that is worthless (Khetriwal, Kraeuchi et al. 2009).

3.3.2.2.Spain

Prior to the implementation of European Directive on WEEE (2003), 75% of large household electronic appliances in Spain were collected by retailers when consumers purchased a new model. The remaining 25% went to collection points or entered municipality take-back system and were subsequently transferred to the metal managers (Queiruga, Benito et al. 2012). A study by Perez-Belis, Bovea et al. (2015) finds out that 67.1% of consumers dispose of their electrical and electronic toys alongside other waste portions in their domestic wastebins. Only 32.9% discard them at designated recycling points as per the WEEE Directive. Thus, light-weight and small EEEs are taken to selected collection outlets, transferred to metal managers or often just discarded at municipal solid waste containers and subsequently landfilled.

As of 2010, Spain has a E-waste collection rate of only 3.3 kg/inhabitant/year, a figure that is way behind those of its European counterparts such as Norway (28.1 kg/ inhabitant/year) or Switzerland (16.6 kg/ inhabitant/year) (Perez-Belis, Bovea et al. 2013). In Spain, Royal Decree (RD) 208/2005 on E-waste management transformed the European Directive into a national legislation (on February 25, 2005), thereby conveying

that for all new EEEs, the producers are required to establish and finance individual or collective waste management systems to ensure that all products on the market were collected and recycled appropriately, without added cost to consumers (Queiruga, Benito et al. 2012).

3.3.2.3.Germany

In Germany, taking the obsolete electronics to designated collection locations is considered a household's statutory duty (Manomaivibool and Vassanadumrongdee 2012). Else, the consumers have to pay in order to get their E-waste collected (Sthiannopkao and Wong 2013). Nevertheless, Dimitrakakis, Janz et al. (2009) argues that the E-waste collection system in Germany is yet to be entirely successful in convincing consumers to handover their used EEEs through dedicated routes meant for addressing the E-waste crisis in the country. This often brings the whole E-waste collection schemes into question. For instance, in spite of the obligation for separate collection and sorting, analyses reveal that E-waste (especially small obsolete electronics) compose from 0.4% w/w up to 1.5% w/w of the household residual waste stream. In Germany, the EAR project (Elektro-Altgera¨te Register Projektgesellschaft b.R.) acts as a E-waste clearing house between municipalities and producers, warranting monitoring and compliances so that producers accomplish their compulsions under the German Elektro Gera¨te Act (Widmer, Oswald-Krapf et al. 2005).

3.3.2.4.The United Kingdom (UK)

Working on consumers' behaviour in the UK, Dindarian, Gibson et al. (2012) question the widely-held belief that E-waste is caused by a desire for the latest technology or innovation. Most of the consumers in Sharston and Manchester, for instance, expressed their willingness to purchase products with the same functionality once they dispose their faulty electronics. Many discarded EEEs are either in perfect working condition or have only minor defects. Nevertheless, those disposing their still

operational products are willing to purchase updated products. Consumers are observed to have little knowledge of disposal routes for E-waste other than public recycling facilities. The EU's WEEE Directive (2003) was transposed into a UK law, 'WEEE Regulations 2006'. After the execution of this law, EPR regime has been stringently implemented in the country. For instance, under this regulation, the seller (irrespective of the product being sold directly or by internet, mail order or telephone) must provide a way for their customers to dispose of their old household EEEs when the seller sell them a new version of the same item.

3.3.3. The African Context

3.3.3.1.Nigeria

In Nigeria, there is no well-established collection, separation, storage, transportation, recycling, disposal facilities and appropriate E-waste management program at present (Alabi and Bakare 2011). E-waste handling system in the country is largely informal. Residents are found to be willing to support and pay for sound E-waste management in Okigwe and Isuikwuato towns (Nnorom, Ohakwe et al. 2009). Consumers with higher income are observed to be more likely to participate voluntarily in E-waste recycling programs (Van Beukering and van den Bergh 2006).

3.3.3.2.Ghana

In Ghana, consumers dispose of their E-waste through informal scrap collectors. E-waste collectors (mostly youth) execute door-to-door collections from different consumers such as private homes, institutions etc. Previously the collectors did not have to pay anything for obsolete EEEs which have changed with increasing competition fuelled by increasing youth unemployment and the entrance of collectors with more potential. As a result, today, the waste has begun to attract a competitive price with primary observations suggesting that a collector has to pay $1-2.5 for an obsolete desktop computer (Oteng-Ababio 2012). Further, at Agbogbloshie in Accra (a globally infamous E-waste dumping site) heaps of inoperative old EEEs are continually being dumped

without any consideration to the environmental hazards and threats to the people living in the vicinity (Asante, Adu-Kumi et al. 2011). In a survey, Ghanaian participants displayed same level of awareness of the adverse environmental and health impacts of the current E-waste management practices in Agbogbloshie (Greater Accra), Koforidua (Eastern) and Kwadaso (Ashanti) irrespective of age, occupation or level of education attained (Agyei-Mensah and Oteng-Ababio 2012). Edumadze, Tenkorang et al. (2013) observed that male students are more environmentally aware than their female compatriot in Ghana.

3.3.4. The North American Context

3.3.4.1.The United States

In the US, E-waste generated at the household is considered, legally, a non-hazardous waste with its management remains largely a municipal responsibility and a state affair (Wagner 2009). Storage remains the preferred method to manage end-of- life household electronics in the country, followed by disposal with only a small portion recycled (Lepawsky 2012). More than 70% of obsolete consumer electronic devices are kept in storage on an average for 3-5 years (Kang and Schoenung 2005). The financial accountability for management of E-waste is entrusted to the consumers, rather than to the producers (Lepawsky 2012). As a consequence, 'extended consumer responsibility (ECR)' is endorsed instead of EPR. The US Environmental Protection Agency's data shows that about 80% of US consumers are willing to pay a fee of less than $5 for recycling of obsolete electronics (Kang and Schoenung 2006).

California (as the first state in the country to pass E-waste laws in 2003) requires a fee paid directly by the consumer in order to treat their obsolete electronics (Li 2011). In an attempt to overturn this situation of allotting financial responsibility to consumers, Maine in 2004 became the first state in the US to adopt a household E-waste law with a producer responsibility provision by adopting a modified EPR approach. Maine's program is based on a shared responsibility in which all three primary stakeholders—the

producer, the generator (the households or other consumers), and the municipality—share the E-waste management (primarily transportation and recycling) costs (Wagner 2009).

Although the U.S. consumers are offered a significant number of options to manage their E-waste, the approaches are not consistent with respect to the E-waste types accepted or by location (Townsend 2011). For instance, computers and cell phones are often accepted at multiple drop-off locations, whereas, power tools, fans, and vacuum cleaners may have much fewer, if any, drop-off locations. The significance of 'convenience' and 'familiarity' with recycling are important factors determining consumers' behaviour in the country. People living in more than 5 miles distances away from the closest collection/drop-off center are less likely to recycle. 'Familiarity' with recycling paper, glass, plastics, or metal boosts the willingness to recycle E-waste (Saphores, Nixon et al. 2006). Further, the gaps in regional and national policies puzzle the EEE producers and consumers and prolong potential detrimental environmental and human health impacts of hazardous E-waste management.

3.3.4.2.Canada

In Canada, both 'product stewardship' programs and ECR (Lepawsky 2012) are used for E-waste management. ECR allocates financial responsibly of E-waste management mainly to its consumer citizens. Legislated environmental fees and/or public funds are generally utilized as a funding-base under a product stewardship program and it usually don't assign producers the financial responsibility (ECCC 2013). Electronics Product Stewardship Canada (EPSC) had established this product stewardship programs in eight Canadian provinces— Quebec, Nova Scotia, PEI, British Columbia, Saskatchewan, Ontario, Manitoba, and Newfoundland and Labrador—in association with the Retail Council of Canada (RCC). Further, Alberta has an Electronics Recycling Administrative Policy under which an Advanced Disposal Surcharge (ADS) is collected on eligible EEEs sold to consumers. Each provincial program in Canada, excluding Ontario's (which let producers decide if such fees are hidden or visible), necessitates a system of consumer–citizens paying a visible fee to finance the E-waste recovery plans (Lepawsky 2012).

3.3.5. The Latin American Context

3.3.5.1.Brazil

Often obsolete computers with their peripherals are collected from the households, offices etc of consumer-citizens (de Oliveira, Bernardes et al. 2012). The most preferred method of E-waste disposal among Brazilian consumers in the city of Belo Horizonte-Minas Gerais was found to be 'donation' (Franco and Lange 2011). Some take back and recycling programmes are initiated by Motorola, Dell etc. In Brazil, the key complexity related to the execution of E-waste recycling practices is the collection system. It is because its efficacy depends not merely on the education plus support of the citizens, however also on collaboration amongst industrial waste producers, distributors and the local/national governments (Araujo, Magrini et al. 2012).

3.3.5.2.Mexico

In Mexico, there is no formal E-waste collection program because of the absence of legal assurances on the liability of government, manufacturers/distributors, and the general public (Garcia, Roman-Moguel et al. 2012). The immense majority of the 2443 Mexican municipalities do not have the human or economic means or legal infrastructures to tackle the urban solid waste crisis (de Oliveira, Bernardes et al. 2012), thereby making E-waste management a major challenge in the country. The study by Garcia, Roman-Moguel et al. (2012) observed that there are 125 obsolete computers stored per 1,000 houses with 99,000 obsolete computers stored in the study area of Northeast Mexico alone. The survey reported that obsolete computers have been stored for a mean of 1.8 years with a maximum of 8 years. Only 19% of the houses have disposed obsolete computers.

Further, computers deemed obsolete by bulk consumers are important assets for internet kiosks and cafes that provide internet access to consumers with limited needs. Obsolete computers are not always disposed of for economic incentives. Instead, 'donation' of computers to friends and family members is a popular end-of-use management option with 20-36% of computers is donated in the country (Estrada-Ayub

and Kahhat 2014). Some corporations donate or sell old EEEs to schools, employees and other organizations.

3.3.6. Australian Context

Australian National Television and Computer Recycling Scheme (NTCRS), a major outcome of National Product Stewardship Scheme, builds on existent recycling endeavours by local councils, charitable and other organisations to facilitate consumers (especially small businesses and householders) to drop-off their redundant computer products and televisions at certain collection locations free of charge across Australia. By 2021-2022, the NTCRS expects upto 80% enhancement in the recycling rate. There are more than 40 drop off points available in Queensland, Australian Capital Territory, Western Australia, South Australia, Victoria, and New South Wales since the NTCRS commenced in May, 2012 (ABS 2013).

In Australia, there is a recycling fee applied when consumers buy new products. Consumer can recycle their EEEs through local municipalities and private collections organized by business association to collect E-waste. EPR and ARF are the most preferred finance scheme for consumers towards funding E-waste management (Davis and Herat 2010; Davis and Herat 2008). Lack of awareness on E-waste was observed among Australian citizens (in 29 councils in Queensland) on issues about E-waste. Over 80% of the respondents from the councils indicated that they believed the public were only ‘slightly aware’ (40%) or ‘not at all aware’ (40%) of the problem (Davis and Herat 2008).

3.4.Consumers’ E-waste *Disposal Behaviour and Awareness* in India

It is approximated that 75% of obsolete EEEs in India are stored due to ambiguity about how to manage them properly (Ramachandra and Varghese 2004). A pervasive view of E-waste as a commodity causes a reluctance to dispose it off immediately (Sinha 2008). As majority of consumers prefer to store their E-waste at home rather than

returning it to the producers, it limits the successful implementation of reverse logistic approaches (Dixit and Badgaiyan 2016) or EPR module. Dwivedy, Suchde et al. (2015) argue that as consumers in India expect some kind of financial benefits while discarding their E-waste, the EPR model is prone to failure in the country. A study in the IT hub of Pune observed computer waste being stored for up to 14 years. Resulting in a longer average life, obsolete EEEs often changes many hands (frequently finds secondhand and even third-hand users) in India before finally getting disposed off (Borthakur 2014).

Nevertheless, most of the E-waste in India is disposed of either through auction (usually a route adopted by and limited to various Government establishments) or sold to the scrap dealers (kawariwalas) which in turn are sold to the recyclers in the informal sector (Raghupathy and Chaturvedi 2013). Scrap dealers or 'kawariwalas', collect E-waste from diverse individual or bulk consumers and pass them to the recyclers. In contrast to developed countries such as Switzerland, where consumers pay a recycling fee, in India it is the waste collectors or the kawariwalas who pay consumers a positive price for their obsolete EEEs (Sinha-Khetriwal, Kraeuchi et al. 2005). This acts as an incentive for consumers to dispose their obsolete electronics through informal waste collectors. Informal collection of E-waste in India leads to higher collection rates and several social and economic benefits to the poor strata of the country (Pariatamby and Victor 2013).

Regarding the awareness, considerable fraction of middleclass population of Delhi, for instance, is still unaware of E-waste. However, on receiving information they could associate the repercussions of inappropriate E-waste management practices with harmful health outcomes (Kwatra, Pandey et al. 2014). Unaware of the methods of disposal, many households and other institutes dispose their E-waste with regular household wastes in India (Borthakur 2015). A significant portion of the E-waste produced in the Mumbai Metropolitan Area is disposed off in the regular bins which call for effective E-waste awareness campaigns among manufacturers and consumers (Rode 2012).

The study by Kwatra, Pandey et al. (2014) observes the willingness of EEEs users in New Delhi to pay extra cost for appropriate E-waste management in the city with proper sharing of costs between consumers and producers. They believe that equal

responsibilities rest on the shoulders of producers, consumers and governments for effective E-waste management in the city. For instance, even if government takes initiative to construct E-waste recycling facilities, existing literatures reveal that without appropriate consumers' awareness, a recycling system never achieves its utmost efficiency (Sarath, Bonda et al. 2015). Thus, effectiveness of E-waste recycling is subjected to consumer participation, technical capacity, various national legislations etc (Li, Zeng et al. 2015). The current E-waste situation in India necessitates the constructive involvement of its various stakeholders in terms of consumers' attitude and awareness, local governance, infrastructural capacity, dominance of the informal sector and so on.

3.5.Discussion

Significant differences exist in consumers' E-waste disposal behaviour and awareness across diverse countries. Understanding these dynamic and locale specific characteristics are fundamental in improving any E-waste management initiative. Nevertheless, considering the involvement of a large number of stakeholders (in the form of manufacturers, retailers, consumers, scrap dealers, recyclers etc) in the entire E-waste management process, an appropriate analysis of consumers' disposal behaviour and associated awareness is rather exigent. Table 3.2 shows a comparative analysis of the countries considered in this chapter with respect to 1) their consideration of obsolete EEEs as 'waste' or 'valuables', 2) dominance of the 'formal; vs. 'informal' E-waste management sector and 3) presence of specific E-waste legislations in the specific country.

Table 3.2: A Comparative Analysis of the Countries Considered

Sr. No	Country	Obsolete EEEs Considered as		Dominance of Sector		Presence of Specific E-waste Legislation	
		'Waste'	'Valuables'	Formal	Informal	Yes	No
1.	China		✓		✓	✓	
2.	Japan	✓		✓		✓	
3.	Korea		✓	✓		✓	
4.	Thailand		✓		✓		✓
5.	Vietnam		✓		✓		✓
6.	India		✓		✓	✓	
7.	Switzerland	✓		✓		✓	
8.	Spain	✓		✓		✓	
9.	Germany	✓		✓		✓	
10.	UK	✓		✓		✓	
11.	Nigeria		✓		✓		✓
12.	Ghana		✓		✓		✓
13.	USA	✓		✓		✓	
14.	Canada	✓		✓		✓	
15.	Brazil		✓	✓		✓	
16.	Mexico		✓		✓		✓
17.	Australia	✓		✓		✓	

3.5.1. Waste vs. Valuables

Unlike developed countries, where products once discarded are considered 'waste' having no intrinsic value, 'waste' is considered valuable in developing countries. People in India, for instance, are reluctant to discard their obsolete electronics immediately without any financial incentive as E-waste is still considered a worthy commodity. Here electronic products often find different users before finally getting disposed off. It could be viewed on a positive light from environmental and health risk prospective as it delays the entry of E-waste into the toxic waste stream and contributes to waste minimization.

The door-to-door scrap collection, where consumers are paid a decent price for their obsolete electronics, is a common practice in India. This leads to the growth of a large informal sector in the country where 95% of E-waste generated is taken care of

(Chatterjee 2012). On the contrary, considering their population size, the per capita E-waste generation is large in developed countries as compared to its developing counterparts (See: Figure 3.1). It says a lot about the disposable approach or culture of the people in some throwaway societies. Thus, the E-waste is observed differently in different countries, which in turn, are instrumental in shaping consumers' disposal behaviour.

3.5.2. Financing the E-waste Management Initiatives: The Payment Models

Not only between the developed and developing countries alone, variations concerning E-waste management initiatives are ubiquitous within the developed countries or within the developing countries as well. One such variation involves the allocation of responsibility to finance E-waste management programmes. Currently, there are two main financial models adopted for E-waste management around the world: 'consumers pay' and 'manufacturers/producers pay' (Chi, Wang et al. 2014). EPR is widely practiced in developed countries such as Japan, Korea and EU member countries. However, ECR is extensively exercised in another set of developed countries such as the US and Canada where legislations around E-waste place financial responsibility for waste management chiefly on consumers and not on producers. Nevertheless, these two models have the potential to overlap with each other.

In Switzerland, for instance, ARF is charged on all new appliances in order to finance the collection and recycling of E-waste. Therefore, although the Swiss system of E-waste management largely depends on EPR, consumers still pay the ARF. Further research in this area needs to be undertaken in order to establish or delineate these two payment models. Contrary to these two models, scrap dealers or 'kawariwalas' largely pay consumers a positive price for their obsolete electronics in countries such as India and China. This acts as an incentive to the consumers' to sell their discarded electronics to the scrap dealers and earn some financial profit. Such diversities in financing E-waste management initiatives by respective countries depict an interesting picture and calls for

adequate addressing by the research community to identify appropriate policy for different countries.

3.5.3. The Omnipresent Ambivalence

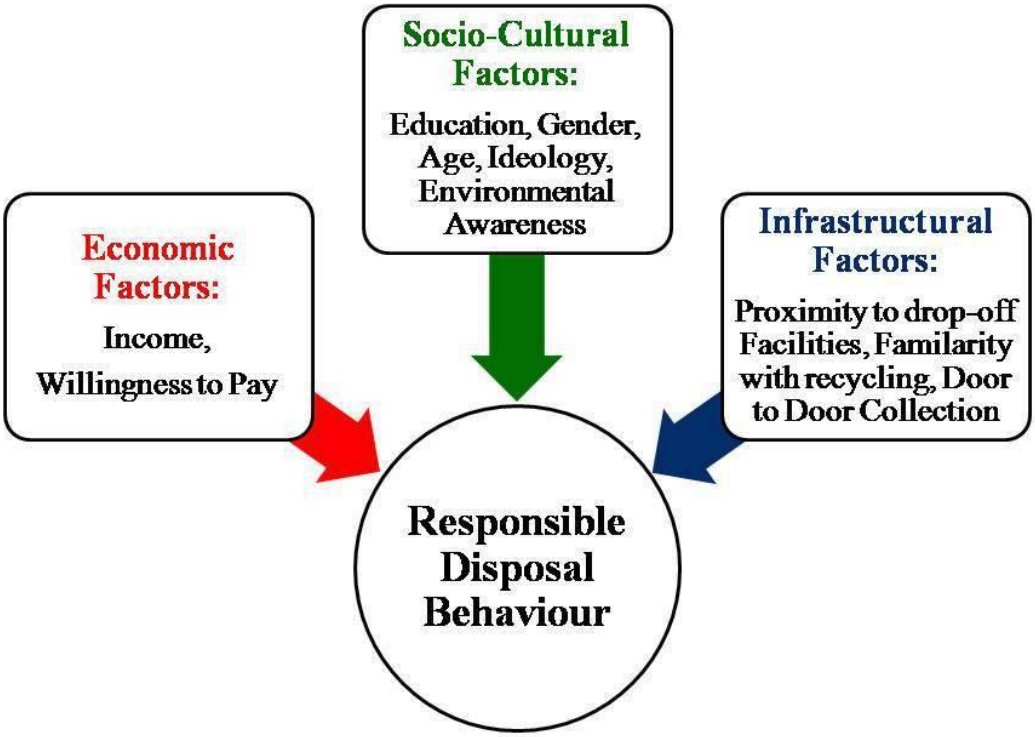
Our analysis shows an omnipresent ambivalence towards sustainable management of E-waste across the globe. For instance, it is estimated that 70-75% of obsolete electronic items are stored in countries like the US and India due to uncertainty of how to manage them appropriately. Mexico and India record E-waste being stored up to 8 years and 14 years respectively. The study by Ylä-Mella, Keiski et al. (2015) reveals that high consumer awareness in Finland on E-waste is yet to be translated into responsible recycling behaviour with 55% of respondents have two or more unused mobile phones at homes. Thus, perplexity on E-waste disposal is not confined to the developing nations alone and ubiquitous across countries. In such scenarios, effective implementation of E-waste management policies remains highly uncertain and challenging.

3.5.4. Factors Influencing E-Waste Disposal Behaviour and Awareness

One of the primary reasons behind the inadequate collection responses of E-waste by local governments is the lack of public awareness about the significance of proper E-waste disposal. The recycling attitudes of consumers are influenced by socio-cultural-economic conditions, having appropriate knowledge, facilities and opportunities to recycle. For instance, Switzerland is considered a model for successful implementation of EPR regime and a sustainable E-waste management case. Despite undertaking similar initiatives, Spain records that 67.1% of its consumers dispose of their electrical and electronic toys together with other waste portions in domestic wastebins. In Spain, the per capita collection rate of E-waste is also far lower than its several European counterparts. Thus, consumers' awareness and access/opportunity to recycle determine their recycling behaviour (Baxter and Gram-Hanssen 2016), which in turn, can be a challenging endeavour considering the time/efforts required and consumers' often prevalent out-of-

sight-out-of-mind attitude (Mozo-Reyes, Jambeck et al. 2016). While some developing countries are engaged in extracting maximum financial benefits from their obsolete electronics, consumers in Thailand, Brazil and Mexico prefer 'donation' is a preferable mean to dispose their E-waste. Thus, consumers' behaviour is dynamic across countries and influenced by factors such as ideology of consumers, familiarity/convenience of recycling activities, age, gender, income and education among others. Figure 3.2 shows various economic, socio-cultural and infrastructural factors accountable for responsible E-waste disposal behaviour.

Figure 3.2: Factors Affecting Consumers' E-waste Disposal Behaviour



High educational level emerges to be currently the most significant factor in raising the potential of a household's willingness to pay for E-waste treatment in Baoding, China. Nigerian experience indicates that consumers with higher income are more likely

to participate voluntarily in recycling programs. However, participants displayed same level of awareness of the adverse environmental and health impacts of the current E-waste management practices in Ghana irrespective of age, occupation or level of education attained. Although a study in Ghana indicates that male students are more environmentally aware than their female colleagues, some scholars concluded no meaningful relationships between environmental attitudes and gender.

'Convenience' (mainly in terms of distance) and 'familiarity' with recycling are important factors shaping consumers' behaviour in the US. Therefore, one pertinent option to boost consumers' recycling attitude is to increase the number of E-waste collection centers at close intervals. There is an ideological aspect involved with E-waste disposal too. While most European or North American consumers believe that they are mitigating environmental degradation by engaging in recycling activities, such an attitude is predominantly absent in countries like India or China. In these developing countries financial attributions largely determine consumers' E-waste disposal attitude. This makes E-waste management initiatives especially challenging for the developing world.

3.6.Conclusions

E-waste is a complex stream of toxic waste which requires specific handling considerations. Effective and responsible management of E-waste is a global concern today. Considering the depth of the E-waste problem, this chapter was an attempt to review two key elements greatly accountable for influencing sustainable E-waste management initiatives: Consumers' E-waste 1) 'Disposal Behaviour' and 2) 'Awareness'. Taking into account the locale specific characteristics of consumers' E-waste disposal behaviour and awareness, we have attempted to perform an extensive review on the global context and identify the measures adopted by the consumers of different countries to dispose off their E-waste. The purpose was to provide a comprehensive overview on the current global E-waste scenarios.

We observe significant differences in consumers' E-waste disposal behaviour not only 'between' the developed and developing countries, but also 'within' these countries.

The chapter further especially explained the complexities in India's E-waste management system due to its multifaceted socio-economic, cultural and other associated connotations influencing consumers' disposal behaviour and awareness. We conclude that global experiences on consumers' E-waste disposal behaviour and awareness could be helpful for a particular country to devise inclusive E-waste management strategies to adequately address their current E-waste crisis. For instance, learning from the US's experience and taking advantages of Indian consumers' 'familiarity' with recycling (the country has a long history of practicing recycling of glass, paper, metal, plastics etc), establishing E-waste drop-off centres at regular intervals for better 'convenience' has the potential to ensure responsible disposal behaviour. There is also a need for effective formulation and implementation of E-waste policies in the lines of European Union member countries and China.

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Chapter 4

E-waste Disposal Behaviour and Awareness of Household Consumers in the City of Bangalore

4.1.Introduction

Solid waste, as one of the major global environmental concerns, has observed significant increases during the recent past due to factors such as rising population, booming economy, rapid urbanization, the rise in community's standards of living and so on (Song, Li et al. 2015). This already existent problem has been amplified manifolds with the emergence of Electronic waste (E-waste) – often regarded as one of the most problematic fractions of solid waste. Due to improper collection and treatment procedures, E-waste has the potential to pose serious risk to the environment and society by releasing and spreading harmful pollutants (Lu, Nakajima et al. 2012). With a growth rate of 3-5% per year and current global production of 30-50 million tonnes, it is potentially one of the biggest challenges to sustainability in the present-day world (Menikpura, Santo et al. 2014).

The alarming growth of E-waste across the globe has the potential to continue unabated due to factor such as the booming consumer electronics industry, contributing significantly to the rapid changes in the economic and social landscape (Zeng, Song et al. 2015). For instance, in little over a decade, mobile phones have changed from being a novel luxury item to a near-necessity worldwide (Wilhelm, Hutchins et al. 2015). The phenomenal advancement and growth in electronic industries has come about with increasing numbers of consumer and business electronic products per capita (which has been raised manifold in the last two decades) and a downward trend in prices of newer products (Ghosh, Ghosh et al. 2015). All these have resulted in a drastically reduced average lifetime of electronic products and further intensified the problem of E-waste management. Thus, not only confined to its present context, the rapidly increasing quantity of E-waste across the globe has serious future implications over its management and recycling (Pant 2013).

A number of issues such as the toxicity from hazardous materials, collection, recycling and recovery of useful resources etc require adequate addressing for proper E-waste management (Vadoudi, Kim et al. 2015). Considering the intensity of the global E-waste problem, it is essential to evaluate the current E-waste management scenario in India, a country laden with huge volumes of both domestically generated and illegally imported E-waste. Further, the country has its own unique characteristics with respect to its waste management practices in terms of consumers' E-waste disposal behaviours, knowledge and awareness. It should be acknowledged that no programme of E-waste management would be successful without the cooperation of the generators of E-waste, whether they are 'individual' or 'bulk' consumers. Thus, consumer's awareness about the health/environmental hazards of their discarded electrical and electronic equipments (EEEs) and their way of E-waste disposal determine the effectiveness of any E-waste management initiative.

In this chapter, we are focusing on 'household consumers' as they are one of the largest generators of E-waste in India. Yet there is no organized system to collect the E-waste from the individual consumers at the household level in the country. We had conducted a primary survey to explore the E-waste management practices in the city of Bangalore. We have chosen the city because of its position as a prominent information technology (IT) hub, business and educational hub of India. The city is one of the largest producers of E-waste in the country (MoEF 2008). We focussed on queries such as: What are the different modes of E-waste disposal practiced by the consumers in Bangalore? Do consumer's knowledge and awareness level determine or shape their disposal behaviour? What are the major factors that affect the consumers' behaviour towards E-waste disposal? Thus, we attempt to address India's E-waste crisis in an adequate detail with the support of an empirical study carried out in Bangalore and situate possible policy responses to mitigate this emerging concern.

4.2.E-waste in Bangalore

Bangalore, the capital of Karnataka State in Southern India, is the third most populous city in the country. Popularly known as the 'Silicon Valley of India', Bangalore has a preeminent position as India's leading IT employer and exporter (Ha, Agusa et al. 2009). IT is the most prominent sector of Bangalore's knowledge economy (Reddy 2015). Unlike many other Indian cities handling primarily illegally/legally imported E-waste, Bangalore handles more of domestically produced E-waste (Sthiannopkao and Wong 2013). For instance, the city has to take care of an estimated 30,000 to 40,000 obsolete computers produced every year from the IT industry alone (Needhidasan, Samuel et al. 2014). Home to more than 1200 foreign and domestic technology firms, Bangalore figures significantly in the danger list of cities faced with E-waste hazards (Pinto 2008). Further, the city stands among India's leading educational and commercial hubs.

In the recent past, the emergence of the city as the IT capital of the country encouraged a large population to migrate to the city to explore its academic and business potentials. It is because IT industries demand a well-trained labour force and credible financial institutions. Consequently, a significant and large educational and business sector (including financial institutions such as a prominent banking sector) started blooming in the city. All these sectors together with the IT sector became large users of EEEs and generators of E-waste. Today, Bangalore ranks among the top ten (placed third in the ranking) Indian cities that are repository of E-waste (MoEF 2008). By looking at the city profile of Bangalore, it could be concluded that as a rapidly emerging city with a sizable users of EEEs, it has the potential to serve as a model for evaluating the issue of E-waste in India.

4.3.Collection of Empirical Data

In order to understand the awareness level and disposal behaviour of household consumers, a semi-structured questionnaire consisting of a total number of 18 multiple-choice and open-ended questions (calling for short answers) was formulated and

distributed among 300 purposively selected respondents in the city of Bangalore. According to Afroz, Masud et al. (2013), sample sizes larger than 30 and less than 500 are appropriate for most research. Both online questionnaire survey (using the online survey portal 'Survey Monkey') and face-to-face interviews were carried out. Owing to their hectic schedule, most of the respondents preferred the mode of online web-based survey over on-site face-to-face interview. During the online method, respondents could easily answer the questionnaires by marking their options with a mouse, and clicking the submit button when they finished (Yin, Gao et al. 2014). Further, during online surveys, they can take their own time to complete the questionnaire, may be within a few hours to a few days, as per their convenience.

Among the 300 questionnaires distributed, a total number of 203 questionnaires were returned back, among which the number of effective questionnaires was 190 (as some questionnaires were incomplete and hence not considered). Thus, the general response rate of the survey was 67.66% and effective response rate of the survey was 63.33%. Questionnaires were distributed among people with a minimum qualification of a bachelor's degree or a diploma. The detail demographic profile of the respondents is provided in Table 4.1. We had further adopted informal face-to-face interview method with some of the respondents during our field trip in Bangalore. The purpose of this practice was to have a view on their experiences with EEEs purchase and E-waste disposal in person.

It had been a challenge to convince people to fill up the questionnaire in the fast paced city of Bangalore. Therefore, at first we identified the key informants and through them, we approached other individuals who participated in our study and provided relevant information. Thus, it was a kind of respondent-driven snowball sampling where we banked on the respondents at each wave to drive the next wave. Accordingly, we had made use of our personal and professional contacts, brief them about our research interest and ask them to circulate our questionnaires among their peer groups. Such ideas had certainly helped us get a response rate of over 60% among a well-occupied mass of citizens in an equally demanding city. Nevertheless, a large number of people directly

showed their disinterestedness on the topic and were not willing to cooperate during both online survey and on-site interviews.

In some instances, we opted for measures such as an informal discussion over a cup of coffee at popular outlets in the city in order to facilitate and maximize our responses. These informal discussions primarily aided in obtaining relevant information on the experiences of these individual consumers concerning EEEs purchase and E-waste disposal. In this way, we had been successful in receiving a decent number of responses. Further, field observations and secondary data from various scientific papers, newspapers, government and NGO reports were part of the whole study process.

Table 4.1: Demographic Profile of the Respondents

Criteria		Frequency	Percentage
Gender	Male	116	61.06
	Female	74	38.94
Age Group	22 to 29	68	35.78
	30 to 39	111	58.43
	40 to 49	6	3.16
	50 to 59	2	1.05
	60 to 65	3	1.58
Annual Income	Upto Rs. 2, 50, 000	16	8.42
	From 2, 50, 001 to 5, 00,000	36	18.95
	From 5, 00, 001 to 10, 00, 000	59	31.06
	Above 10, 00, 000	76	40
	Not Declared	3	1.57
Education	Graduate	87	45.78
	Post Graduate	69	36.32
	PhD and Above	31	16.33
	Diploma Holders and Others	3	1.57
Occupation	Engineer	73	38.42
	Doctor	5	2.64
	Lawyer	7	3.68
	Academicians and Researchers	34	17.89
	Other IT professionals (HR Manager etc)	48	25.27
	Others	23	12.10
Job Sector	Government	37	19.48
	Private	150	78.94
	Self Employed	3	1.58

The questionnaire was structured into five main parts: (1) ownership of EEEs; (2) obsolescence rate of EEEs; (3) disposal behaviour of E-waste; (4) awareness on E-waste; and (5) demographic information of the respondents. With respect to the questions in the questionnaire, respondents were asked to choose one or more options whenever needed in the multiple-choice questions. The first part focused on the ownership of EEEs in terms of computers (including Personal computers, Laptops, Notebook computers, and Notepad computers) and mobile phones. For a start, respondents were asked approximately how many computers (including all its varieties) and mobile phones that they have in their houses. The respondents were further asked to segregate the number into 'in-use' and 'unused' or 'out-of-use' units of the same.

Continuing with questions related to the ownership of EEEs, the respondents were directed to the second part, i.e., 'obsolescence of EEEs' and asked questions such as the tentative frequency of change/exchange of their computers and mobile phones. The third part of the questionnaire captured the patterns of households' E-waste disposal behaviours and reasons or determinants leading to such behaviour. For instance, they were asked what they usually do with the mobile phones/computers those they no longer use. In the fourth part, respondents were tested for their awareness on issues concerning E-waste, such as, potential hazards from E-waste and India's E-waste Rules. The demographic information of the respondents was listed in the fifth part of the questionnaire. This information has the potential to provide important linkages with respect to age, gender, income, education etc's influence on consumers' E-waste disposal behaviour and associated awareness.

The detailed questionnaire has been provided in the Appendix I of this dissertation.

4.4.Results and Discussion

4.4.1. Ownership of EEEs

During the years between 1993 and 2000, India has observed a growth of 604% in the ownership of personal computers (PC) as compared to the world average of 181% (Sinha-Khetriwal, Kraeuchi et al. 2005). Likewise, the number of internet users in the country has increased from 0 in 1990 to 26 per 100 people in 2015[16]. Owing to the city profile of Bangalore, it could be expected that a considerable portion of the internet users in India is based in Bangalore and mobile phones (especially smartphones) and computers are the primary means for this internet use. Accordingly, our respondents were asked about the number of in-use and obsolete (out-of-use) mobile phones and computers that they possess.

On an average, two in-use mobile phones and one in-use personal computer were reported per capita. While most of the respondents have none to one obsolete PC, the number of out-of -use mobile phones awaiting disposal stood at an average of two phones per person. A few respondents said that they have upto five mobile phones with them that they no longer use. Although the respondents expressed their willingness to responsibly dispose of these phones, they have no idea about how to do the same. Overall, the number of out-of -use mobile phones is observed to be equal to or higher than that of the number of in-use phones.

4.4.2. Time and reasons for updating/replacement/new purchase of EEEs

During the past decades, the diverse consumer and market needs have led to a rapid growth of EEE categories, subsequently resulting in a shortened lifecycle and a fast replacement of EEEs (Gu, Wu et al. 2016). As the second most populous country in the world, India has a massive market for EEEs. Indian cities, in particular, have always been major attractions for electronic giants across the globe. During our survey, a maximum 46.4% of the respondents said that they change/exchange their mobile phones every 2-3 years, while 88.8% of the respondents replace their computers every 3-4 years.

[16] See: http://data.worldbank.org/indicator/IT.NET.USER.P2

Considering the commonly adopted international criteria which calculate an average lifespan of 4 to 6 years for PCs (Yu, Williams et al. 2010; Afroz, Masud et al. 2013), our result suggests that PCs used by the households are phased out within the product lifetime. Same could be postulated for the mobile phones as mobile phone has a potential functional lifespan of approximately ten years (Paiano, Lagioia et al. 2013). Interestingly, while no respondent said that she/he replaces her/his PCs within 1-2 years, it was observed that nobody uses their mobile phones and PCs beyond 4 years. Table 4.2 shows the frequency of mobile phones and computers replacement in the study sample.

Table 4.2: Replacement time for mobile phones and PCs

Years	Mobile Phones (%)	Computers (%)
1-2	20.3	0
2-3	46.4	11.2
3-4	33.3	88.8
Above 4	0	0
Total	100	100

Regarding the major reasons for replacement of mobile phones and PCs, 68.1% of the respondents suggested that considering the cost of repair, it is wiser to purchase a new product rather than repairing the older one. Consumers nowadays rarely take their non-functional electronics to a repair shop as replacement is often easier and cheaper than repair (Rubin, de Castro et al. 2014). In Bangalore, while 53.8% of our respondents were attracted to the novel features in the latest models, only 1.1% respondents chose to purchase new EEEs influenced by their colleagues/friends who regularly buy latest models. It shows that conspicuous consumption is not a driving force for majority of the consumers in the city.

This finding is particularly significant in the context of our study sample where 40% and 31% of our respondents belong to the high and middle income group respectively and yet are not engaged in "the practice of imitating the consumption standards of those perceived to be from a higher status group with the intent to also possess that status" (Wisman 2009:91). This particular trait of Indian consumers rejects their engagement in

'conspicuous consumption' by defying their involvement in purchasing 'prestige' or 'status' goods. Nevertheless, it is important to take note of the 53.8% of our respondents who do purchase new gadgets attracted by the novel features. The rapid innovation, miniaturization and affordability associated with these electronics goods and gadgets (Zeng, Gong et al. 2016) influence such a consumer behaviour. Table 4.3 documents the major reasons for replacement/purchase of new mobile phones or computers.

Table 4.3: Major reasons for replacement/purchase of new mobile phones or computers

	Reasons	Responses (%)*
1.	The old one has become non functional	48.3
2.	The old one cannot be repaired	34
3.	Considering the cost of repair, it is wiser to buy a new one than repairing the old one	68.1
4.	The latest models have attractive novel features	53.8
5.	Carrying the latest model will increase my status in the society	2.2
6.	All my colleagues/friends are buying the latest models, so do I	1.1

*Multiple Choice Options

4.4.3. Methods of disposal

Table 4.4 reports the major E-waste disposal behaviours among the respondents. A maximum of 59.3% respondents mentioned that they keep their obsolete EEEs at home. Two previous studies correspond to such consumers' disposal behaviour in India. Ramachandra and Varghese (2004) suggested that 75% of obsolete electronic items in India are stored due to uncertainty of how to manage them appropriately. The same kind of situation prevailed even after 10 years when Borthakur (2014) reported large piles of waste EEEs stored at various banks, educational institutes and households in the city of Pune due to lack of suitable management options and consumer awareness. On an average, 2 mobile phones were stored unused per person in the study sample in Bangalore. The number of unused mobile phones was observed to be higher than the

number of in-use phones. Compared to mobile phones, the number of stored unused computers was lesser, with maximum 1 computer stored per person only at certain cases.

Table 4.4: E-waste Disposal Behaviours

	Disposal Behaviour	Response Rate (%)*
1.	I keep them stored at home	59.3
2.	I give them e.g. to my children/relatives	32.6
3.	I sell them to the scrap dealers or 'kawariwalas' at certain price	19.8
4.	I leave them at the store when buying a new one	22.1
5.	I take them to the recycling centre	9.3
6.	I dispose them with mixed waste	2.3

*Multiple Choice Options

Corresponding to a major Indian socio-cultural characteristic, 32.6% of our respondents preferred to give their obsolete EEEs to others for subsequent use. It signifies a typical Indian cultural attribute where a pervasive view of E-waste as a commodity causes a reluctance to dispose of E-waste immediately (Sinha 2008). For instance, when the respondents were asked whether they consider their obsolete electronics as 'waste' or 'valuables', 63.7% of them said that they consider their E-waste to be 'valuables'. Accordingly, obsolete EEEs often change many hands in the country before finally getting disposed off. Interestingly, 22.1% of the respondents said that they leave their obsolete EEEs at the store while purchasing a new one. Such behaviour is influenced by popular exchange or buy-back offers where consumers could purchase new EEEs at a discounted rate in exchange of their older EEEs.

Our findings complement the conclusion drawn by UNEP (2007) where it stated that instead of selling E-waste in the scrap market, the preferred practice in India is to get it exchanged from retailers while purchasing a new EEE or pass it on to relatives or friends. A modest 19.8% respondent in Bangalore said that they prefer to sell their E-waste to the scrap dealers or 'kawariwalas' at certain price. Financial incentive is a major determinant of consumers' E-waste disposal behaviour in India. As E-waste is considered a

commodity with some intrinsic value, consumers' expect some monetary return while disposing it off.

4.4.4. Willingness to Repair and Recycle

Table 4.5 shows the willingness of the respondents to repair or recycle their obsolete EEEs. It has been observed that although 80% and 85.3% of the respondents were willing to repair and recycle their obsolete EEEs respectively, 95.8% of the respondents did not have any information about the availability of any formal recycling centre in the city. Therefore, the most preferred practice for them is to store their E-waste at home. A number of IT companies have E-waste collection facilities in their company premises where their employees could leave their obsolete EEEs. Other than that, there is a complete lack of awareness about the availability of such services in the city for proper disposal of E-waste. A few respondents who work at the IT sector acknowledged that they take their E-waste to their company to dispose it off, but have no idea how their company deals with this waste thereafter. This calls for adequate transparency and awareness generation on the E-waste management policies of the IT companies and general public.

Table 4.5: Willingness to Repair and Recycle

	Yes		No		No Idea	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1.Willingness to Repair	152	80	38	20	0	0
2.Willingness to Recycle	162	85.3	25	13.3	3	1.4
3. Knowledge about Formal Recycling Centre	8	4.2	182	95.8	0	0

4.4.5. Knowledge and Awareness about E-waste

Knowledge and awareness of the consumers about both in-use and obsolete EEEs depend on a number of factors. Therefore, respondents were asked a range of questions to assess the same. For instance, they were asked if they purchase functionally equivalent products just because of the 'looks' or 'brands'. Unlike countries such as China and Malaysia, where the respondents gave higher priority to famous brands while purchasing their household EEEs (Afroz, Masud et al. 2013), a majority of 69.5% of the respondents in Bangalore said that they do not purchase products considering the brands.

Table 4.6 enlists the knowledge and awareness of the respondents on E-waste and its rules. It has been observed that majority of the respondents, accounting for 84.7%, have knowledge about E-waste and 81.6% consider E-waste to be hazardous to the human health and the environment. However, only 7.4% of the respondents have knowledge about the Indian government's E-waste (Management and Handling) Rules, 2011 which had been implemented in the country since 1st May, 2012. Considerable number of the respondents, i.e. 92.6%, is entirely ignorant about the rules that have been in place since the past several years. Realizing this gap, the new E-waste (Management) Rules, 2016 has placed greater emphasis on awareness generation and strict implementation of its various provisions.

Table 4.6: Knowledge and Awareness about E-waste

	Yes		No		Don't Know	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1.Knowledge about E-waste	161	84.7	29	15.3	0	0
2.Is E-waste considered hazardous	155	81.6	25	13.2	10	5.2
3. Knowledge about E-waste Rules, 2011	14	7.4	176	92.6	0	0

4.4.6. Relationship between Annual Income, Education, Gender, Age and E-waste Disposal Behaviour and Awareness

Table 4.7 shows the income and education-wise distribution of the respondents and their perception about E-waste. We observe that with rise in income, people considering their obsolete EEEs to carry some 'value' decrease from 81.3% to 60.4%. It signifies the financial condition of a person and its influence on his/her E-waste disposal behaviour. On the contrary, the percentage of people considering their out-of-use EEEs as 'waste' increases with the increase in annual income. While only 18.7% of the respondents in the lower income group consider their obsolete EEEs as 'waste', 39.6% of the respondents in the higher income group consider the same. It is apparent that those who consider E-waste as 'valuables' are unlikely to dispose them off immediately. As the education level of the people goes up to PhD and above, the worth of E-waste for them also increases. Such attitudes may be influenced by factors such as respondents belonging to the low or middle income group stratum of the society or they have become more environmentally sensitive towards the consumption of resources with their education.

A number of studies have correlated education with environmentally sustainable behaviour. Li, Liu et al. (2012), for instance, argued that high educational level appears to be the most significant aspect in raising the potential of a household's willingness to pay for E-waste treatment cost in Baoding, China. However, Mensah and Oteng-Ababio (2012) observed the same level of awareness on the adverse environmental and health impacts of the current E-waste management practices in Agbogbloshie (Greater Accra), Koforidua (Eastern) and Kwadaso (Ashanti) in Ghana irrespective of the respondent's level of education. Therefore, our findings in Bangalore call for further studies on the topic with a larger sample size in order to establish the relation.

Table 4.7: Perception of E-waste: 'Waste' vs. 'Valuables'

Criteria	Income Group (Annual)				Education			
	Upto Rs. 2,50000 (%)	Rs 2,50,001 to 500,000 (%)	Rs.500,001 to 10,00,000 (%)	Above 10,00,000 (%)	Bachelors (%)	Masters (%)	PhD and Above (%)	Diploma
Waste	18.7	33.4	37.3	39.6	36.9	37.6	19.4	33.4
Valuable	81.3	63.8	62.7	60.4	63.1	60.8	80.6	66.6
Don't Know	0	2.8	0	0	0	1.6	0	0

Table 4.8 shows the influence of annual income and education on awareness and knowledge about E-waste and associated issues. We observed that at 93.7%, willingness to repair their EEEs is the maximum in the low income group strata and this group is more aware of recycling centres present in the Bangalore city as compared to its higher income counterparts. The number of people with some knowledge about E-waste recycling centre in the city decreases with the increase in income level. Interestingly, nobody in the highest income group of above 10, 00,000 INR were aware of the presence of any E-waste recycling centre in Bangalore. This shows that there is an important relation between the income level and responsible E-waste disposal behaviour. A higher income level does not necessarily imply a greater environmental responsibility.

While the low income group tries to maximize the life of their EEEs because of the economic disparity and everyday struggle, the higher income groups do not give much attention to locate a recycling or repairing centre within the city because they can conveniently afford to purchase newer products at regular intervals. Irrespective of their level of education, 75-100% of the respondents had knowledge about E-waste and 82-100% of the respondents were willing to recycle their obsolete EEEs. The very low level of awareness on the e-waste (Management and Handling) Rules, 2011 even after 4 years of its implementation could considered to be a significant indication of the ineffective and erroneous information dissemination mechanism on important environmental issues in India. Nevertheless, it is noteworthy that due to the lesser number of participants in the category of 'Diploma and Others', their percentage on awareness and knowledge

parameters may look higher than the others. Most of the participants in this category fall under the low income group. Further studies with a larger sample size on this parameter could establish their behavioural responses and awareness in a better way. To conclude, we observe no significant influence of education on consumers' E-waste disposal behaviour and awareness.

Table 4.8: Annual Income and Education vs. Disposal Behaviour, Knowledge and Awareness

Criteria	Income Group (Annual)				Education			
	Upto Rs. 2,50,000 (%)	From 2,50,001 to 5,00,000 (%)	From 5,00,001 to 10,00,000 (%)	Above 10,00,000 (%)	Bachelors (%)	Masters (%)	PhD and Above (%)	Diploma and Others (%)
1.Willingness to Repair	93.7	75	79.6	81.5	80.4	73.5	90.3	66.6
2.Willingness to Recycle	87.5	83.3	81.3	89.4	82.3	86.7	96.7	100
3.Knowledge about Recycling Centre	18.7	5.5	3.3	0	2.3	4.3	6.4	33.3
4.Knowledge about E-waste	81.2	77.7	88.1	88.1	75.8	88.4	100	100
5.Knowledge about E-waste Rules, 2011	6.2	5.5	6.7	9.2	3.4	2.9	22.5	66.6

Table 4.9 shows the gender and age dimensions associated with E-waste disposal behaviour and awareness. We have observed that within our study sample, male respondents showed more willingness to repair their electronics (85.3%) than their female counterparts (71.6%). Male and female respondents score almost equal in all other parameters barring the knowledge about the E-waste rules, 2011 where female participants showed a higher level of awareness than their male counterparts. Nevertheless, the respondents showed very low level of awareness on E-waste recycling centres and E-waste Rules, 2011 irrespective of their age and gender. Considering the age

aspect, we observed that the willingness to repair and recycle their E-waste increases with increase in age. This could be attributed to a throwaway culture gradually and strongly arriving among today's urban Indian city dwellers in contrast to their elder city compatriots.

Table 4.9: Gender and Age vs. Disposal Behaviour, Knowledge and Awareness

Criteria	Gender		Age				
	Male (%)	Female (%)	22 to 29 (%)	30 to 39 (%)	40 to 49 (%)	50 to 59 (%)	60 to 65 (%)
1.Willingness to Repair	85.3	71.6	77.9	80.1	83.3	100	100
2.Willingness to Recycle	83.6	87.8	83.8	84.6	100	100	100
3.Knowledge about Recycling Centre	4.3	4.5	8.8	1.8	0	0	0
4.Knowledge about E-waste	85.3	83.7	85.2	83.7	100	100	66.6
5.Knowledge about E-waste Rules, 2011	5.1	10.8	8.8	6.3	0	0	0

4.5.Conclusions

Sustainable and responsible E-waste management in India is a mammoth task. The diverse socio-cultural, economic and environmental disparities within the country further intensify the problem of massive generation of E-waste. Therefore, it is fundamental to investigate the existing E-waste disposal behaviour and the level of awareness of the individuals at households in order to assess their willingness to improve the current E-waste management system and to devise appropriate E-waste management policies. Our study at the 'Silicon Valley of India', i.e. Bangalore, attempts to provide some useful insights from this perspective. One major characteristic of the city is that majority of the E-waste produced here is domestically generated. Thus, the city has the potential to act as

a model to address the E-waste generated inland in India and its associated management challenges.

We had observed that 59.3% of the respondents in Bangalore keep their obsolete EEEs stored due to the lack of knowledge about its management. While 80% to 85.3% of the respondents in the city were willing to repair and recycle their obsolete electronics, more than 95% of them did not have any knowledge about the presence of formal E-waste recycling facilities in the city. Similarly, although above 80% of the respondents had knowledge about the environmental and health hazards of E-waste; 92.6% of the respondents were clueless about the E-waste Rules, 2011 even after several years of its implementation. Such findings call for immediate attention of the policymakers to establish formal E-waste collection/recycling mechanisms within the city and create mass awareness campaigns about such initiatives and associated laws (e.g. the very recent E-waste (Management) Rules, 2016).

We had also observed that both computers and mobile phones in Bangalore are phased out very much within the product lifetime. Further we found more number of 'unused' mobile phones per person than the number of 'in-use' mobile phones. Considering the intensity of the E-waste generation in the city, this trend is alarming and needs urgent policy consideration. We have also noted that considerable number of our respondents prefer to deposit their older electrical/electronic devices at store while purchasing a new one, mostly under the 'Exchange Offer' schemes. This sensitivity of Indian consumers could be incentivized through the Extended Producer Responsibility (EPR) initiatives of the manufacturers. The 'Exchange Offer' schemes could be linked to the 'Take Back Schemes' to maximize the collection of E-waste from the individual household consumers.

On a positive note, Bangalore has recently taken some pioneering steps towards responsible management of its E-waste. For instance, Saahas and Environmental Synergies in Development (ENSYDE) have set up nine collection units extensively for E-

waste at nine Bangalore One[17] centres in ten wards in and around J.P. Nagar[18], a popular residential area in the city. These units have been successful in collecting over 250 kg of E-waste including mobile phones and laptops in less than a month's time. With more than ten years of experience in the waste management sector in Bangalore, Saahas and ENSYDE have further collaborated with Karnataka Postal Circle and are planning to set up three collection units at select post offices in south Bangalore. Pre-arranging pick-up meetings with resident's welfare associations and other institutions in Southern Bangalore, a mobile pick-up vehicle has been moving around in the area as well. An organized system of E-waste collection has the potential to provide sufficient input materials to the city's twenty seven Karnataka State Pollution Control Board (KSPCB) authorized and registered E-waste dismantlers/recyclers (the list of KSPCB authorized dismantlers/recyclers are provided in the Appendix IV).

Again on a constructive note, we noted that the city of Bangalore still possess some typical Indian socio-cultural characteristics such as considering E-waste as 'valuables', changing several hands before final disposal, defying 'brand' or 'looks' consciousness and so on. Considering obsolete EEEs as 'valuables' and finding its second- and third hand users farther down the income chain delay the entry of E-waste to the toxic waste stream. Such behaviour aids in both environmental protection and resource conservation. Policymakers should encourage such behaviours among the consumers for sustainable E-waste management practices in the city. Finally, we conclude that individual's responsible E-waste disposal behaviour and associated awareness are keys to any successful E-waste management initiative and thus, it is essential to address these diversities in an adequate detail.

[17] Bangalore One or B1 is an e-Governance project by The Government of Karnataka. See: https://www.bangaloreone.gov.in/public/aboutbone.aspx

[18] See: http://www.thehindu.com/news/cities/bangalore/Now-drop-off-e-waste-at-select-centres-post-offices-in-Bengaluru/article17362939.ece

Chapter 5

E-waste Management and Bulk Consumers: An Empirical Worldview

5.1.Introduction

The new millennium has observed an increasing demand and proliferation of electronic equipments, resulting in an exponential increase in the E-waste generation (Morris and Metternicht 2016). Globally, electronics is recognized as the largest, most affluent, high-technology industry with the greatest 'value adding' prospective, responsible for changing the social and economic landscape (Zeng and Li 2016). The city of Bangalore houses a number of Information Technology (IT) and Electronics Company which contribute significantly to the city's economy. Nearly all the major IT firms of the Europe and the US have set up their research & development (R&D) centers and software development facilities in Bangalore (Patibandla and Petersen 2002). The Indian government's catalytic role in establishing the first software technology park in Bangalore in 1990 has played a pivotal role in the growth of the industry in Bangalore.

The region in and around Bangalore already had a significant presence in the public sector manufacturing industries and laboratories such as telecommunications, aerospace, defence electronics etc which provided the necessary infrastructures and skill advantages for the further development of the city's IT and electronics sector (Parthasarathy and Aoyama 2006). Consequently, apart from being a base for major Indian IT services providers such as Wipro, Infosys, Tata Consultancy Services (TCS), Tech Mahindra, HCL Technologies etc, the city became a preference for a large number of multinational companies seeking to establish their offshore development centers within India.

Further the State of Karnataka could be arguably called the cradle of banking sector in India with seven leading banks in the country – Canara Bank, the State Bank of Mysore, Corporation Bank, Syndicate Bank, Karnataka Bank, Vijaya Bank and Vysya Bank – started off from the state (Sharma 2005). Among them Canara Bank, the State Bank of Mysore, Corporation Bank and Vysya Bank have their headquarters in the city of

Bangalore. The emergence of the IT sector further boosted to the growth of the city's banking sector with many international and national banks establishing their branches and offices in the city.

The city of Bangalore houses a number of premier educational institutes in the country. Apart from the presence of several management, science and technology and law institutes, the city has internationally acclaimed institutes like the Indian Institute of Management (IIM Bangalore), Indian Institute of Science (IISc), Tata Institute of Fundamental Research (TIFR-Centre for Applicable Mathematics), National Law School, The National Institute of Mental Health and Neurosciences (NIMHANS), Institute for Social and Economic Change (ISEC), International Institute of Information Technology (IIIT) etc. The presence of leading educational institutes essentially provided the necessary human resources to the IT sector during its formative years which has been continuing till date. Describing the role of the city's education sector on its development as an IT hub, Joshi (2014) states, "Bangalore was known till the '70s as the destination of public sector industries. In the '80s and '90s, it donned the role of producer of quality engineering, medical and management graduates. In the '90s, with economic liberalization and development of information technology and IT-enabled services in India, Bangalore took centre-stage and emerged as the IT destination of India"[19].

Considering the intricacy in E-waste management system in Bangalore, this chapter is an attempt to evaluate the current E-waste disposal mechanisms in three significant sectors in the city of Bangalore – 1) IT and Electronics, 2) Banking and 3) Educational Institutes. These three sectors feed each other and survival of all three is very much interconnected. Further these sectors are listed under the 'bulk consumers' in the recent E-waste (Management) Rules, 2016 and are responsible for the generation of considerable quantities of E-waste in the country.

[19] See: http://timesofindia.indiatimes.com/home/education/news/What-makes-Bangalore-an-education-hub/articleshow/35613634.cms

5.2.Bulk Consumers in the City of Bangalore

The study was carried out at three different sectors, namely 1) information technology (IT) and electronics, 2) banking sector, 3) educational institutes. All these sectors are the 'bulk consumers of EEE' in India (MoEF 2016; MoEF 2008) and hence they are the 'bulk producers of E-waste' in the country. While selecting the study samples, key representatives under each category were tried to be included. For instance, regarding the banking sector, the first five banks (see: Table 5.1) represent major public sector banks present in the city with headquarters of Canara Bank and the State Bank of Mysore situated in Bangalore. The next three represent private sector banks and the last two represent cooperative banks. The third largest IT Company in India, Wipro[20], was considered as a major representative from the IT sector. Similarly, Indian Institute of Management, Bangalore (IIM-B) was chosen as a key representative from the educational sector in the city.

Table 5.1: The Bulk Producers of E-waste Considered for the Study Purpose

A. Information Technology and Electronics	**B. Banking sector**
1. Wipro 2. A major multinational electronics giant (name withheld on request of the interviewee)	1. Canara Bank 2. The State Bank of Mysore 3. Bank of India 4. Indian Bank 5. The South Indian Bank 6. Kotak Mahindra Bank 7. HDFC Bank 8. ICICI Bank 9. Karnataka Bank 10. Apex Bank
C. Educational Institutes 1. Indian Institute of Management, Bangalore (IIM-B)	

[20] http://www.Wipro.com/documents/The-Financial-Express-change-management-a-hurdle-in-way-of-automation.pdf

5.3.Collection of Data

Both primary and secondary sources of information were evaluated in connection with our topic of concern. Semi-structured interviews were carried out with selected representatives from each sector. One basic questionnaire was prepared for the selected sectors. While collecting information, prior attention was given to the specific requirements of the sector concerned. For instance, we were aware that being high security zones, entry to the IT and electronics companies in Bangalore would be highly restricted. Therefore in this sector, prior appointments through E-mail were taken by contacting the concerned officers/staffs dealing with E-waste/sustainability issues in the company.

Although we attempted to get in touch with a number of IT companies, only a handful of them provided us access to collect information on their E-waste management practices and preferences. As our attempts to take prior appointments in the banking and educational sector resulted in no substantial success, we therefore chose to directly visit some of the representative institutes under each category. The largest branch or the head office of the respective bank was visited. Mostly we interacted with persons from the IT department in these banks and educational institutes and tried to gather purposeful information related to the procurement of electronic items and disposal policy of E-waste in their organization.

Further, we analysed the available E-waste management policies of these organizations accessible through the host websites. For instance, a few policy documents on E-waste management initiatives, such as that of Wipro's, were evaluated. The compliance of the management initiatives of these different sectors to the e-waste management (management and handling) rules, 2011 and the recent E-Waste (Management) Rules, 2016 was critically examined. It had, however, been a challenge to gather relevant and precise information from these organisations regarding their actual E-waste management practices. Nonetheless, we had collected the data from different other sources (such as policy documents, annual reports, press reports, interviews, personal observations and so on) to identify the emerging E-waste management practices followed by the bulk consumers in the city of Bangalore.

5.4.Results and Discussion

5.4.1. Current Disposal Practices and Policies at the *IT and Electronics* Sector

The result of the study reflects that today, E-waste generated in each of these sectors are increasing at a fast pace, necessitating effective implementation of responsible management strategies. For instance, IT giants such as Wipro takes up a 'Tech Refreshing' approach every 3 to 4 years, where a lot of EEEs are declared obsolete and thus, disposed off. Due to the rapid progress in the area of IT and electronics, newer and modified versions of software are introduced every few months. Mostly, older hardware is not compatible with the new software and purchase of a new device appeals more to the owner over modification of the older devices. A number of our respondents pointed out that considering the cost of modification or repair and the uncertainty involved thereafter, it is wiser to purchase a new device with a warranty period than modification or repairing.

On its customers' front, Wipro has an effective take-back programme wherein it had collected 241 tonnes of E-waste in 2010-2011 and 247 tonnes in 2012-13 with a target of 100% recycling of E-waste through prescribed methods by 2014-2015. Subsequently the total volume of E-waste collected and recycled through authorized vendors in 2014-2015 was a significant 317 tonnes[21]. This E-waste also included some non-Wipro products sold as a part of integrated IT services projects. The gradually increasing volume of E-waste collected by Wipro is a positive indication and contribution towards India's sustainable E-waste management initiative. All E-waste collected by this IT giant are recycled by authorized recyclers.

Wipro engages closely with government on E-waste policy advocacy, both through industry networks and direct contacts. For instance, Wipro was a convener of the working group of the Confederation of Indian Industry's (CII) Environment committee on E-waste whose goal was to bring producers, customers, recyclers and government together to a

[21] Wipro Sustainability Report, 2014 – 2015 available at http://wiprosustainabilityreport.com/14-15/Sustainability-Report-with-special-14-15.pdf

common platform in order to discuss improvements in the e-waste (Management and Handling) Rules 2011.

It has been observed that at institutional levels, such as in the IT and electronics sector, there are provisions to address the E-waste generated by their own facilities. For instance, Wipro's waste management strategies are centered on either (1) recycling the waste for further use or (2) arranging for safe disposal[22]. Wipro pursues rigorous waste management processes by segregating waste into various categories such as inorganic, organic, hazardous, biomedical, E-waste, packaging etc in order to operationalize its waste management strategies. These diverse categories of waste are subsequently either recycled internally in its in-house facilities or outsourced through vendors.

Wipro provides the responsibility of sustainable E-waste management to the 'Central Material Facility' of the company. The company maintains a mass-balance report where E-waste recyclers have to report back to the company about the procedures adopted to dispose of the collected obsolete EEEs. In detail reporting on the treatment and disposal mechanisms for hazardous and non-hazardous components of E-waste is a compulsory practice. The company seeks proof of the disposal procedures that the recyclers claim to have adopted and thus, cross-checks the data provided by the recyclers. Wipro even has its own recycling facility in the city of Bangalore to promote recycling of obsolete lamps. In its recycling facility, heavy metals present in waste lamps are segregated and reused. Mercury, present in the lamp, is usually distilled and then used again.

Wipro has collaborated with Electronic Light Manufacturing Association, Bangalore for responsible disposal and recycling of waste lamps. In collaboration with an Australian NGO, InfoActiv, Wipro assisted in creating a common platform for responsible E-waste management in the Electronic City Industrial area in Bangalore which hosts the majority of IT companies in the city and thus, produces considerable volume of E-waste. InfoActiv is considered a major organization with key focuses on E-waste. The platform

[22] Wipro Annual Report, 2015 – 2016 available at http://www.wipro.com/microsite/annualreport/2015-16/natural-capital.html

provided by the Wipro-InfoActiv collaboration aids in streamlining the processes for E-waste management from the bulk consumers. Wipro is currently working on an E-waste programme for the Electronics City Industrial Township Authority (ELCITA) cluster. Further Wipro continues to be a part of the sub-committee on 'Waste' in the CII National Environment Committee.

Unlike Wipro, a talk with an official of a major global electronics giant (name withheld to secure the identity of the interviewee) provided a different picture. For instance, a major concern for the electronics company is the disposal of mobile phones meant for 'trial' purposes. Average 4 to 5 trials per month are carried out in different facilities of the company which involve the use of a large amount of trial mobile phones. In order to avoid duplication by the competitors and other market-related concerns, these trial phones are safely disposed off and subsequently destroyed in bulk once testing and experimentations are completed. As per the information provided, the mobile phones (and cameras) are just taken to the landfill sites and crashed with the help of crashing machines or vehicles. This activity is carried out in direct supervision of the company's authorized persons in order to avoid any manipulation or loopholes. In most of the cases, these are high-definition mobile phones eventually attracting high prices in the market.

The person interviewed had around 70 to 80 trial mobile phones under his control. Considering the size of the company and the number of people engaged in testing activities, it could be postulated that huge quantities of waste phones are produced in different facilities of the company in different Indian cities. However, mobile phones are not the only equipment that undergoes such a procedure. It is applied to many other EEEs before eventually finding its way to the market.

On a positive note, both the companies provide their employees the facility to drop off their E-waste in specified bins situated inside the company's premises. However, a discussion with a number of employees shows that they don't have much idea regarding the whereabouts of the obsolete EEEs once those are discarded in the bins.

5.4.2. Current Disposal Practices and Policies at the *Banking and Educational* Sector

Regarding the E-waste management practices in the banking sector, popular public sector banks in Bangalore, such as the Canara Bank stated that the maximum functional life of the computers in their various branches is 5 years. A respondent at the State Bank of Mysore revealed that the dumping tendency is more in the public sector banks as compared to their private sector counterparts because of the popular negligence among citizens towards public resources in the country. Consequently, minimal efforts are being undertaken to repair the faulty parts of the EEEs and the out-of-use EEEs almost immediately find their way to the store house situated at the bank's premises. This store house acts as a large base of obsolete computers waiting the disposal procedure such as passing of tenders and auctions.

However, a premier educational institute, Indian Institute of Management, Bangalore (IIM-B), affirmed that they always try their best to repair their faulty electronics in order to maximize the lifespan. This kind of behaviour by a bulk consumer could be considered as a positive state of affair in the current E-waste management regime in the country. Nevertheless, it has been observed that electronics such as mobile phones and computers are discarded while still in their useful life. This signifies a gradually declining lifespan of EEEs at each of the sectors considered. Once discarded, all these EEEs contribute to the E-waste stream of the country.

It has been observed that 'auction' is the most preferred measure to get rid of their obsolete electronics in both the banking sector and educational institutes. For instance, there is no significant difference between E-waste disposal practices among public, private and corporate banks and all abide by the rules of auction to manage their E-waste. While passing the tenders, only E-waste recyclers authorized by the Karnataka State Pollution Control Board are called for bidding. Karnataka Bank was the only bank which showed genuine interest in providing relevant information on their E-waste disposal practices and said that they follow a strict buy-back policy. With their dealer Wipro, they have an agreement which says that Wipro should replace their older computers while the bank purchases new computers from the company. However computer peripherals such

as printers don't come under this buy-back policy. Therefore, the bank has to discard the printers through scrap dealers at certain price. IIM-B declares that it obtains certificates from the recyclers regarding eco-friendly disposal of the E-waste produced in their campus.

On a positive note, IIM-B has undertaken a number of commendable initiatives towards managing the E-waste responsibly not only in their campus, but also in the city of Bangalore. For instance, a start-up named 'Binbag' was incubated at NS Raghavan Center for Entrepreneurial Learning (NSRCEL) at IIM, Bangalore in 2014. The motto of Binbag is 'Waste is a resource – only when treated the right way; treated wrongly it is an environmental burden'. Under the leadership of founder Mr. Achitra Borgohain, the start-up currently deals with all kinds of E-waste together with paper and plastic waste. The business model of Binbag is based on three pillars – Awareness, Access and Assets (in the form of physical infrastructure or recycling facilities). The company essentially works with an aim to fill up the gap between the NGOs and recyclers.

During our conversation with Mr. Borgohain, we were informed that Binbag has aided in recycling of approximately 12 tonnes of E-waste and has provided its service to 4000 customers in the city of Bangalore as of June 2016. He further stated that 10 to 12 kg of E-waste per capita was collected from some localities in the city. Recently, the company has shifted its focus to 'bulk consumers' of EEEs and stopped picking up products from individual consumers. The start-up has already been attracting major global attention and Mr. Borgohain shared with us the experience of the company being covered in national and international media such as BBC News[23], The Hindu[24] and Business Insider. Further, he has been invited as a speaker in several global platforms including United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) in June 2016.

[23] See: http://www.bbc.com/news/business-32339196

[24] See: http://www.thehindu.com/news/cities/bangalore/startup-offers-gifts-in-exchange-for-etrash/article6473587.ece

Many branches of several public and private sector banks complained about obsolete computers and peripherals lying unattended for several years awaiting tender calls. Usually an Annual Maintenance Contract (AMC) is maintained with the dealer who looks after the computers during and after the warranty period. However, the period for which these EEEs are maintained after the warranty period is gradually decreasing because of the preferences to purchase new EEEs instead of repairing or modifying the older ones. Unlike Wipro and IIM-B, most of the banks considered for our study purpose were observed to be ignorant about the disposal procedure followed by the recycling agencies. Here, an 'Out of Sight, Out of Mind' kind of an attitude was seemed to be largely prevalent.

5.5.Conclusions

During the initial years of economic liberalization and IT revolution in India, E-waste registered a significant growth. It is particularly true for the last one decade. Today, E-waste management is a challenging task especially in major Indian cities. As a rapidly emerging city and India's largest IT hub, Bangalore is no exception. Bangalore produces considerable amount of E-waste from the IT and Electronics companies, banking sector and educational institutes present in the city. Thus, the city figures prominently in domestic generation of E-waste through its bulk E-waste producers. Moreover, with a large literate population of around 88%, the penetration of EEEs in Bangalore households could expected to be higher than that of many other Indian cities. Thus, the city is an E-waste hub of India, ranked 3rd among the E-waste generating cities in the country as per government report.

In the city of Bangalore, we had observed that the bulk consumers such as IT and electronic companies, banks and educational institutes primarily adopt two different approaches to comply with the new EPR guidelines as per the E-waste (Management) Rules, 2016. These are: (1) IT companies like Wipro adopts a 'take back system' where it is responsible for taking back the products originally produced in its various facilities from consumers; (2) Most of the banks and educational institutes take 'auction' as the

measure by calling tenders from authorized E-waste recyclers with one bank embracing an 'E-waste exchange system', or; complying through Producer Responsibility Organizations (PROs) towards responsible E-waste management in the city. Nevertheless, auction is still practiced by a number of IT companies through state pollution control board's authorized recyclers.

Nevertheless, E-waste management initiatives in the city are still inadequate and require major infrastructural and administrative considerations. For instance, most of the banks included in our study provided a disappointing picture towards their E-waste management systems. Either they are reluctant to provide any relevant information or mentioned 'auction' as the only key measure that they adopt towards disposal of their obsolete EEEs through registered recyclers. Beyond that, most of the banks are oblivious of responsible E-waste disposal mechanisms. A public sector bank representative even complained that the throwaway tendency is more in these banks because of the omnipresent lackadaisical attitude towards public properties in the country. Awaiting tender calls, large volumes of E-waste are lying redundant in several banks. The attempts to repair old EEEs are almost absent because today, consumers believe that it is wiser to purchase a new device with a warranty period rather than repairing or modifying the older EEEs. This leads to rapid obsolescence of EEEs while still in their useful lives.

The global electronics major considered for our study purpose reflects the issues concerning 'trial' mobile phones and other EEEs which are destroyed in bulks after testing. Such disposal practices call for thoughtful and innovative initiatives for sustainable E-waste management. On a positive note, leading IT Companies in India like Wipro takes up some commendable initiatives towards responsible disposal of their E-waste. The company keeps track of their obsolete EEEs not only during the disposal procedures within the company, but also after their E-waste reaches the end of the recyclers by seeking proof of the disposal procedures that the recyclers claimed to have adopted.

Similarly, IIT-B mentioned that they always try to maximize the life of their EEEs. Therefore, instead of throwing their non-functional EEEs right away, the preferred practice is to get them repaired or modified to the extent possible. Nevertheless, the

lifespan of different EEEs vary from sector to sector. On a positive note, IIT-B has incubated a start-up for initiating responsible E-waste management practices in the city and the effort, till date, has been a success with huge volume of E-waste collected and national/international recognition received.

Nonetheless, a lack of transparency was observed in all the sectors towards providing relevant information on their E-waste management practices. Due to unavailability of adequate information from a number of IT and electronics company, banks and educational institutes, it is very difficult to estimate the exact amount of E-waste generated and available for recycling. We argue that if such ambiguity persists across these bulk producers of E-waste, it is rather intricate to formulate effective E-waste management strategies and policy initiatives for the city. A transparent system across these diverse sectors with adequate infrastructural provisions and administrative control is one of the key measures to address Bangalore's E-waste apprehensions.

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Chapter 6

'Public Understandings of E-waste and Its Disposal' in India: Developing a Conceptual Framework

6.1.Introduction

Today, the electronic industry is one of the world's most important industries. From its steady growth during the past decades to creating a large number of employment opportunities, promoting technological developments and eventually fuelling an increasing generation of electronic waste (E-waste) through obsolete EEEs (Singh, Li et al. 2016), the industry asserts its significance in the present day context. Every EEE comes with its own practical lifespan and becomes obsolete after a specific period of time contributing to the E-waste stream. Further, consumers are encouraged to discard their EEEs very much within their functional lifespan due to factors such as rapid economic growth, advancements in technology, increasing demand for information and communication technologies (ICT), urbanization processes, readily accessible and economical newer designs etc (Herat 2008; Fraige, Al-khatib et al. 2012). As Echegaray (2016:191) argues, "Deliberate curtailment of product lifespan and the symbolic devaluation of devices appear especially acute in the electronics segment, thus pushing up E-waste volumes".

Product obsolescence corresponds to a major sustainability challenge. Consequently, E-waste becomes a key global challenge in terms of both environmental and resource recycling considerations (Zeng, Yang et al. 2017). Addressing the E-waste issue is of great significance in the contemporary world. On one hand, E-waste is a source of toxic elements such as lead, cadmium, mercury, chromium and polybrominated biphenyls, while also being a source of valuable metals such as iron, copper, aluminium, gold, silver among many others (Madrigal-Arias, Argumedo-Delira et al. 2015). E-waste, thus, is a rich stream of critical raw materials and it is imperative to recover those materials to achieve resource efficiency (Ongondo, Williams et al. 2015). However, this

could only be ensured through a responsible E-waste disposal mechanism by consumers of a particular country.

While many studies on E-waste issues have been published in the last decade, only a few of them addresses publics' E-waste disposal behaviour and associated awareness (Borthakur and Govind 2017). Studies on publics' understandings of E-waste and its responsible disposal practices and preferences are still a rarity in the global research scenario. Further, although E-waste associated problems in India share a lot in common with that of its counterparts in the developing world, research interest on the topic is yet to gain momentum in the country (Borthakur and Singh 2017). All these aspects call for an immediate attention from the research community towards adequate addressing and understanding of E-waste and associated issues in India. Although a number of existing studies have dealt with several E-waste related issues such as extraction of valuable materials from E-waste, its health and environmental impacts, assessment of E-waste quantities, informal recycling, consumers' knowledge and awareness, regulatory frameworks etc in diverse countries, we observed the lack of a systematic framework to analyse these various E-waste concerns.

Thus, this chapter is a journey from the review of existing literatures on a few relevant conceptual frameworks for waste management studies towards a new conceptual framework of 'public understandings of E-waste and its disposal' in India. This new conceptual framework underlying our work uses elements that stem from the ideas of the theory of planned behaviour (TPB) and conspicuous consumption. The empirical study carried out in the city of Bangalore with individual consumers at the household level has been considered to validate the relevance of the new conceptual framework. By developing this comprehensive framework, we primarily try to analyse publics' perceptions of E-waste and the determinants of their EEE purchase and E-waste disposal behaviour.

6.2.Conceptual Frameworks for Waste Management Studies

6.2.1. Theory of Planned Behaviour (TPB)

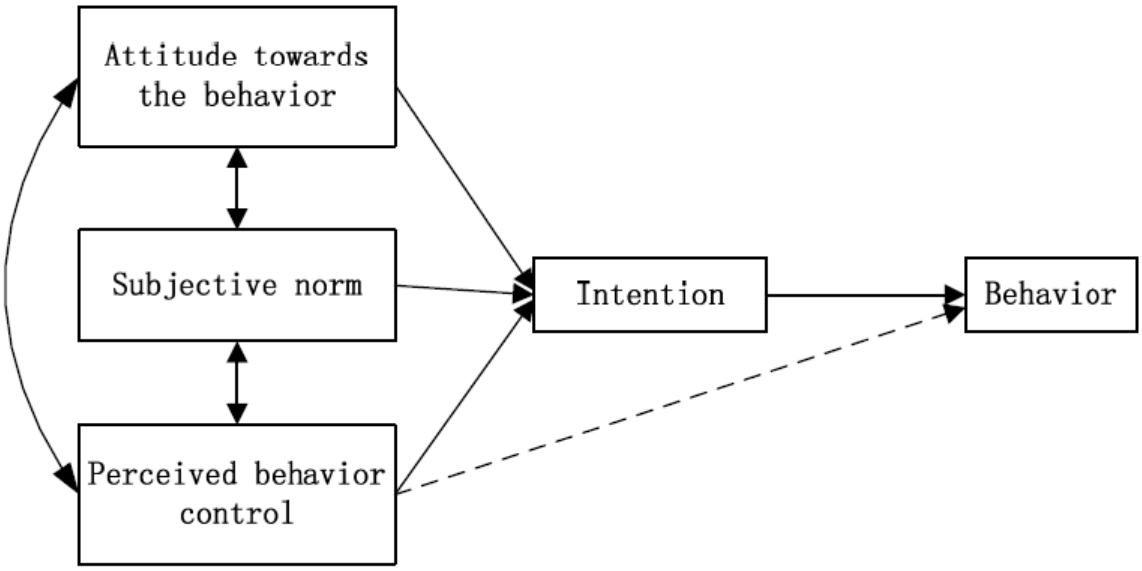
The Theory of Planned Behaviour (TPB) provides a conceptual framework for systematically identify the factors that have the potential to influence consumers' waste disposal behaviour and awareness. The TPB has intense implications for the development of sustainable waste management via adoption of sustainable practices by a community or industry (Phillips, Holley et al. 2002). It is a widely used social science and more precisely, a psychological framework for the prediction and understanding of particular behaviours in specified contexts. The TPB is a well-researched intention model that has been proved successful in predicting and explaining behaviours across a wide variety of domains (Yoon 2010). Born as the 'Theory of Reasoned Action (TRA)', it was reformulated as the 'Theory of Planned Behaviour', specifically in order to explain some of the reasons why individuals may not behave as they intend (Barber 2011).

According to TRA, one's intention to behave is the best predictor of the specific kind of behaviour. The intention is influenced by two major factors: attitudes towards the behaviour, and subjective norms or perceived social pressure (Archer, Elder et al. 2008). As stated by Ajzen (1991:188), *attitude towards the behaviour* refers to "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in the question". The more favourable is the attitude towards the behaviour in question; the more that the individual is likely to perform that certain behaviour (Yadav and Pathak 2016). *Subjective norms* refer to "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991:188).

The TPB adds to the TRA (See: Figure 6.1) by including a third variable: *perceived behavioural control*, a measure of a person's perception of his/her ability to execute the behaviour in question (Ghani, Rusli et al. 2013). In simpler words, it refers to the perceived ease or difficulty in performing a certain behaviour (Archer, Elder et al. 2008). Nevertheless, the core of the Ajzen's theory remains the same, i.e. individuals are more likely to perform the behaviours that they feel positive toward (Barber 2011). As further described by Ajzen (1991:181), "A central factor in the theory of planned behaviour is the individual's intention to perform a given behavior. Intentions are assumed to capture

the motivational factors that influence a behaviour; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behaviour".

Figure 6.1: Theory of Planned Behaviour (TPB)



Source: Ajzen 1991

Considerable support for the framework of the TPB has emerged since its inception in early 1990s. Nevertheless, a number of authors have argued that the theory does not explain individual's behaviour in adequate detail and thus, suggested the inclusion of additional variables within the model (Tonglet, Phillips et al. 2004). Addressing the 'sufficiency' of the TPB, Ajzen (1991:199) too had offered the scope of insertion of further explanatory variables, provided that these variables can be revealed to have a considerable and distinct contribution to the theory. Consequently, it has been observed that the majority of the researches utilizing the TPB as a theoretical framework, especially in the context of recycling behaviour, have attempted to integrate additional predictors (Botetzagias, Dima et al. 2015). Accordingly, we have used the idea of

'conspicuous consumption' with the TPB to substantiate our conceptual framework and have a comprehensive view of the current EEEs consumption and E-waste disposal behaviour among consumers in India in general and Bangalore in particular.

6.2.2. Conspicuous Consumption

The term 'conspicuous consumption' was originally coined by Thorstein Veblen (1899) to describe a specific kind of behaviour. A number of authors have considered Veblen's contribution as offering of a theory that could be used to explain distinctive prototypes of consumer behaviours (Campbell 1995). Over a hundred years back, Veblen observed the behaviour of rich American people and subsequently proposed that these people were engaged in spending a considerable fraction of their time and money on redundant and unproductive leisure expenses (Chaudhuri, Mazumdar et al. 2011). Accordingly, in his celebrated treatise on 'the leisure class', he argued that affluent individuals often consume highly conspicuous goods and services in order to advertise their wealth, thereby achieving greater social status (Bagwell and Bernheim 1996). Wealth confers status and respect and conspicuous consumption is a mean to display wealth (Arrow and Dasgupta 2009). In the own words of Veblen (1899:36-41):

— "[...] Conspicuous consumption of valuable goods is a means of reputability to the gentleman of leisure. [...] The basis on which good repute in any highly organized industrial community ultimately rests is pecuniary strength; and the means of showing pecuniary strength, and so of gaining or retaining a good name, are leisure and a conspicuous consumption of goods. [...] Conspicuous consumption claims a relatively larger portion of the income of the urban than of the rural population, and the claim is also more imperative. [...] It is not that the city population is by nature much more eager for the peculiar complacency that comes of a conspicuous consumption, nor has the rural population less regard for pecuniary decency. But the provocation to this line of evidence, as well as its transient effectiveness, is more decided in the city".

Attempts to flaunt one's accomplishments and social position could be considered a fundamental human instinct (Chaudhuri, Mazumdar et al. 2011). Consequently, human's capability to function in a particular societal setting is often affected by what

others think of them. The concept of conspicuous consumption attributed to Veblen, thus, refers to a consumption pattern that is intended for corresponding one's financial status to others where consumption is frequently used as a 'signal' to ascertain one's economic rank relative to others (Friehe and Mechtel 2014). Primarily, three factors are proposed to influence conspicuousness: 1) materialism, involving the significance of obtaining material possessions, 2) public self-consciousness, involving the apprehension regarding impression and appearance, and 3) self-esteem, where one is judged by his/her worthiness (Lewis and Moital 2016).

Veblen's effect is no longer restricted only to the wealthy or affluent individuals or to the industrialized countries. During the recent past, attributions of conspicuous consumption have been observed in a range of industrializing countries. For instance, the exceedingly conspicuous nature of ceremonial expenditures in terms of dowry and wedding celebrations in India and burial practices in South Africa (Linssen, van Kempen et al. 2011) indicate an increasing quest for social status. Thus, less wealthy individuals too aspire for conspicuous goods and services in order to attain a certain social status where they are looked upon differently from their contemporaries. Further in the Indian scenario, the convergence of information, communication and entertainment has brought about a new momentum in the consumer electronics industry attracting a lot of attention from its citizens. Changing life styles, growing consideration about status and esteem, higher disposable income and greater affordability are responsible for fuelling this growth in the country.

To a great extent, the rapidly emerging volume of waste generated could be attributed to such behaviours and processes. As stated by Venn (2006:45), "the tragedy of corporate capitalism is that untold misery is inflicted on millions globally as an integral part of a system for producing consumers with large disposable incomes who can then pig out on disposable goods to feed the existential need for recognition, generating even more rubbish". As a result, conspicuous consumption is today becoming more and more available to the masses which ensure individuals being judged gradually more through their lifestyles and material possessions (Lewis and Moital 2016).

It is true that conspicuous consumption acts as a driver of the market for newer and costlier products and their early disposal. Consumption and disposal behaviour, however, are also affected by other socio-economic factors. For instance, recycling behaviour as an environmentally responsible behaviour is positively influenced by knowledge about recycling, self-organization of recycling initiatives, and disagreement with rationalization for non-recycling (Hansmann, Bernasconi et al. 2006). Again, in complete contrast to the developing world, the western society is influenced by a 'use and throw' culture where the practice of repair and recycle is relatively restricted (Pandey 2015). Campbell (1995:38), as a critique of conspicuous consumption, argues, "[…] Veblen's term is often used in little more than a vague descriptive sense to refer to any nonutilitarian forms of consumption, or merely to that which is judged extravagant, luxurious, or wasteful". Further, the concept of conspicuous consumption is often discussed in the scenarios of western societies although with changing patterns of consumption, it is percolating to the developing societies as well (Pandey 2015). This calls for adequate studies on the influence of conspicuous consumption on consumers in the industrializing countries.

6.3.Research Model and Hypothesis

6.3.1. A New Conceptual Framework – 'Public Understandings of E-waste and its Disposal'

The management of E-waste in terms of consumers' disposal behaviour and awareness is both complex and multifaceted. Therefore, we attempt to devise a research model in the form of a conceptual framework through which a comprehensive essence of E-waste management challenges and opportunities in India could be figured out. Accordingly, in this thesis, a conceptual framework towards 'Public Understandings of E-waste and its disposal' in the context of India has been developed. The empirical study carried out in the city of Bangalore on consumers' E-waste disposal behaviour and awareness is used as a supporting element to test the framework. This new conceptual

framework uses elements that emerge from concepts such as the theory of planned behaviour (TPB) and conspicuous consumption.

Although a number of studies on waste management issues have utilized the TPB as a theoretical framework (for instance, studies by Echegaray and Hansstein 2017; Zhang, Huang et al. 2015; Yla-Mella, Keiski et al. 2015; Botetzagias, Dima et al. 2015; Pakpour, Zeidi et al. 2014; Ghani, Rusli et al. 2013; Tudor, Barr et al. 2007; Hansmann, Bernasconi et al. 2006; Phillips, Holley et al. 2002 etc), Veblen's concept of conspicuous consumption, though widely known and commonly invoked, has rarely been examined critically and the associated 'theory' has never been tested (Campbell 1995). In this study, our attempt is to both test and analyse the implications of conspicuous consumption and the TPB on consumers electrical and electronic equipments (EEEs) purchase and E-waste disposal behaviours respectively. Under each of these two theories, we have formulated a hypothesis and later tested them against our field experience. Thus, considering these two concepts having distinct yet interrelated linkages, we endeavour to develop the framework towards 'Public Understandings of E-waste and its disposal' in the context of India.

In this study, the problem of E-waste in India is tried to be evaluated from its roots. For that reason, it is essential to assess peoples' behaviours both in terms of consumption and disposal of EEEs. The framework of 'conspicuous consumption' has the potential to direct us evaluate an individual's EEEs consumption patterns and its subsequent outcomes as E-waste. A significant research literature on 'status' or 'prestige' goods have been initiated by Veblen's writings on conspicuous consumption (Bagwell and Bernheim 1996). Several forms of EEEs, such as the products by electronic giant 'Apple', are considered by many as integral part of 'status' or 'prestige' goods in today's Indian societal setup. As described by Lauridsen and Jorgensen (2010:488), "Contemporary electronic products are icons of modernity and relate to core issues of consumption and identity. Electronic devices such as mobile phones and flat screen TVs function as status symbols for the individual consumer. In developing countries, statistics on the number of telephones and TVs are used as indicators of the state of development".

Thus, to some consumers, especially to the urban rich, possessing the latest forms of EEEs acts a source of higher social status, pride and larger self satisfaction. Many a times, it leads to EEEs being conspicuously consumed to flaunt or maintain social status and thus, becomes a cause for throwaway culture or society. The insignificant price difference between repairing an old electronics and purchasing a new one further contributes to a throwaway culture. The TPB, on the other hand, is one of the most commonly used and influential psychological theories for explaining pro-environmental behaviours (Botetzagias, Dima et al. 2015) and widely used to investigate waste disposal and recycling behaviours (Echegaray and Hansstein 2017). It has the potential to guide us assess consumers' E-waste disposal activities as per their behavioural intention in terms of attitude, subjective norms and perceived behavioural control.

Considering the significance of the above mentioned conceptual frameworks for waste management studies and taking reference from the celebrated writings on 'Public Understanding of Science (PUS)', we propose to develop the framework of 'Public Understandings of E-waste and its Disposal' in Indian context. Nevertheless, it would have been impractical to directly execute PUS's postulates in the context of 'waste' as majority of PUS's observations are drawn from nuclear power technologies, medical research, metallurgy theory and so on (Wynne 1995). It is, thus, unrealistic for us to directly draw from PUS because of the fact that 'E-waste' cannot be called a direct 'science' or 'technology'. Instead, 'E-waste' is essentially an emerging toxic 'waste stream' in need of immediate research and policy attention. 'E-waste' results from diverse scientific and technological interventions and thus, could be called a certain kind of by-product of science and technological progressions.

Nevertheless, at the same time, we firmly believe that, as evaluating the understanding of 'science' by the public, it is equally important to assess how public perceive or understand a waste type like 'E-waste' which, in turn, shapes their disposal behaviour. Therefore, public understanding of a particular waste category has the potential to be equally significant as that of their understanding of a particular 'science' or 'technology'.

Accordingly, we have taken some hints from the writings on PUS while constructing our conceptual framework. Bauer (2009:224) explains the evolution of PUS as:

— "In the second half of the 1980s, new concerns emerge under the title 'public understanding of science'. This transition is marked by the influential report of the Royal Society of London of 1985. Like the previous literacy phase, the diagnosis is that of a public deficit. However, now attitudes to science are fore-grounded. The public does not show sufficient support for science; and this is of concern to scientific institutions. The Royal Society took the view of many of its members and assumed that better knowledge will be the driver of positive attitudes; hence the axiom: 'the more you know, the more you love it'. This research agenda moved away from knowledge to that of attitudes".

Describing PUS, Wynne (1995:361-364) writes:

— "Public understanding of science (PUS) is a wide and ill-defined area involving several different disciplinary perspectives. […] The dominant agenda of PUS research (and practice) was shaped by problematizing publics, and their cognitive processes and capabilities. […] It offers a rich repertoire of ideas about the different potential forms of constructive public engagement with science. [...] The PUS research agenda is thus confined to measuring, explaining and finding remedies for apparent shortfalls of 'correct understanding and use' (of science). [...] A proper approach to PUS has to problematize what is meant not only by 'science' but also by 'understanding'. [...] Scientific meaning cannot be taken for granted [...]".

Several of the PUS's attributions could provide substantial insights towards development of the framework for 'Public Understandings of E-waste and its Disposal'. For instance, while assessing the issues related to E-waste, it is essential to problematize 'public' and their 'understanding' of the issue in question. Drawing from Wynne (1995), for instance, it would be interesting to evaluate the E-waste related behaviours among 'attentive' versus 'general' public and their respective understanding of issues concerning E-waste in India. Attentive public are essentially "the part of the general community already interested in (and reasonably well-informed about) science and scientific activities" (Burns, O'Connor and Stocklmayer 2003: 196). In the empirical study in Bangalore, our primary focus was on the 'attentive' public who we believe to have

possessed some relevant information on our topic of concern. Accordingly, our survey involves people with a minimum of bachelor's degree or a basic diploma qualification who have some kind of exposure to the world affairs.

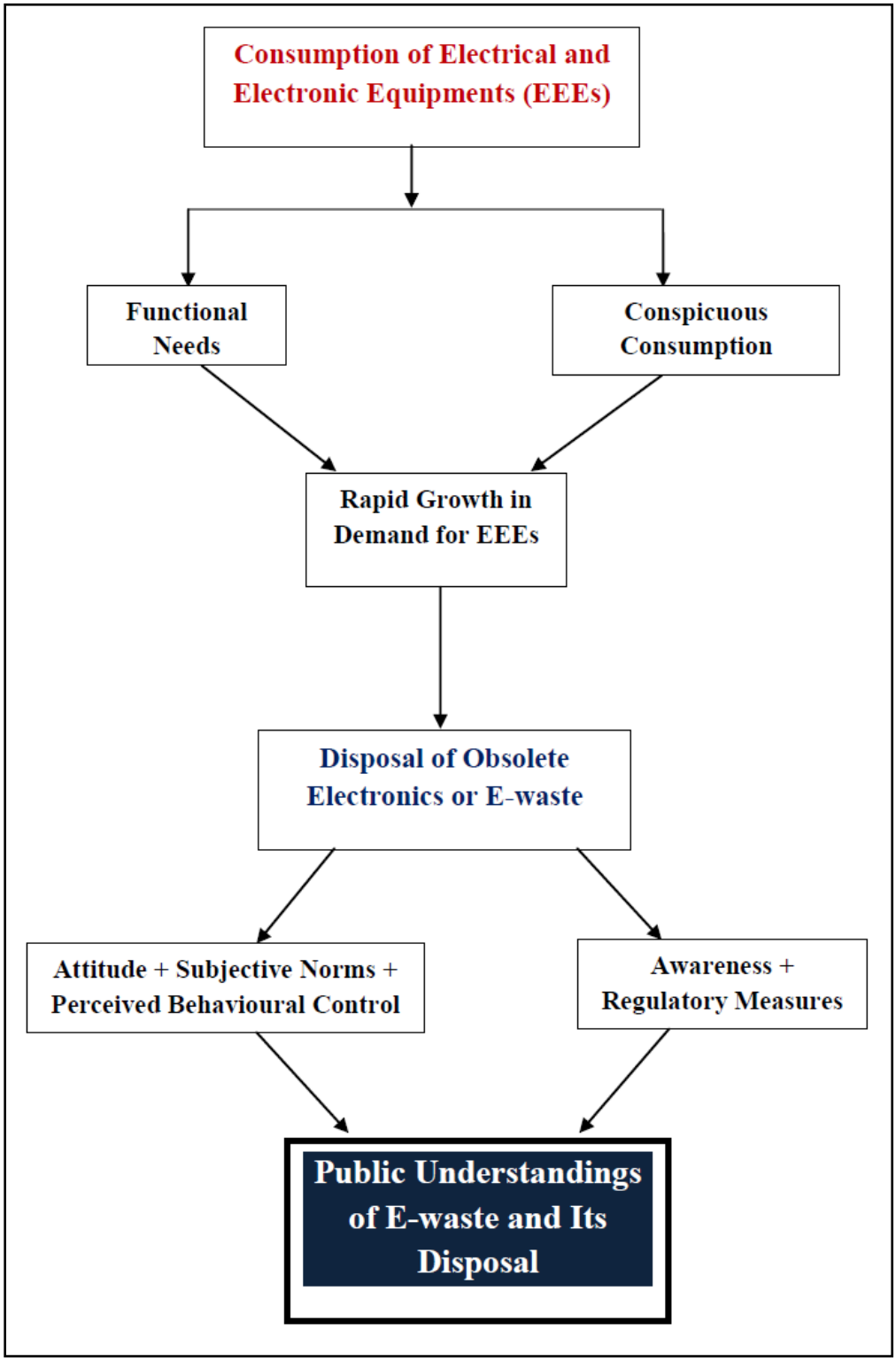
Nevertheless, drawing a distinct line between 'attentive' versus 'general' is difficult as the people we believed to be 'attentive' in general may possess no significant information on a particular issue, especially if the issue is novel (like that of E-waste) and yet to gain adequate attention from the media, research and policy community. However, by problematizing 'public' we restrict ourselves from implying that the 'knowledge' concerning E-waste is unproblematic. We acknowledge the often confusing perception of 'E-waste' (for instance, its diverse definitional frameworks across countries and territories and the diversity in the EEEs being included in these definitions) that influences publics' understandings. Accordingly, we shall try to identify the different potential forms of constructive public engagements with E-waste.

Publics' understanding of E-waste is the key to their acceptance of various policies or initiatives for sustainable management of E-waste. To achieve the required public understanding, it is necessary to translate and communicate the associated problems and its technical or non-technical solutions to the people in an understandable form. It is also essential to provide an opportunity to the interested individuals and groups to have their views on a particular issue. For instance, the authors Xu, Wang et al. (2014) argue that consumers' behavioural attitude, environmental knowledge, legal advocacy, their subjective norms, perceived behavioural control and previous recycling experiences directly influence E-waste management activities in a particular city. Consumption, disposal behaviour/culture and public awareness coupled with motives for economic development are the main factors influencing E-waste generation in any country (Lu, Zhang et al. 2015). Therefore, we attempted to devise a comprehensive conceptual framework through which the complexities associated with public' consumption of EEEs, disposal behaviour of obsolete EEEs and perception on E-waste could be adequately addressed.

While devising the new framework (See: Figure 6.2), we considered the fact that peoples' actual EEEs consumption may be influenced by two factors: 1) Functional needs

and 2) Conspicuous consumption. While conspicuous consumption has created a society which could be characterized by 'expensiveness' in terms of 'prestige' and 'status' goods, functional needs are inevitable to carry out a particular task in a specified context. Nonetheless, irrespective of the motivation for purchase and consumption, all the EEEs have a particular lifespan and become obsolete after a specific period of time. Here come the concerns associated with disposal of E-waste. The TPB assists us in determining the reasons or intentions that shape consumers' waste disposal behavioural pattern in terms of attitudes, subjective norms and perceived behavioural control. Regulatory measures of a particular country or region and awareness of the public also potentially impact E-waste disposal behaviour. Amalgamation of all these diverse considerations contributes towards a framework for 'Public Understandings of E-waste and its Disposal' particularly in the context of India.

Figure 6.2: Public Understandings of E-waste and its Disposal



6.3.2. Research Hypothesis

H1: An individual's attitude, subjective norms and perceived behavioural control have positive influences on E-waste disposal intention.

An individual's attitude towards a particular behaviour is a function of one's perception of the behaviour as positive or negative, right or wrong, pleasant or unpleasant, interesting or boring and consequences of performing the behaviour (Godfrey, Scott et al. 2012). For instance, to a significant extent, perceiving recycling to be inconvenient is negatively associated with the participation of people in recycling programmes (Hansmann, Bernasconi et al. 2006). However, we assume that in the context of our study sample, an individual's attitude has a positive influence on his/her waste disposal intention.

Subjective norms are the perceived social pressures to engage or not to engage in certain behaviours (Pakpour, Zeidi et al. 2014). Possible sources of these social factors include pressure from family, neighbours, peers, or the community (Zhang, Huang et al. 2015). We assume that these social factors have a positive influence on an individual's waste disposal intention.

Perceived behavioural control refers to an individual's past experience, availability of resources, opportunities and obstacles in performing the behaviour in question (Sarkis 2017). It reflects the perceived ease or difficulty in carrying out a specific behaviour. Several studies, however, indicate that perceived behavioural control does not have considerable effect on predicting recycling behaviour (Ari and Yilmaz 2016). We assume its influence to be positive on an individual's waste disposal intention.

H2: Consumers try to demonstrate their status to be above their counterparts and imitate the consumption standards of those they think to be at a higher status.

Wisman (2009:91) argues, "Veblenian conspicuous consumption manifests itself in two dimensions. Consumption that permits 'invidious comparison' is meant to demonstrate one's status to be above those below. 'Pecuniary emulation', on the other

hand, refers to the practice of imitating the consumption standards of those of higher status with the intent of appearing to also possess that status". One of the major signals of both is consumer's willingness to pay a higher price for a functionally equivalent good.

6.4.Survey Design and the Questionnaire

In order to establish and test the relevance of our conceptual framework, we collected data from individual consumers at the household level in the city of Bangalore (See: Chapter 4 and Appendix I for design of the survey and the questionnaire respectively). We also have interviewed a number of respondents to elicit their experiences and practices about E-waste management in detail in order to understand their motives and apprehensions related to the purchase of EEEs and disposal of E-waste.

6.5.Results and Discussion

6.5.1. Conspicuous Consumption and E-waste

In Bangalore, we observed that 53.8% our respondents are attracted towards novel features in the latest models of electronics. However, only 1.1% of the respondents purchase new EEEs influenced by their colleagues/friends who regularly buys those latest models. It is interesting to note that approximately 40% and 30% of our respondents belong to the high and middle income group respectively. Yet they are not engaged in the practice of 'imitating the consumption standards of those from higher status with the intent to also possess that status' (Wisman 2009). Although in our second hypothesis, we assumed that there is an increasing competition among Indian consumers which satisfies both the dimensions of Veblen effect i.e. invidious comparison and pecuniary emulation, the result of our study proved something different. The respondents of our study do not contest hard to either demonstrate their status above their counterparts or busy imitating the consumption standards of those they think to be at a higher status.

Again, Veblen effects are said to exist when consumers exhibit a willingness to pay a higher price for a functionally equivalent good (Bagwell and Bernheim 1996). We

assume that this tendency could be observed among Indian consumers, especially while purchasing consumer electronics like mobile phones, laptops, televisions etc in the name of certain brands. Accordingly, we asked our respondents if they purchase functionally equivalent products just because of the 'looks' or 'brands'. Within the study sample, 69.5% of our respondents in Bangalore said that they do not purchase products considering merely the 'brands' or 'looks'. Only 2.2% of the respondents believe that carrying the latest model will increase their status in the society. It is in contrast with countries such as China and Malaysia, where the respondents gave higher priority to famous brands while purchasing their household EEEs (Afroz, Masud et al. 2013), This particular trait of Indian consumers rejects their engagement in 'conspicuous consumption' by defying their involvement in purchasing 'prestige' or 'status' goods.

It has been observed that 80% of the respondents were willing to repair their older electronics. However, 68.1% of the respondents believe that considering the cost of repair, it is wiser to buy a new product than repairing the old one. Consumers nowadays rarely take their non-functional electronics to a repair shop as replacement is often easier and cheaper than repair (Rubin, de Castro et al. 2014). For instance, the respondents of the study by Islam, Abdullah et al. (2016) in Dhaka, Bangladesh consider repeated repairing of electronics to be an economic burden for them. Our study complements the study in Bangladesh and illustrates that purchasing a new product may be financially more feasible to the consumers than repair. For instance, a respondent in our study sample describes,

— "I had a Nikon Camera. After 2 years of use, it developed a crack at the place which holds the batteries. The crack is very tiny, may be, approximately 3mm * 3 mm in size. But due to this minute crack, the camera could no longer hold the batteries. I went to an authorized repairing shop by Nikon. The shop said that they would charge me INR 2600 for the repair. During the same time, some offers on electronics were going on in Amazon (the online shopping site). I checked for a camera in their site and purchased a camera for INR 3000. By spending INR 400 more, I got a new camera with a higher resolution than the previous one".

The negligible price difference between repairing an old product and purchasing a newer one could be attributed as one of the major reasons for rapid disposal of EEEs. Further the inconvenience associated with repair services dissuades consumers from repairing their obsolete products even if the consumers may favour repairing over disposal. In today's society, a gradual decline in repair activities also might have taken place due to factors such as the high cost of spare parts and labour. This expensive repair services deter consumers from refurbishing or repairing their obsolete objects (McCollough 2009), even if the consumers may perhaps favour repair over disposal (Sabbaghi, Behdad et al., 2016). Nevertheless, we observed that a few environmentally attentive citizens do not like to discard their EEEs at short intervals, but forced to do so because of functional reasons. As described by a respondent who works at the IT sector,

— "I do not want to discard my laptop or desktop after using them only for a few years. However, new and modified versions of some softwares that I regularly use are launched every few months. These softwares need significant data space and sometimes higher configuration. Many a times, the older hardwares are not compatible with the new softwares. Therefore, in order to maintain uninterrupted services, my company and I have to discard our older electronics and buy new ones. We know that this is not a good practice. It is harmful to the environment. But modifying the existing hardware may cause difficulty in the future uses. We work in groups where we need to interact with our team members and clients who are based in different parts of the world. Instructions and decisions have to be followed or taken instantly. The softwares should always be working perfect. Therefore, it is always better to purchase a new computer altogether which guarantees at least a few years of uninterrupted services. Most of the time, it is also financially gainful".

The experience of the person above conveys that he is well aware of the repercussions of frequent disposal of electronics and considers the practice to be unsustainable. However, there are concerned about uninterrupted services, economic benefits and impression of himself and his company. Therefore, he is forced to contribute to a 'throwaway culture' by regular disposal of electronics as E-waste. It has been observed that 88.8% of our respondents replace their computers (PCs) every 3-4 years. Considering the commonly adopted international criteria which calculate an average lifespan of 4 to 6

years for PCs (Yu, Williams et al. 2010; Afroz, Masud et al. 2013), our result suggest that PCs are phased out very much within the product lifetime. Mobile phones have an even shorter lifespan.

6.5.2. The TPB and E-waste

According to the TPB, individuals may form intentions to behave in one way, and not another way, but when confronted with actual situations and actual choices, they may be guided by emotions or several other things (Barber 2011). This is well evident in our study sample where 85.3% of the respondents were willing to recycle their E-waste. This means individuals hold positive attitudes towards responsible E-waste disposal intention which, ideally, should have resulted in a higher recycling rate among the citizens. However, this intention is influenced by perception of the task's actual feasibility in terms of favourable and unfavourable circumstances, perceived ease or difficulty in carrying out this specific behaviour and social pressure. For instance, raising feasibility and information dissemination concerns, 59.3% of the respondents mentioned that they keep their obsolete EEEs stored at home and 95.8% of the households have no information about the presence of any formal E-waste recycling facilities in Bangalore. The obsolete electronics are mostly stored at home because of lack of knowledge about their management (Ramachandra and Varghese 2004).

As two important aspects of an individual's perceived behavioural control, our findings signify that the lack of availability of resources and opportunities (Sarkis 2017) restricts an individual's waste disposal intention. Nevertheless, with a positive attitude towards responsible E-waste disposal intention and in the absence of available information and opportunities, *perceived behavioural control* could not be considered a key determining factor of an individual's waste disposal intention. Complementing our finding, Tonglet, Phillips et al. (2004) argue that perceived behavioural control does not emerge to be a considerable predictor of individual's recycling behaviour.

Our findings complements a study carried out in major metropolitan areas of Brazil on intention-behaviour gap in E-waste recycling as well. The Brazilian case shows that,

while great majority of the respondents embrace a positive intention towards recycling, few of them behave appropriately (Echegaray and Hansstein 2017). Although our first hypothesis too says that an individual's *attitude* has a positive influence on waste disposal intention; Bangalore fails to capitalize on it because of inadequate waste management infrastructure in the city and lacuna in dissemination of information about E-waste disposal facilities.

We further analysed the impact of s*ubjective norms* in terms of social pressures on waste disposal in our study sample. We observed that 32.6% of our respondents give their unused electronics to their children/relatives. This is a very common Indian cultural characteristic where electronics change several hands farther down the income chain before finally being disposed off as E-waste (Sinha-Khetriwal, Kraeuchi et al. 2005). Thus, subjective norms may have a positive influence on E-waste disposal intention and overall environmental sustainability.

Nevertheless 19.8% of the respondents sell their E-waste to the scrap dealers or 'kawariwalas' at certain cost. Financial gain is important for Indian consumers. It is because of the fact that electronic equipments are often considered as commodities with some inherent values even after their useful life is over. One of our respondents said,

— "Currently I have a HTC mobile phone. My son insisted me to purchase it a few months back. Previously I used a Google Nexus which I purchased for INR 28000. Now although I don't use that anymore, I don't feel like discarding it off. I inquired about its price in a secondhand market through my driver. The shopkeepers told that I shall get a maximum of INR 3000 for the mobile. The mobile is only three years old and working almost perfect. Moreover, how can you sell a phone so cheap when you originally purchased it so expensive? I don't mind laying it unused in my house. But I am not going to sell it so cheap or donating such a costly phone to someone for use".

Nevertheless, apart from monitory values, there may be 'emotional values' attached to products as well. As described by one of our respondents,

— "I know that this phone stopped working properly and I recently have purchased a new one. I also know that my older phone is a kind of 'waste' now. But I was gifted that phone by my mother who is no more with us. I

remember the occasion when she gifted me this phone. It was my 21st birthday and I had just graduated with good marks from my college. Even if I don't use the phone now, it is and will remain precious to me".

Another respondent stated,

— "I purchased one of my older phones with my first salary. It was a Nokia Lumia phone. Although I had subsequently purchased two other models (one from HTC and another from Samsung) after that, the Nokia phone remains special. I was keen on buying a smart phone ever since my B.Tech days. But, of course, as a student, it was difficult to buy one. Therefore, as soon as I started earning, it was the first gift I had given to myself. I shall never consider it to be a 'waste' even if I no longer use it".

Some of our respondents, accounting for 22.1%, said that they leave their obsolete electronics at the stores when buying a new electronic product. This could be attributed to exchange and buy back offers popular in India especially during the festive seasons (Borthakur 2014). Nevertheless, we observed that 84.7% of our respondents have knowledge about E-waste and 81.6% consider E-waste to be hazardous to human health and environment. However, more than 90% of these people do not have any knowledge about the E-waste (Management and Handing) Rules, 2011 and about the presence of recycling centres in their city. Therefore, the scope of conversation on the topic in the public domain (in terms of family, peers and neighbours) is still largely insignificant to influence their actual disposal intention. Also, it signifies that although we assumed most of our respondents to be 'attentive' public, they are largely ignorant about an emerging crisis in their society in terms of 'E-waste'.

6.5.3. Age, Gender, Education and Income's Roles on an Individual's E-waste Disposal Preferences

In the sections above, we assessed the relevance of conspicuous consumption and the TPB on consumers' EEE consumption and E-waste disposal patterns. In order to evaluate the role of age, gender, education and income on an individual's E-waste

consumption and disposal preferences, we decided to focus on two specific parameters: 1) Do individual purchase products influenced by 'brands' or 'looks' and 2) How individual perceive their obsolete electronics: 'waste' or 'valuables'. This is because examining all of the parameters in the questionnaire on the basis of gender, age, income group etc will be a tedious task and will create some confusion. Therefore, we decided to focus on two specific characteristic parameters related to the each conceptual framework and distribute it according to the respondent's age, gender and so on. While, the first parameter helps us assessing 'conspicuous consumption', the second parameter acts as an indicator towards the validity of the TPB. Thus, we attempted to delineate the diverse responses of the individuals concerned and look for any visible contradictions (See: Table 6.1 and Table 6.2).

Table 6.1 (a): Age vs. 'Brand' or 'Looks'

Age (Years)	'Brand' or 'Looks' Consciousness		
	Yes (%)	No (%)	999* (%)
22 to 29	33.8	64.8	1.4
30 to 39	28.8	71.2	0
40 to 49	16.7	83.3	0
50 to 59	0	100	0
60 to 65	33.3	66.7	0

Table 6.1 (b): Income vs. 'Brand' or 'Looks'

Income Level	'Brand' or 'Looks' Consciousness		
	Yes (%)	No (%)	999* (%)
Upto Rs. 2,50000	18.7	81.3	0
Rs 2,50,001 -500,000	19.5	77.8	2.7
Rs.500,001 - 10,00,000	33.9	66.1	0
above 10,00,000	35.5	64.5	0
999*	0	100	0

Table 6.1 (c): Gender vs. 'Brand' or 'Looks'

Gender		'Brand' or 'Looks' Consciousness		
		Yes (%)	No (%)	999* (%)
	Male	29.9	69.2	0.90
	Female	30.1	69.9	0

Table 6.1 (d): Education vs. 'Brand' or 'Looks'

Education		'Brand' or 'Looks' Consciousness		
		Yes (%)	No (%)	999* (%)
	Graduate	29.9	68.9	1.2
	Post graduate	40.5	59.5	0
	Ph.D.	9.6	90.4	0
	Diploma	0	100	0

*999 signifies no value

Table 6.2 (a): Gender vs. Obsolete EEEs as 'Waste' or 'Valuable'

Gender		Obsolete EEEs Considered as 'Waste' or 'Valuable'		
		Waste (%)	Valuable (%)	999* (%)
	Male	35	64.1	0.90
	Female	36.9	63.1	0

Table 6.2 (b): Education vs. Obsolete EEEs as 'Waste' or 'Valuable'

Criteria	**Education**			
	Bachelors (%)	Masters (%)	PhD and Above (%)	Diploma (%)
Waste	36.9	37.8	19.4	33.4
Valuable	63.1	60.8	80.6	66.6
999*	0	1.4	0	0

Table 6.2 (c): Age vs. Obsolete EEEs as 'Waste' or 'Valuable'

Age Group		Obsolete EEEs Considered as 'Waste' or 'Valuable'		
		Waste (%)	Valuable (%)	999* (%)
	20-29	39.7	58.8	1.5
	30-39	35.1	64.9	0
	40-49	16.6	83.4	0
	50-69	20	80	0

Table 6.2 (d): Income vs. Obsolete EEEs as 'Waste' or 'Valuable'

Criteria	**Income Group (Annual)**			
	Upto Rs. 2,50000 (%)	Rs 2,50,001 to 500,000 (%)	Rs.500,001 to 10,00,000 (%)	Above 10,00,000 (%)
Waste	18.7	33.4	37.3	39.6
Valuable	81.3	63.8	62.7	60.4
999*	0	2.8	0	0

*999 signifies no value

It has been observed that consciousness for 'brands' or 'looks' declines from 33.8% in the age group in 20s to 16.7% in the age group of 40s. This may be due to the fact that respondents, who are in their 20s today, were born during the beginning of the era of economic liberalization in India and thus, have been exposed to the global market from their initial formative years. Contrary to them, people in the age group of 40s were exposed at a much later age to the same global market, which may have restricted their outlook towards 'brands' or 'looks' consciousness. It illustrates that the urban youths are increasingly being attracted to newer brands and looks. We have observed that, 'brands' or 'looks' consideration increases with an increasing income level. It increases from 18.7% to 35.5% along the income group. The probability of conspicuous consumption rises with such an attitude among the high income group of people. Nevertheless, we did not find any significance difference between male and female respondents while

considering this parameter. Among the respondents, 29.9% of male and 30.1% of female showed their interests towards ‘brands’ or ‘looks’.

While approximately 30% to 40% of our respondents having bachelors and masters degree are ‘brands’ or ‘looks’ conscious, only 9.6% of the PhD degree holders are found to be mindful of the same. The impact of education on this parameter, though, remains uncertain to conclude with. For instance, no basic diploma holders, similar in the lines of the PhD holders, showed their interest in ‘brands’ or ‘looks’. A further study with a larger sample size of PhD and basic degree holders could establish this relation. It is noteworthy here that many of our respondents are engineers with B.Tech or B.E. degree holders and are employed mostly in the IT sector of the city of Bangalore. They are doing reasonably good for themselves and thus, have the tendency to opt for newer EEEs at regular intervals as young and well-earning members of the society,

Again while evaluating obsolete EEEs as ‘waste’ or ‘valuables’, we observed that 64.1% of male and 63.1% female members consider E-waste to have certain kind of ‘values’. Thus, gender has no significant influence on obsolete electronics being considered as ‘waste’ or otherwise. On the contrary, there is an increasing tendency of E-waste being considered to possess some ‘value’ with increasing age. From 58.8% in the respondents in their 20s to more than 80% in the age group above 40, there is a considerable increase in this parameter. Such findings illustrate that there is an increasingly probability of E-waste generation in the near future in the city of Bangalore if the urban youths keep on considering obsolete EEEs as complete ‘waste’.

This also signifies an alarming trend where younger population of the city might be increasingly engaged in ‘status’ or ‘prestige’ goods consumption as compared to their elderly counterparts. Income has a pivotal role in determining a product as ‘waste’ or ‘valuable’. We observed an increase in the number of people considering their obsolete electronics as ‘waste’ items with a rise in income level. While only 18.7% of the people in the income bracket upto INR 2, 50,000 considers their unused EEEs as ‘waste’, the figure increases to 39.6% with income group above INR 10, 00,000. While only 19.4% PhD holders consider their unused EEEs as ‘waste’, more than 33-38% of the bachelor, masters and diploma degree holders consider the same.

6.6.Conclusions

Publics' disposal behaviour and awareness/perception is central in any successful E-waste management initiative. This chapter was a journey from a review of existing literatures on a few relevant and widely used conceptual frameworks for waste management studies towards a new conceptual framework of 'public understandings of E-waste and its disposal' in the context of India. This new conceptual framework underlying our work uses elements that stem from the ideas of the theory of planned behaviour (TPB) and conspicuous consumption. The empirical study carried out in the city of Bangalore with individual household consumers was considered to validate the relevance of the new conceptual framework. The aim was to analyse publics' perceptions of E-waste and the determinants of their EEE purchase and E-waste disposal behaviour.

Among our respondents, 53.8% are attracted towards novel features in latest models of electronics: However, only 1.1% respondents purchase new EEEs influenced by their peers. Thus, they are not engaged in the practice of 'imitating the consumption standards of others'. Veblen's effects are said to exist when consumers exhibit a willingness to pay a higher price for a functionally equivalent good. We observed that 69.5% of our respondents in Bangalore do not purchase products merely considering the 'brands' or 'looks' and only 2.2% of the respondents believe that carrying the latest model will increase their status in the society. Thus, the empirical study corresponds that our respondents in Bangalore do not necessarily engaged in conspicuous consumption with the intention to exhibit their status to be higher than the others or imitating the consumption standards of those whom they perceive to possess a higher status than them. This is an important finding considering that approximately 40% and 30% of our respondents belong to high and middle income group respectively. Functional needs (48.3%) and cost-consideration (68.1%) primarily drive the consumers' EEEs purchase intent.

Majority of the individuals interviewed were willing to repair and recycle their old electronics. For instance, 85.3% of the respondents were willing to recycle their E-waste. This means individuals hold positive attitudes towards responsible E-waste disposal intention. However, more than 90% of our respondents do not have any knowledge about

the e-waste (Management and Handing) Rules, 2011 and about the presence of recycling centres in their city. As two important aspects of an individual's perceived behavioural control, our findings signify that the lack of availability of information and opportunities restricts an individual's waste disposal intention. Accordingly, although our first hypothesis too says that an individual's attitude has a positive influence on waste disposal intention; Bangalore fails to capitalize on it because of inadequate waste management infrastructure in the city and lacuna in dissemination of information about E-waste disposal facilities.

Again in the absence of available information and opportunities, perceived behavioural control could not be considered a key determining factor of an individual's waste disposal intention. With financial incentive still an important factor for Indian consumers, 19.8% of the respondents sell their E-waste to the scrap dealers or 'kawariwalas' at certain cost. Reflecting a common Indian cultural characteristic, 32.6% of our respondents give their unused electronics to their children/relatives. Thus, subjective norms may have positive influence on E-waste disposal intention and overall environmental sustainability. Overall, it could be concluded that the city of Bangalore with its consumers still possesses certain characteristics which could be directed towards responsible E-waste management in the city. With ample infrastructural provisions for environment and resource friendly E-waste disposal mechanism, the city could manage their E-waste sustainably. An adequate awareness among its citizens could be a key factor in realizing the full potential of such an effort.

Chapter 7

Conclusions

In this study, an attempt has been made to explain the current E-waste management dynamics in India with special emphasis on consumers' E-waste disposal behaviour and their awareness. With a growth rate of 7% per annum, E-waste has become an important waste stream in India in terms of its volume and toxicity. Due to the presence of considerable portions of hazardous chemical constituents including heavy metals and persistent organic pollutions, the current generation of E-waste with its ever-growing volume has the potential to cause detrimental human health and environmental hazards if not meticulously managed. Although the generation of E-waste has observed considerable increase during the recent past, its management practices and policy initiatives are still in an embryonic stage in the country. Considering these diverse reflections, this study tried to provide a comprehensive overview of E-waste and its management challenges in India so that effective policy instruments could be formulated and successfully implemented.

Accordingly, as an initial step, a detailed review of the existing literatures on generation and management of E-waste with consideration of consumers' E-waste disposal behaviour and awareness was performed. In order to explore firsthand the current E-waste management problems in India, an empirical study was carried out in the city of Bangalore (now Bengaluru), popularly known as the 'Silicon Valley of India', because of its position as a prominent information technology (IT) hub of the country. The city, further, is an educational hub housing a number of premier educational institutes in the country and is considered by many as the cradle of banking sector in India. The city profile of Bangalore expresses that it has a rapidly emerging market for electrical and electronic equipments (EEEs) and thus, has the potential to act as a 'model' city for evaluating the issues concerning E-waste in India. Overall, our primary motive is to attract attention of the scientific community, policymakers, academicians, local

communities and NGOs towards the grave concerns associated with negligent E-waste management practices in India and identify its 'locale specific' characteristics.

7.1.Management of E-waste in India

Environment and resource-friendly management of E-waste is a complex task in Indian context. Both domestic generation and legal/illegal import together contribute to the rapid growth of E-waste in India. The estimation of annual E-waste generation in the country differs from one source to the other. It ranges from 480,000 tonnes of E-waste as estimated by a few researchers to 1.85 million tonnes as estimated by the Associated Chambers of Commerce and Industry of India (ASSOCHAM) in 2016. Nevertheless, the sizes of all these estimations are equally large. A number of authors argue that while the per-capita E-waste generation in India is reasonably low (at 1.4 kg per capita per year as per the United Nations University's record for the year 2014), the total absolute quantity generated is huge because of the large population size and greater demands for EEEs in the country.

A study by UNU and UNEP has predicted that by the year 2020, a growth of 500% would be observed in India with respect to E-waste from old computers alone as compared to its level in 2007. Moreover, substantial quantities of E-waste (upto 50,000 tonnes per year) is sent primarily as 'donations' by several developed countries to India which feeds the informal recycling sector mushrooming in the country. Thus, the considerable volume of E-waste generated in the country calls for immediate attention from the scientific community and policymakers.

Regarding the management challenges of E-waste in India, the precious metal components (including gold and silver) present in E-waste provide significant incentives for recycling. On the other hand, hazardous chemical toxicants pose serious threats to the human health and environment if not meticulously managed. This duality needs to be addressed adequately and effectively. The whole system of E-waste management in the country is dominated by the informal sector. This sector is characterized by rudimentary yet effective techniques for E-waste recycling involving a large number of urban poor.

For instance, in order to extract various valuable metals from E-waste, workers in this sector use mixtures of concentrated acid solutions without any health and safety measures. Further, the involvement of a large number of women and children cause serious intimidations to the already intense informal E-waste recycling apprehensions. Integration of the informal sector with the formal sector could be a viable alternative or E-waste management option towards ensuring responsible E-waste disposal, recycling and treatment practices.

Nonetheless, these informal E-waste recycling activities provide ample employment and entrepreneurship opportunities to a large number of low skilled people. Therefore, E-waste management policies should take into consideration such management associated implications. The two recent E-waste associated rules in India of 2011 and 2016 have emphasized on Extended Producer Responsibility (EPR) as a model for ensuring responsible E-waste management practices in the country. However, effective implementation of EPR remains a major challenge which could be attributed to certain peculiarities in India's E-waste management system. For instance, with some financial incentives involved, Indian consumers prefer to sell their obsolete EEEs to the scrap dealers or kawariwalas at certain price rather than adhering to the principles of EPR. In the country, the common practice is that neither the producers nor the consumers pay for E-waste management. It is the scrap dealers who pay consumers a positive price for their E-waste. Such behaviour is in complete contrast with most developed countries where either the producers pay in an EPR framework or consumers pay in frameworks like 'Advanced Recycling/Disposal Fee'.

Therefore, it is essential to devise a 'locale specific' E-waste management plan considering various local customs, characteristics, peculiarities, socio-economic cultures, positive or negative drivers of the existing E-waste scenario etc. One cannot replicate E-waste policy of a model country and implement it effectively in Indian context. A system that works best in a particular country may not work at all in the context of an another country.

Further, there was no legal framework on E-waste in India before the year 2011 which provided ample time for the unprecedented growth of E-waste in the country

without appropriate management efforts. Although the IT revolution started in India way back in early 1990s, a proper policy related to E-waste was being introduced almost after 20 years, in 2011, in the form of the 'e-waste (management and handling) Rules, 2011'. While the number of registered E-waste recycling vendors has increased after the implementation of the E-waste rules in 2011 and the very recent rules of 2016, the informal sector is still dominating the E-waste recycling businesses across the country. Moreover, the time period between formulation and implementation of policy in India is mostly much higher than that of the developed economies. The administrative delays in law enforcement are one of the major barriers in the implementation of appropriate policy measures in the country.

7.2.Global Experiences and their Implications

India's E-waste apprehension has its own specific characteristics. The diverse socio-cultural, economic, political, technological, infrastructural and environmental considerations among its citizens pose serious challenges in formulating one, widely accepted and explicit E-waste management strategy in the country. It is not at all possible to effectively imitate and reproduce a foreign country's E-waste management experience in Indian context. Nevertheless, it is important to take into account the diverse global experiences and try to develop inclusive agendas to effectively address the E-waste crisis of a particular country.

India could, thus, learn from an individual country's E-waste experience and attempt to formulate a comprehensive plan for sustainable management. For instance, learning from the US's experience and taking advantages of Indian consumers' 'familiarity' with recycling (the country has a long history of practicing recycling of glass, paper, metal, plastics etc), establishing E-waste drop-off centres at regular intervals for better 'convenience' has the potential to ensure responsible disposal behaviour. Further, a minimum Advanced Recycling Fee (ARF) or Advanced Disposal Fee (ADF) for new EEEs may be introduced in India based on the existing socio-economic status of the country. Paying an ARF or ADF in turn will encourage the producers to exercise the

Extended Producer Responsibility (EPR) in the country. Learning from the Chinese experience where the laws on E-waste are increasingly executed stricter, it is important for India to stringently implement its recent E-waste (Management) Rules, 2016.

7.3.E-waste Disposal Practices and Awareness in Bangalore

The empirical study was carried out with two kinds of consumers in the city of Bangalore – 1) individual consumers and 2) bulk consumers. The results of the study carried out with the 'individual consumers' at the household level indicate that majority of the households (59.3%) still keep their obsolete electronics stored due to lack of knowledge about proper E-waste management. High Awareness on E-waste and high willingness to recycle/repair their E-waste (above 80% in both the cases) are yet to be translated into responsible disposal/recycling behaviour as 95.8% of the respondents have no knowledge about the presence of any formal recycling centre in the city. Although more than 80% of the individual respondents have knowledge about E-waste; approximately 93% of the respondents are clueless about the E-waste Rules, 2011 even after several years of its implementation. Such findings call for immediate attention of the policymakers to establish formal E-waste collection/recycling mechanisms within the city and create mass awareness campaigns about such initiatives and associated laws (e.g. the very recent E-waste (Management) Rules, 2016).

We have also noted that considerable number of our respondents have deposited their old electrical/electronic devices at store while purchasing a newer one, mostly under the 'Exchange Offer' schemes. This sensitivity of Indian consumers could be incentivized through the EPR initiatives of the manufacturers. Further, we have found more or equal number of 'out-of-use' mobile phones per person with the number of 'in-use' mobile phones. Accordingly, we had observed that both computers and mobile phones in Bangalore are phased out very much within the product lifetime. Considering the intensity of E-waste generation in the city, this trend is alarming and needs urgent policy consideration.

Three sectors listed as 'bulk consumers' of EEEs under the recent E-waste (Management) Rules 2016 namely 1) IT and Electronics, 2) Banking and 3) Education were considered for the study purpose too. Our experience suggests that these bulk consumers adopt primarily two different approaches to comply with the new EPR guidelines as per the E-waste (Management) Rules, 2016 and the previous e-waste (Management and Handling) Rules, 2011. These are: (1) IT companies like Wipro adopts a 'take back system' where it is responsible for taking back the products originally produced in its various facilities from consumers; (2) Most of the banks and educational institutes take 'auction' as the measure by calling tenders from authorized E-waste recyclers with some banks embracing an 'E-waste exchange system', or; complying through Producer Responsibility Organizations (PROs) for responsible E-waste management in the city. However, we sense a lack of meticulous initiatives towards addressing the E-waste crisis largely prevalent across these sectors.

Overall, the E-waste management initiatives in the city are still inadequate and require major infrastructural and administrative considerations. A lack of transparency was observed in all the sectors towards providing relevant information on their E-waste management practices. Even repeated attempts did not result in gathering purposeful information from a number of IT and Electronics Company, banks and educational institutes. We argue that if such ambiguity exists across these bulk producers of E-waste, it is very complex to devise and implement effective E-waste management plans and policies in the country.

7.4.Public Understandings of E-waste and its Disposal

In this study, we propose that conspicuous consumption and the theory of planned behaviour (TPB) could be close associates and together have the potential to contribute towards a framework of 'Public Understandings of E-waste and its disposal' in Indian context. As described earlier, conspicuous consumption leads us in assessing publics' perception and awareness towards *consumption* of electronics. The TPB, on the other hand, helps us assess consumers' waste *disposal behaviour*. Therefore, we attempted to

develop a preliminary model or framework to comprehensively address the consumers' EEE purchase and E-waste disposal behaviours especially in the context of India. This model entitled 'Public Understandings of E-waste and its Disposal' is tested against the empirical study carried out in the IT hub of Bangalore, India with the individual consumers at the household level.

We observed that in spite of majority of our respondents belonging to the high and middle income group and 53.8% of them being attracted towards novel features in latest models, only 1.1% of them purchase new EEEs influenced by their colleagues/friends who regularly purchases newer EEEs. Majority of our respondents in Bangalore said that they do not purchase products only considering the 'brands' or 'looks'. Further, they do not believe that carrying the latest model will increase their status in the society. Thus, the empirical study corresponds that our respondents in Bangalore do not necessarily engage in conspicuous consumption with the intention to exhibit their status to be higher than the others. They are also not engaged in imitating the consumption standards of those they think to be at a higher status.

Majority of the respondents were willing to repair and recycle their older electronics (more than 80% in both the cases). This means that these individuals hold positive attitudes towards responsible E-waste disposal intention. However more than 90% of our respondents do not have any knowledge about the presence of formal E-waste recycling centres in Bangalore or about the e-waste (Management and Handing) Rules, 2011. As two important aspects of an individual's perceived behavioural control, our findings signify that the lack of availability of information and opportunities restricts an individual's waste disposal intention. Accordingly, although an individual's attitude has a positive influence on waste disposal intention; Bangalore fails to capitalize on it because of inadequate waste management infrastructure in the city and lacuna in dissemination of information about appropriate E-waste disposal facilities. This positive attitude is yet to be translated into responsible E-waste disposal behaviour.

Nonetheless, with a positive attitude towards responsible E-waste disposal intention and in the absence of available information and opportunities, perceived behavioural

control could not be considered a key determining factor of an individual's waste disposal intention. Such findings call for adequate information dissemination mechanism about E-waste management initiatives in the city. Complementing a major Indian socio-cultural characteristic, financial gain is important for Indian consumers as EEEs are often considered as commodities with some inherent values. This in turn helps in delaying and reducing the amount of E-waste generated as EEEs often find second and third hand users father down the income chain. Thus, subjective norms may have positive influence on E-waste disposal intention and overall environmental sustainability. Nevertheless, we believe that the scope of conversation on E-waste in the public domain (in terms of family, peers and neighbours) is still largely insignificant to influence their actual disposal behaviour. We conclude that Indian consumers possess a number of positive attributions which could be directed towards responsible E-waste disposal behaviour. The challenge lies in formulating appropriate policy initiatives to encourage these positive characteristics so that a sustainable E-waste management system in the country could be achieved.

7.5.Policy Implications

Our study signifies an important aspect of current global E-waste research trajectory. We observed that majority of the researches on E-waste are being carried out on issues such as recycling of E-waste, chemical analysis and pollution studies, microbial studies, lifecycle assessment, health impact studies of E-waste constituents and so on. A significant portion of such researches are laboratory based work carried out in a controlled environment and confined within a particular set of researchers. We, therefore, wonder how successful these research findings have been in creating awareness among the policymakers towards addressing the E-waste crisis. Researches on E-waste have observed a considerable growth during the last few years. A significant amount of such researches address the critical chemical toxicants present in E-waste and the need for ensuring responsible E-waste management practices, especially in the developing world.

But are we able to bring these research findings from 'Lab to Land'? The answer remains highly unsatisfactory.

Time and again, the scientific community has pointed towards the toxicity of E-waste and demonstrate informal E-waste recycling sector as sites of uncontrolled emission of pollutants of diverse kinds. Here, the larger question remains: To what extent these significant research findings are influencing the policy community of the developing world? Or are these findings still restricted or confined in the laboratories of the scientific establishments without any practical policy implications? We believe that serious thoughts should be engaged in such questions in order to address the alarming growth of E-waste and informal E-waste recycling sector in the developing world.

Further, in the context of the Indian E-waste scenario, we have observed that although E-waste associated problems in India share a lot in common with that of its counterparts in the developing world, research interest on the topic is yet to gain momentum in the country. For instance, India is second only to China in import and processing of E-waste with the capital city of Delhi being the primary destination and primary recycling centre. Delhi, today, is considered the most polluted city in the world with Delhi High Court recently declared the air pollution in the national capital an 'emergency'. Unorganized and informal E-waste recycling activities definitely contribute its shares to the deteriorating air quality in Delhi.

However, unlike Guiyu, the largest E-waste recycling site in China or Taizhou, the second largest one or Agbogbloshie, Ghana, Delhi and other E-waste recycling hubs in India attract not as much research and policy interest from the international community as the Chinese or Ghanaian hubs do. Thus, we believe that there are selective research focuses among the international scientific community while addressing the diverse E-waste concerns even within the developing world. While some countries are getting their due attention, some equally important countries are being somewhat deprived of the appropriate consideration. Considering the locale specific characteristics of E-waste management practices, we believe that essential focus on various E-waste and associated issues of diverse developing countries is the need of the hour in order to devise appropriate policy initiatives.

From our study, it emerges that consumers' disposal behaviour and awareness are central to any successful E-waste management interventions without which no reuse/recycling efforts would be fully functional and satisfactory, no pollution abatement initiatives would be entirely successful, no policy instruments could be satisfactorily implemented, no detrimental health/environmental consequences of E-waste could be addressed sufficiently and chaotic dubious E-waste management processes would progress towards an erratic fate. A key policy implication of our study is to inform the policymakers about the current E-waste dynamics in India so that effective management strategies could be formulated and successfully implemented.

7.6.Scope for Future Research

Our experience during the course of the study shows that natural and applied science based research on E-waste involving recycling technologies and models, microbiological studies, health impacts and pollution/emission studies on E-waste and its components are far more dominant than social science or science policy based research approaches dealing with E-waste management strategies, public perception and awareness, trade on E-waste etc. This calls for more vibrant and comprehensive research approaches in order to evaluate the problem of E-waste from its core. Further, it is essential to acknowledge that consumers' E-waste disposal behaviour and awareness are dynamic across countries. Therefore, E-waste management initiatives together with consumers' disposal behaviour and awareness should be 'locale specific' and need immediate research and policy attention. Considering the complexities of the current global E-waste scenario, we propose that further research on this area from both social and natural science perspectives in both developed and developing countries are essential in order to address the existing E-waste management problems in an adequate detail.

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Appendix I

Centre for Studies in Science Policy, School of Social Sciences,

Jawaharlal Nehru University, New Delhi 110067

Topic: Electronic Waste Management, Consumers' Awareness and Disposal Behaviour in the City of Bangalore

Questionnaire for the 'Individual Consumers'

How many computers and mobile phones do you have?	**Computers:** In-use = Out of use = **Mobile phones:** In-use = Out of use =
How frequently do you change/exchange your mobile phones?	1. 1–2 years 2. 2-3 years 3. 3-4 years 4.Above 4 years
How frequently do you change/exchange your computers?	1.1–2 years 2.2-3 years 3.3-4 years 4.Above 4 years
What are the major reasons for replacement/purchase of new mobile phones or computers?	1. The old one has become non functional 2. The old one cannot be repaired 3. Considering the cost of repair, it is wiser to buy a new one than repairing the old one 4. The latest models have attractive novel features 5. Carrying the latest model will increase my status in the society 6. All my colleagues/friends are buying the latest models, so do I

What do you usually do with the mobile phones/computers that you no longer use?	1. I keep them stored at home 2. I give them e.g. to my children/relatives 3. I sell them to the scrap dealers or 'kawariwalas' at certain cost 4. I leave them at the store when buying a new one 5. I take them to the recycling centre 6. I dispose them with mixed waste
You consider your unused electronics as:	1. Waste 2. Valuable
Are you willing to repair your electronics?	1. Yes 2. No
Your obsolete electronics are harmful to the human health and environment:	1. Yes 2. No
Have you ever heard about 'Electronic Waste' or 'E-waste'? 1. Yes 2. No If Yes, **Are you willing to recycle your E-waste?** 1. Yes 2. No **Are you aware of any company/initiative in your city through which you can dispose off/recycle your old electronics?** 1. Yes 2. No	
Are you aware of the 'e-waste (Management and Handling) Rules, 2011'?	1. Yes 2. No

<u>Demographic Information of the Respondents</u>

Please tick mark or highlight the relevant option

1. **Gender**

a) Male

b) Female

2. Age Group

a) 22 to 29
b) 30 to 39
c) 40 to 49
d) 50 to 59
e) 60 to 65

3. Annual Income

a) Upto Rs. 2, 50, 000
b) From 2, 50, 001 to 5, 00,000
c) From 5, 00, 001 to 10, 00, 000
d) Above 10, 00, 000
e) Don't want to declare

4. Education

a) Graduate
b) Post Graduate
c) PhD and Above
d) Diploma Holders and Others

5. Occupation

a) Engineer
b) Doctor
c) Lawyer
d) Academicians and Researchers
e) Other IT professionals (HR Manager etc)
f) Others

6. Job Sector

a) Government
b) Private
c) Self Employed

Appendix II

Centre for Studies in Science Policy, School of Social Sciences,

Jawaharlal Nehru University, New Delhi 110067

Topic: Electronic Waste Management, Consumers' Awareness and Disposal Behaviour in the City of Bangalore

Questionnaire for the 'Bulk Consumers'

Name of the Organization:

1.	What is the average life of the computers at your institute?
2.	Who is responsible for maintenance of the computers in your institute? Is it the dealer from whom computers were purchased or somebody else?
3.	Do you maintain 'Annual Maintenance Contract' or any such agreements with anyone towards maintenance of your computers and related equipments?
4.	How do you usually discard your outdated or unused computers and related equipments?
5.	Who decides the process of discarding of the computers and related electronics?
6.	Do you discard your obsolete electronics by giving them to the scrap vendors at a certain price?
7.	Does your institute have an E-waste management policy?
8.	What steps do your institute takes to comply with "the E-waste (Management and Handling) Rules, 2011"?

Appendix III

List of Registered E-Waste Dismantlers/Recyclers in India (as on 29-12-2016) as per Central Pollution Control Board (CPCB)

Serial No.	State	Number of Registered Recyclers	Name
1.	Chhattisgarh	2 Unit	• M/s. Navrachna Recycling Pvt. Ltd. • M/s. ADV Metal Combine Pvt. Ltd.
2.	Gujarat	12 Unit	• E-Process House • E-coli Waste Management P. Ltd • ECS Environment Ltd • M/s. Earth E-Waste Management Pvt. Ltd • Pruthavi E-Recycle Pvt. Ltd • M/s. Gujarat Refilling Centre • M/s. Greencare E-Recycle Company • M/s Felix Industries Pvt. Ltd • M/s Recotech E-waste Management • M/s. E-front line recycling Pvt. Ltd • M/s Dron E-waste Solution • M/s Eximo Recyclers
3.	Haryana	16 Unit	• M/s. 3R Recyclers • M/s. A 2 Z E-Waste Management ltd • M/s. Giriraj Metal • M/s. Green World International, Pvt. Ltd • M/s. Exigo Recycling Pvt. Ltd • M/s. R. K. Sons Enterprises (P) Ltd • M/s. Green Vortex Waste Management, (P), Ltd. • M/s. Thapar Disposal Industries • M/s. Eco Friendly Metal Pvt. Ltd. • M/s. E-Waste Solution • M/s. SMS Enterprises • M/s. Earth Sense Recycle, Pvt. Ltd • M/s Mittal Battery Industry • M/s. Namo E-Waste Management Ltd • M/s. Deshwal Waste Management Pvt. Ltd.
4.	Karnataka	57 Units	• M/s. Ash Recyclers • M/s. E- Parisara Pvt Ltd

			• M/s. Eco E-waste Recyclers India Pvt. Ltd • M/s. Sriram Eco Raksha Computer Services Pvt. Ltd • M/s. E-Wardd & Co • M/s. K. G. Nandani Enterprises, • M/s. ECO- BIRDD Recycling Company, Pvt.Ltd. • M/s. FA Enterprises • M/s. Ameena Enterprises • M/s E-R3 Solutions Pvt. Ltd • M/s. Trishyirya Recycling India Pvt. Ltd., • M/s. E-Friendly Waste Recyclers • M/s. Tech Logic • M/s. Samarthanam Trust • M/s. Sai Recyclers • M/s. Nobel Technology • M/s. Cerebra Integrated Technologies Ltd • M/s. Ecovision Recycling • M/s. Arrow Systems • M/s. Digicomp Complete Solutions Ltd • M/s. Afeefa Spectro Alloys • M/s. H. M. G. Eco care Recyclers Pvt. Ltd • M/s. E-Scrappy Recyclers • M/s. E- Pragathi • M/s. Hindustan Computers • M/s. Trackon E-waste Recyclers Pvt. Ltd • M/s. Rashi E-Waste • M/s. Rashi E-Waste Solutions Pvt. Ltd • M/s. Green Globe Enterprise • M/s. 4R Recycling Pvt. Ltd • M/s. TES-AMM Indian Pvt. Ltd • M/s. E-Prarisaraa Pvt. Ltd • M/s. Shobith Industry • M/s. XL Engineering and Fabricators • M/s. MKK E-Waste Enterprises • M/s. Sri Sai Company • Khanija Recycling

			• M/s. Royal Touch • M/s. Moogambigai Metal Refineries • M/s. KH E-Waste Recyclers • M/s. BSMR Metals • M/s. Greenscape Eco Management Pvt. Ltd • M/s. Coral Communication and Networks Pvt. Ltd • M/s. RPN Industries • M/s. Intro Tech Recyclers • M/s. Sogo Synergy Private Limited • M/s. General Eco Transtech Private Limited • M/s. Macro Engineering Services • M/s. R. N. Traders • M/s. Terra Firma Biotechnologies Pvt. Ltd • M/s. Mak Technology Industrial • M/s. Earth Sense Recycler Pvt. Ltd • M/s. E Pragathi Recycling • M/s. SLV Enterprises • M/s. E-Green Recycling • M/s. E Ward and Company • M/s. Regerlis (India) Private Limited
5.	Maharashtra	32 Unit	• M/s. Earth Sense Recycle Pvt Ltd • M/s. Just Dispose Recycling Pvt Ltd • M/s. Mercury Metal industries • Sabbir Traders • M/s Hi- Tech Recycling India (P) Ltd. • Green World Recycling • E-Recon Recycling • M/s. Ecocentric Management Pvt. Ltd • M/s. Clean Tech • M/s. Arihant E-Recycling Ltd • M/s. Z-Tronics Infratel Pvt. Ltd • M/s. Green Valley E-waste Management Pvt. Ltd • M/s. Indian Scrap Traders • M/s. Go-Green Recycling • M/s. Hari International • M/s. Suritex Pvt. Ltd • M/s. R. T. Corporation

			• M/s. Aqsa Stamping • M/s. Mahalaxmi E-Recyclers Pvt. Ltd • M/s. V. M. Traders • M/s. Green IT Recycling Center Pvt. Ltd • M/s. Environcare Recycling Pvt. Ltd • M/s. Shree Mohantara Solutions • M/s. Anand Computer Systems • E-Waste Recycling • M/s. Krishna Metal Refinery • M/s. R. K. E-Recycling International LLP • M/s. Eco Recycling Limited • M/s. ECO Friend Industrial • M/s. Evergreen Recyclekaro (I) Pvt. Ltd • M/s. E-incarnation Recycling Pvt. Ltd • M/s. Ecocentric Management Pvt. Ltd
6.	Madhya Pradesh	3 Units	• M/s. Unique Echo Recycle • M/s. Hostech Eco Management Pvt. Ltd • M/s Green Earth Recycling
7.	Orissa	1 Unit	• M/s. Sani Clean Pvt. Ltd
8.	Punjab	1 Unit	• M/s. Ramky Enviro Engineers Ltd.
9.	Rajasthan	10 Unit	• M/s. Green Escape Eco Management Pvt. Ltd • M/s Greenscape Eco Management Pvt Ltd • M/s K.G. Metalloys • M/s. Deshwal E-waste Recycler • M/s. Green Leaf Recycling Industries • M/s. ETCO E-Waste Recycler Pvt.Ltd • M/s. Vasoo Metals (Division-III) • M/s. R.P. Industries • M/s. S.B.J. & Co. • M/s. Shukla E-Waste Processors
10.	Tamil Nadu	14 Unit	• M/s Victory Recovery & Recycle Technologies India Pvt.Ltd • M/s. TES AMM Private Limited • M/s Trishyiraya Recycling India Pvt. Ltd.,

			• M/s Ultrust Solutions (India)Pvt.Ltd • M/s INAA Enterprises • M/s. AER world wide (India) Pvt. Limited • M/s. SEZ Recyclers • M/s. Tritech Systems • M/s. Shri Raaam Recycling • M/s. Green R2 Re-Processors Pvt. Ltd • M/s. Abishek Enterprises • M/s. B.V. Enterprises • M/s. Leela Traders • M/s. GEMS Recycling Pvt. Ltd
11.	Telangana	4 Units	• M/s. Earth Sense recycle Private Limited • M/s Ramky E- Waste Recycling • M/s. Z Enviro Industries Pvt. Ltd • M/s. Envrio Collection Centre (Dismantling Unit
12.	Uttar Pradesh	22 Units	• M/s. Auctus – E Recycling Solutions Pvt. Ltd • Mahaluxmi metal Alloys (India) Pvt. Ltd • M/s. N.K. Products • M/s Bharat Oil • M/s Plant Green Recycling Pvt. Limited • Rocket Sales • Arsh Recycling Pvt. Ltd • Green Tech Ramen Pvt. Ltd • M/s. Sims Recycling India Pvt. Ltd • Halcyon Electrotech Pvt. Ltd • Intarvo Formulae Recyclers Services Pvt. Ltd • M/s. TIC Group India Pvt. Ltd • Auctus Recycling Solutions Pvt. Ltd • M/s. Khan Traders • Green Tech Recycling • Narora Atomic Power • M/s. E-Waste Recyclers India • M/s. J. A. O. E-Waste Recycling Company • M/s. Oasis Eco E-Waste Recycling • M/s. Hin Green E-Waste Recycling

			Pvt. Ltd • M/s. Hayat-E-Recyclers Pvt. Ltd • M/s. Prakesh Metal House
13.	Uttarakhand	3 unit	• M/s. Attero Recycling Pvt. Ltd • M/s. Bharat Oil and Waste Management Ltd • M/s. Resource E-Waste Solutions Pvt. Ltd
14.	West Bengal	1 unit	• M/s. J.S. Pigments Pvt. Ltd.

Total Capacity = 438086 MTA

Source: http://www.cpcb.nic.in/List_of_E-waste_Recycler_as_on_29.12.2016.pdf

Appendix IV

Karnataka State Pollution Control Board (KSPCB) Authorized and Registered E-waste Recyclers/Dismantling

Serial No.	Name of unit	Authorized Quantity (MT/A)	Activity
1.	M/s. Ash Recyclers	120 MT/A	E-waste recycling
2.	M/s. E-Parisara Pvt Ltd	8820 MT/A	E-waste recycling
3.	M/s. Sriram Eco Raksha Computer Services Pvt Ltd	500 MT/A	Dismantling of E-waste
4.	M/s. E-Wardd & Co	600 MT/A	E-waste recycling
5.	M/s. K.G. Nandini Enterprises	7,200 MT/A	E-waste recycling
6.	M/s. Eco Birdd Recycling Company Pvt. Ltd	350 MT/A	E-waste recycling
7.	M/s. FA Enterprises	100 MT/A	Dismantling of E-waste
8.	M/s. Ameena Enterprises	560 MT/A	E-waste recycling
9.	M/s. E-R3 Solutions Pvt. Ltd	290 MT/A	Dismantling of E-waste
10.	M/s. Trishyirya Recycling India Pvt. Ltd	500 MT/A	Dismantling of E-waste
11.	M/s. Tech Logic	240 MT/A	Dismantling of E-waste
12.	M/s. Samarthanam Trust for the Disabled	3326 No's/A	Reconditioning of printer cartridge
13.	M/s. Green Globe Enterprises	120 MT/A	Dismantling of E-waste
14.	M/s. Sai Recyclers	300 MT/A	Dismantling of E-waste
15.	M/s. Nobel Technology	300 MT/A	Dismantling of E-waste
16.	M/s. Cerebra Integrated Technologies Ltd	600 MT/A	Dismantling of E-waste
17.	M/s. Ecovision Recycling	300 MT/A	Dismantling of E-waste
18.	M/s. Royal Touch	90 MT/A	Recycling of printer Cartridges
19.	M/s. Arrow Systems	120 MT/A	Dismantling of E-waste
20.	M/s. Trackon E-waste Recyclers Pvt. Ltd	300 MT/A	E-waste recycling
21.	M/s. Digicomp Complete Solutions Ltd	180 MT/A	Dismantling of E-waste

22.	M/s. Afeefa Spectro Alloys	300 MT/A	E-waste recycling
23.	M/s. E-Scrapy Recyclers	300 MT/A	E-waste recycling
24.	M/s. Eco-Ewaste Recyclers India Pvt Ltd	300 MT/A	E-waste Dismantling & segregation
25.	M/s Hindustan Computers		E-waste Dismantling & segregation
26.	M/s Rashi E-waste	300 MT/A	E-waste Dismantling & segregation
27.	M/s. H. M. G. Eco Care recycling Pvt. Ltd	300 MT/A	E-waste recycling

Source: http://kspcb.kar.nic.in/KSPCB%20%20Authorized%20&%20Registered%20E-waste.pdf

Annexure

[PUBLISHED IN THE GAZETTE OF INDIA, EXTRAORDINARY PART-II, SECTION-3, SUB-SECTION (i)]

GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 23rd March , 2016

G.S.R 338(E). - Whereas the draft rules, namely the e-waste (Management) Rules, 2015, were published by the Government of India in the Ministry of Environment, Forest and Climate Change *vide* number G.S.R. 472(E), dated the 10th June, 2015 in the Gazette of India, Extraordinary Part II, section 3, sub-section (ii) inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of the period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS the copies of the Gazette containing the said notification were made available to the public on the 10th day of June, 2015;

AND WHEREAS the objections and suggestions received within the specified period from the public in respect of the said draft rules have been duly considered by the Central Government;

NOW, THEREFORE, in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the e-waste (Management and Handling) Rules, 2011, published in the Gazette of India, section 3, sub-section (ii), *vide* number S.O. 1035(E), dated the 12th May, 2011, except as respects things done or omitted to be done before such supersession, the Central Government hereby makes the following rules, namely:-

CHAPTER I

PRELIMINARY

1. Short title and commencement. - (1) These rules may be called the E-Waste (Management) Rules, 2016.
(2) They shall come into force from the 1st day of October, 2016.

2. Application. - These rules shall apply to every manufacturer, producer, consumer, bulk consumer, collection centres, dealers, e-retailer, refurbisher**,** dismantler and recycler involved in manufacture, sale, transfer, purchase, collection, storage and processing of e-waste or electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational but shall not apply to -

(a) used lead acid batteries as covered under the Batteries (Management and Handling) Rules, 2001 made under the Act;
(b) micro 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.

3. Definitions. - (1) In these rules, unless the context otherwise requires, -

(a) 'Act' means the Environment (Protection) Act, 1986 (29 of 1986);
(b) 'authorisation' means permission for generation, handling, collection, reception, storage, transportation, refurbishing, dismantling, recycling, treatment and disposal of e-waste, granted to manufacturer, dismantler, refurbisher and recycler;
(c) 'bulk consumer' means bulk users of electrical and electronic equipment such as Central Government or State Government Departments, public sector undertakings, banks, educational institutions, multinational organisations, international agencies, partnership and public or private companies that are registered under the Factories Act, 1948 (63 of 1948) and the Companies Act, 2013 (18 of 2013) and health care facilities which have turnover of more than one crore or have more than twenty employees;
(d) 'Central Pollution Control Board' means the Central Pollution Control Board constituted under sub-section (1) of section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974);
(e) 'collection centre' means a centre or a collection point or both established by producer individually or as association jointly to collect e-waste for channelising the e-waste to recycler and play such role as indicated in the authorisation for Extended Producer Responsibility granted to the producer and having facilities as per the guidelines of Central Pollution Control Board, including the collection centre established by the dismantler or refurbisher or recycler which should be a part of their authorisation issued by the State Pollution Control Board where the facility exists;
(f) ‘component’ means one of the parts of a sub-assembly or assembly of which a manufactured product is made up and into which it may be resolved and includes an accessory or attachment to another component;
(g) ‘consumables’ means an item, which participates in or is required for a manufacturing process or for functioning of the electrical and electronic equipment and may or may not form part of end-product. Items, which are substantially or totally consumed during a manufacturing process, shall be deemed to be consumables;
(h) 'consumer' means any person using electrical and electronic equipment excluding the bulk consumers;
(i) ‘channelisation’ means to direct the path for movement of e-wastes from collection onwards to authorised dismantler or recycler. In case of fluorescent and other mercury containing lamps, where recyclers are not available, this means path for movement from collection centre to Treatment, Storage and Disposal Facility;
(j) 'dealer' means any individual or firm that buys or receives electrical and electronic equipment as listed in Schedule I of these rules and their components or consumables or parts or spares from producers for sale;
(k) ‘deposit refund scheme’ means a scheme whereby the producer charges an additional amount as a deposit at the time of sale of the electrical and electronic equipment and returns it to the consumer along with interest when the end-of-life electrical and electronic equipment is returned;
(l) 'dismantler' means any person or organisation engaged in dismantling of used electrical and electronic equipment into their components and having facilities

as per the guidelines of Central Pollution Control Board and having authorisation from concerned State Pollution Control Board;

(m) 'disposal' means any operation which does not lead to recycling, recovery or reuse and includes physico-chemical or biological treatment, incineration and deposition in secured landfill;

(n) ‘end-of-life’ of the product means the time when the product is intended to be discarded by the user;

(o) 'environmentally sound management of e-waste' means taking all steps required to ensure that e-waste is managed in a manner which shall protect health and environment against any adverse effects, which may result from such e-waste;

(p) 'electrical and electronic equipment' means equipment which are dependent on electric current or electro-magnetic field in order to become functional;

(q) ‘e-retailer’ means an individual or company or business entity that uses an electronic network such as internet, telephone, to sell its goods;

(r) 'e-waste' means electrical and electronic equipment**,** whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes;

(s) ‘e-waste exchange’ means an independent market instrument offering assistance or independent electronic systems offering services for sale and purchase of e-waste generated from end-of-life electrical and electronic equipment between agencies or organisations authorised under these rules;

(t) ‘Extended Producer Responsibility’ means responsibility of any producer of electrical or electronic equipment, for channelisation of e-waste to ensure environmentally sound management of such waste. Extended Producer Responsibility may comprise of implementing take back system or setting up of collection centres or both and having agreed arrangements with authorised dismantler or recycler either individually or collectively through a Producer Responsibility Organisation recognised by producer or producers in their Extended Producer Responsibility - Authorisation;

(u) ‘Extended Producer Responsibility - Authorisation’ means a permission given by Central Pollution Control Board to a producer, for managing Extended Producer Responsibility with implementation plans and targets outlined in such authorisation including detail of Producer Responsibility Organisation and e-waste exchange, if applicable;

(v) ***‘***Extended Producer Responsibility Plan’ means a plan submitted by a producer to Central Pollution Control Board, at the time of applying for Extended Producer Responsibility - Authorisation in which a producer shall provide details of e-waste channelisation system for targeted collection including detail of Producer Responsibility Organisation and e-waste exchange, if applicable;

(w) 'facility' means any location wherein the process incidental to the collection, reception, storage, segregation, refurbishing, dismantling, recycling, treatment and disposal of e-waste are carried out;

(x) 'Form' means a form appended to these rules;

(y) ‘historical e-waste’ means e-waste generated from electrical and electronic equipment as specified in Schedule I, which was available on the date from which these rules come into force;

(z) ‘manufacturer’ means a person or an entity or a company as defined in the Companies Act, 2013 (18 of 2013) or a factory as defined in the Factories Act, 1948 (63 of 1948) or Small and Medium Enterprises as defined in Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006), which has facilities for manufacture of electrical and electronic equipment;

(aa) ‘orphaned products’ means non-branded or assembled electrical and electronic equipment as specified in Schedule I or those produced by a company, which has closed its operations;

(bb) ‘part’ means an element of a sub-assembly or assembly not normally useful by itself, and not amenable to further disassembly for maintenance purposes. A part may be a component, spare or an accessory;

(cc) ‘producer’ means any person who, irrespective of the selling technique used such as dealer, retailer, e-retailer, etc.;

(i) manufactures and offers to sell electrical and electronic equipment and their components or consumables or parts or spares under its own brand; or

(ii) offers to sell under its own brand, assembled electrical and electronic equipment and their components or consumables or parts or spares produced by other manufacturers or suppliers; or

(iii) offers to sell imported electrical and electronic equipment and their components or consumables or parts or spares;

(dd) ‘Producer Responsibility Organisation’ means a professional organisation authorised or financed collectively or individually by producers, which can take the responsibility for collection and channelisation of e-waste generated from the ‘end-of-life’ of their products to ensure environmentally sound management of such e-waste;

(ee) ‘recycler’ - means any person who is engaged in recycling and reprocessing of waste electrical and electronic equipment or assemblies or their components and having facilities as elaborated in the guidelines of Central Pollution Control Board;

(ff) 'refurbishment' means repairing of used electrical and electronic equipment as listed in Schedule I for extending its working life for its originally intended use and selling the same in the market or returning to owner;

(gg) 'refurbisher' for the purpose of these rules, means any company or undertaking registered under the Factories Act, 1948 or the Companies Act, 1956 or both or district industries centre engaged in refurbishment of used electrical and electronic equipment;

(hh) 'Schedule' means the Schedule appended to these rules;

(ii) "spares” means a part or a sub-assembly or assembly for substitution which is ready to replace an identical or similar part or sub-assembly or assembly including a component or an accessory;

(jj) 'State Government in relation to an Union territory means, the Administrator thereof appointed under article 239 of the Constitution;

(kk) 'State Pollution Control Board' means the concerned State Pollution Control Board or the Pollution Control Committee of the Union Territories constituted under sub-section (1) of section 4 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974);

(ll) ‘target’ means the quantity of e-waste to be collected by the producer in fulfilment of Extended Producer Responsibility;

(mm) ‘transporter’ means a person or company or entity engaged in the off-site transportation of e-waste by air, rail, road or water carrying a manifest system issued by the person or company or entity who has handed over the e-waste to the transporter, giving the origin, destination and quantity of the e-waste being transported;

(2) Words and expressions used in these rules and not defined but defined in the Act shall have the meanings respectively assigned to them in the Act.

CHAPTER II

RESPONSIBILITIES

4. Responsibilities of the manufacturer. - (1) collect e-waste generated during the manufacture of any electrical and electronic equipment and channelise it for recycling or disposal;

(2) apply for an authorisation in Form 1 (a) in accordance with the procedure prescribed under sub-rule (2) of rule 13 from the concerned State Pollution Control Board, which shall give the authorisation in accordance with Form 1 (bb);

(3) ensure that no damage is caused to the environment during storage and transportation of e-waste;

(4) maintain records of the e-waste generated, handled and disposed in Form-2 and make such records available for scrutiny by the concerned State Pollution Control Board;

(5) file annual returns in Form-3, to the concerned State Pollution Control Board on or before the 30th day of June following the financial year to which that return relates.

5. Responsibilities of the producer. - The producer of electrical and electronic equipment listed in Schedule I shall be responsible for -

(1) implementing the Extended Producers Responsibility with the following frameworks, namely:-

(a) collection and channelisation of e-waste generated from the 'end-of-life' of their products or 'end-of-life' products with same electrical and electronic equipment code and historical waste available on the date from which these rules come into force as per Schedule I in line with the targets prescribed in Schedule III in Extended Producer Responsibility - Authorisation;

(b) the mechanism used for channelisation of e-waste from 'end-of-life' products including those from their service centres to authorised dismantler or recycler shall be in accordance with the Extended Producer Responsibility - Authorisation. In cases of fluorescent and other mercury containing lamps, where recyclers are not available, channelisation may be from collection centre to Treatment, Storage and Disposal Facility;

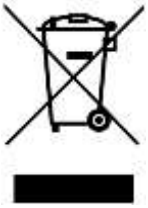
(c) for disposal in Treatment, Storage and Disposal Facility, a pre-treatment is necessary to immobilise the mercury and reduce the volume of waste to be disposed off;

(d) Extended Producer Responsibility - Authorisation should comprise of general scheme for collection of waste Electrical and Electronic Equipment from the Electrical and Electronic Equipment placed on the market earlier, such as through dealer, collection centres, Producer Responsibility Organisation, through buy-back arrangement, exchange scheme, Deposit Refund System, etc. whether directly or through any authorised agency and channelising the items so collected to authorised recyclers;

(e) providing contact details such as address, e-mail address, toll-free telephone numbers or helpline numbers to consumer(s) or bulk consumer(s) through their website and product user documentation so as to facilitate return of end-of-life electrical and electronic equipment;

(f) creating awareness through media, publications, advertisements, posters, or by any other means of communication and product user documentation accompanying the equipment, with regard to -

(i) information on address, e-mail address, toll-free telephone numbers or helpline numbers and web site;
(ii) information on hazardous constituents as specified in sub-rule 1 of rule 16 in electrical and electronic equipment;
(iii) information on hazards of improper handling, disposal, accidental breakage, damage or improper recycling of e-waste;
(iv) instructions for handling and disposal of the equipment after its use, along with the Do's and Don'ts;
(v) affixing a visible, legible and indelible symbol given below on the products or product user documentation to prevent e-waste from being dropped in garbage bins containing waste destined for disposal;



(vi) means and mechanism available for their consumers to return e-waste for recycling including the details of Deposit Refund Scheme, if applicable;

(g) the producer shall opt to implement Extended Producer Responsibility individually or collectively. In individual producer responsibility, producer may set up his own collection centre or implement take back system or both to meet Extended Producer Responsibility. In collective system, producers may tie-up as a member with a Producer Responsibility Organisation or with e-waste exchange or both. It shall be mandatory upon on the individual producer in every case to seek Extended Producer Responsibility - Authorisation from Central Pollution Control Board in accordance with the Form-1 and the procedure laid down in sub-rule (1) of rule 13;

(2) to provide information on the implementation of Deposit Refund Scheme to ensure collection of end-of-life products and their channelisation to authorised dismantlers or recyclers, if such scheme is included in the Extended Producer Responsibility Plan.

Provided that the producer shall refund the deposit amount that has been taken from the consumer or bulk consumer at the time of sale, along with interest at the prevalent rate for the period of the deposit at the time of take back of the end-of-life product;

(3) the import of electrical and electronic equipment shall be allowed only to producers having Extended Producer Responsibility authorisation;

(4) maintaining records in Form-2 of the e-waste handled and make such records available for scrutiny by the Central Pollution Control Board or the concerned State Pollution Control Board;

(5) filing annual returns in Form-3, to the Central Pollution Control Board on or before the 30th day of June following the financial year to which that return relates. In case of the Producer with multiple offices in a State, one annual return combining information from all the offices shall be filed;

(6) the Producer shall apply to the Central Pollution Control Board for authorisation in Form 1, which shall thereafter grant the Extended Producer Responsibility - Authorisation in Form 1(aa).

(7) Operation without Extended Producer Responsibility-Authorisation by any producer, as defined in this rule, shall be considered as causing damage to the environment.

6. Responsibilities of collection centres. - (1) collect e-waste on behalf of producer or dismantler or recycler or refurbisher including those arising from orphaned products;

Provided the collection centres established by producer can also collect e-waste on behalf of dismantler, refurbisher and recycler including those arising from orphaned products

(2) ensure that the facilities are in accordance with the standards or guidelines issued by Central Pollution Control Board from time to time;

(3) ensure that the e-waste collected by them is stored in a secured manner till it is sent to authorised dismantler or recycler as the case may be;

(4) ensure that no damage is caused to the environment during storage and transportation of e-waste;

(5) maintain records in Form-2 of the e-waste handled as per the guidelines of Central Pollution Control Board and make such records available for scrutiny by the Central Pollution Control Board or the concerned State Pollution Control Board as and when asked for.

7. Responsibilities of dealers. – (1) in the case the dealer has been given the responsibility of collection on behalf of the producer, the dealer shall collect the e-waste by providing the consumer a box, bin or a demarcated area to deposit e-waste, or through take back system and send the e-waste so collected to collection centre or dismantler or recycler as designated by producer;

(2) the dealer or retailer or e-retailer shall refund the amount as per take back system or Deposit Refund Scheme of the producer to the depositor of e-waste;

(3) every dealer shall ensure that the e-waste thus generated is safely transported to authorised dismantlers or recyclers;

(4) ensure that no damage is caused to the environment during storage and transportation of e-waste.

8. Responsibilities of the refurbisher. – (1) collect e-waste generated during the process of refurbishing and channelise the waste to authorised dismantler or recycler through its collection centre;

(2) make an application in Form 1(a) in accordance with the procedure laid down in sub-rule (4) of rule 13 to the concerned State Pollution Control Board for grant of one time authorisation;

(a) the concerned State Pollution Control Board shall authorise the Refurbisher on one time basis as per Form 1 (bb) and authorisation would be deemed as considered if not objected to within a period of thirty days;

(b) the authorised Refurbisher shall be required to submit details of e-waste generated to the concerned State Pollution Control Board on yearly basis;

(3) ensure that no damage is caused to the environment during storage and transportation of e-waste;

(4) ensure that the refurbishing process do not have any adverse effect on the health and the environment;

(5) ensure that the e-waste thus generated is safely transported to authorised collection centres or dismantlers or recyclers;
(6) file annual returns in Form-3 to the concerned State Pollution Control Board, on or before the 30th day of June following the financial year to which that return relates;
(7) maintain records of the e-waste handled in Form-2 and such records should be available for scrutiny by the appropriate authority.

9. Responsibilities of consumer or bulk consumer. – (1) consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them is channelised through collection centre or dealer of authorised producer or dismantler or recycler or through the designated take back service provider of the producer to authorised dismantler or recycler;
(2) bulk consumers of electrical and electronic equipment listed in Schedule I shall maintain records of e-waste generated by them in Form-2 and make such records available for scrutiny by the concerned State Pollution Control Board;
(3) consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that such end-of-life electrical and electronic equipment are not admixed with e-waste containing radioactive material as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under;
(4) bulk consumers of electrical and electronic equipment listed in Schedule I shall file annual returns in Form-3, to the concerned State Pollution Control Board on or before the 30th day of June following the financial year to which that return relates. In case of the bulk consumer with multiple offices in a State, one annual return combining information from all the offices shall be filed to the concerned State Pollution Control Board on or before the 30th day of June following the financial year to which that return relates

10. Responsibilities of the dismantler. - (1)ensure that the facility and dismantling processes are in accordance with the standards or guidelines prescribed by Central Pollution Control Board from time to time;
(2) obtain authorisation from the concerned State Pollution Control Board in accordance with the procedure under sub-rule (3) of rule 13;
(3) ensure that no damage is caused to the environment during storage and transportation of e-waste;
(4) ensure that the dismantling processes do not have any adverse effect on the health and the environment;
(5) ensure that dismantled e-waste are segregated and sent to the authorised recycling facilities for recovery of materials;
(6) ensure that non-recyclable or non-recoverable components are sent to authorised treatment storage and disposal facilities;
(7) maintain record of e-waste collected, dismantled and sent to authorised recycler in Form-2 and make such record available for scrutiny by the Central Pollution Control Board or the concerned State Pollution Control Board;
(8) file a return in Form-3, to the concerned State Pollution Control Board as the case may be, on or before 30th day of June following the financial year to which that return relates;
(9) not process any e-waste for recovery or refining of materials, unless he is authorised with concerned State Pollution Control Board as a recycler for refining and recovery of materials;
(10) operation without Authorisation by any dismantler, as defined in this rule, shall be considered as causing damage to the environment.

11. Responsibilities of the recycler. – (1) shall ensure that the facility and recycling processes are in accordance with the standards or guidelines prescribed by the Central Pollution Control Board from time to time;

(2) obtain authorisation from concerned State Pollution Control Board in accordance with the procedure under the sub-rule (3) of rule 13;

(3) ensure that no damage is caused to the environment during storage and transportation of e-waste;

(4) ensure that the recycling processes do not have any adverse effect on the health and the environment;

(5) make available all records to the Central Pollution Control Board or the concerned State Pollution Control Board for inspection;

(6) ensure that the fractions or material not recycled in its facility is sent to the respective authorised recyclers;

(7) ensure that residue generated during recycling process is disposed of in an authorised treatment storage disposal facility;

(8) maintain record of e-waste collected, dismantled, recycled and sent to authorised recycler in Form-2 and make such record available for scrutiny by the Central Pollution Control Board or the concerned State Pollution Control Board;

(9) file annual returns in Form-3, to the concerned State Pollution Control Board as the case may be, on or before 30th day of June following the financial year to which that return relates;

(10) may accept waste electrical and electronic equipment or components not listed in Schedule I for recycling provided that they do not contain any radioactive material and same shall be indicated while taking the authorisation from concerned State Pollution Control Board;

(11) operation without Authorisation by any recycler, as defined in this rule, shall be considered as causing damage to the environment.

12. Responsibilities of State Government for environmentally sound management of E-waste. – (1) Department of Industry in State or any other government agency authorised in this regard by the State Government, to ensure earmarking or allocation of industrial space or shed for e-waste dismantling and recycling in the existing and upcoming industrial park, estate and industrial clusters;

(2) Department of Labour in the State or any other government agency authorised in this regard by the State Government shall:

a. ensure recognition and registration of workers involved in dismantling and recycling;
b. assist formation of groups of such workers to facilitate setting up dismantling facilities;
c. undertake industrial skill development activities for the workers involved in dismantling and recycling;
d. undertake annual monitoring and to ensure safety & health of workers involved in dismantling and recycling;

(3) State Government to prepare integrated plan for effective implementation of these provisions, and to submit annual report to Ministry of Environment, Forest and Climate Change.

CHAPTER III

PROCEDURE FOR SEEKING AND GRANT OF AUTHORISATION FOR MANAGEMENT OF E-WASTE

13. Procedure for Seeking and Grant of Authorisation. -

(1) **Extended Producer Responsibility - Authorisation of Producers.** – (i) every producer of electrical and electronic equipment listed in Schedule I, shall make an application for Extended Producer Responsibility - Authorisation within a period of ninety days starting from the date of these rules coming into force in Form-1 to Central Pollution Control Board;

(ii) on receipt of the application complete in all respects, the Central Pollution Control Board will carry out evaluation of the Extended Producer Responsibility Plan and on being satisfied that the producer has detailed out an effective system to manage Extended Producer Responsibility in the country, shall grant Extended Producer Responsibility - Authorisation, in Form 1(aa) within a period of one hundred and twenty days. The Extended Producer Responsibility - Authorisation shall be valid for a period of five years;

This authorisation shall include among others the targeted quantity of e-waste, product code wise, to be collected during the year. The actual target for collection of e-waste for dismantling or recycling will be fixed on the basis of quantity of electrical and electronic equipment, product code wise, placed in the market in the previous years and taking into consideration the average life of the equipment. The estimated quantity of e-waste generated during the current year will be indicated by the producer and the quantity expected to be collected with the collection scheme proposed to be implemented by the producer will be indicated in the Extended Producer Responsibility plan. The Central Pollution Control Board shall fix the targets in accordance with Schedule III.

(iii) the Central Pollution Control Board, after giving reasonable opportunity of being heard to the applicant shall refuse to grant Extended Producer Responsibility – Authorisation;

(iv) in the event of refusal of Extended Producer Responsibility - Authorisation by the Central Pollution Control Board, the producer will forfeit his right to put any Electrical and Electronic Equipment in the market till such time the Extended Producer Responsibility - Authorisation is granted;

(v) the Central Pollution Control Board after grant of Extended Producer Responsibility - Authorisation shall forward the Extended Producer Responsibility Plan to respective State Pollution Control Board for monitoring;

(vi) an application for the renewal of Extended Producer Responsibility-Authorisation shall be made in Form-1 before one hundred and twenty days of its expiry to Central Pollution Control Board. The Central Pollution Control Board may renew the authorisation for a period of five years after receipt of compliance report from the concerned State Pollution Control Board which shall submit the compliance report to Central Pollution Control Board within sixty days from the date of the receipt of the application. In case of non receipt of the compliance report from the State Pollution Control Board within stipulated time period of sixty days, Central Pollution Control Board may renew the Extended Producer Responsibility-Authorisation after examining such case on merit basis, subject to no report of violation of the provisions of the Act or the rules made there under or the conditions specified in the Extended Producer Responsibility - Authorisation;

(vii) every producer of Electrical and Electronic Equipment listed in Schedule I, shall take all steps, wherever required, to comply with the conditions specified in the Extended Producer Responsibility – Authorisation;

(viii) the concerned State Pollution Control Board shall monitor the compliance of Extended Producer Responsibility - Authorisation, take cognizance of any non-compliance and inform Central Pollution Control Board for taking action, as necessary;

(ix) Central Pollution Control Board shall conduct random check and if in its opinion, the holders of the Extended Producer Responsibility - Authorisation has failed to comply with any of the conditions of the authorisation or with any provisions of the Act or these rules and after giving a reasonable opportunity of being heard and after recording reasons thereof in writing cancel or suspend the Extended Producer Responsibility - Authorisation issued under these rules for such period as it considers necessary in the public interest and inform the concerned State Pollution Control Board within ten days of cancellation.

(x) the Central Pollution Control Board shall maintain an online register of Extended Producer Responsibility - Authorisation granted with conditions imposed under these rules for environmentally sound management of e-waste, and which shall be accessible to any citizen of the country.

(xi) The producer authorised under the provision of this rule shall maintain records in Form-2 and shall file annual returns of its activities of previous year in Form-3 to the Central Pollution Control Board on or before 30th day of June of every year;

(2) **Authorisation of Manufacturer. –** (i) the manufacturer generating e-waste shall obtain an authorisation from the concerned State Pollution Control Board;

(ii) the manufacturer shall make an application for authorisation, within a period of ninety days from the date of these rules coming into force in Form 1(a) to the concerned State Pollution Control Board for grant of authorisation;

(iii) on receipt of the application complete in all respects for the authorisation, the concerned State Pollution Control Board may, after such enquiry as it considers necessary and on being satisfied that the applicant possesses appropriate facilities, technical capabilities and equipment to handle e-waste safely, grant within a period of one hundred and twenty days an authorisation in Form 1(bb) to the applicant to carry out safe operations in the authorised place only, which shall be valid for a period of five years;

(iv) the concerned State Pollution Control Board after giving reasonable opportunity of being heard to the applicant may refuse to grant any authorisation;

(v) every person authorised under these rules shall maintain the record of e-waste handled by them in Form-2 and prepare and submit to the concerned State Pollution Control Board, an annual return containing the details specified in Form-3 on or before the 30th day of June following the financial year to which that return relates;

(vi) an application for the renewal of an authorisation shall be made in Form-1(a) before one hundred and twenty days of its expiry and the concerned State Pollution Control Board may renew the authorisation for a period of five years after examining each case on merit and subject to the condition that there is no report of violation of the provisions of the Act or the rules made thereunder or the conditions specified in the authorisation;

(vii) manufacturer shall take all steps to comply with the conditions specified in the authorisation;

(viii) the concerned State Pollution Control Board shall maintain an online register of authorisations granted with conditions imposed under these rules for

environmentally sound management of e-waste, and which shall be accessible to any citizen of the country.

(3) **Procedure for grant of authorisation to dismantler or recycler.** - (i) every Dismantler or Recycler of e-waste shall make an application, within a period of one hundred and twenty days starting from the date of coming into force of these rules, in Form-4 in triplicate to the concerned State Pollution Control Board accompanied with a copy of the following documents for the grant or renewal of authorisation, namely:-

(a) consent to establish granted by the concerned State Pollution Control Board under the Water (Prevention and Control of Pollution) Act, 1974, (25 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981(21 of 1981);
(b) certificate of registration issued by the District Industries Centre or any other government agency authorised in this regard;
(c) proof of installed capacity of plant and machinery issued by the District Industries Centre or any other government agency authorised in this behalf;
(d) in case of renewal, a certificate of compliance of effluent and emission standards, treatment and disposal of hazardous wastes as applicable from the concerned State Pollution Control Board or any other agency designated for this purpose:

Provided that any person authorised or registered under the provisions of the Hazardous Wastes (Management, Handling and Transboundary Movements) Rules, 2008, and the E-waste (Management & Handling) Rules, 2011 prior to the date of coming into force of these rules shall not be required to make an application for authorisation till the period of expiry of such authorisation or registration:

(ii) the concerned State Pollution Control Board, on being satisfied that the application is complete in all respects and that the applicant is utilising environmentally sound technologies and possess adequate technical capabilities, requisite facilities and equipment to dismantle or recycle and process e-waste in compliance to the guidelines specified by Central Pollution Control Board from time to time and through site inspection, may grant authorisation to such applicants stipulating therein necessary conditions as deemed necessary for carrying out safe operations in the authorised place only;
(iii) the concerned State Pollution Control Board shall dispose of the application for authorisation within a period of one hundred and twenty days from the date of the receipt of such application complete in all respects;
(iv) the authorisation granted under these rules shall be valid for a period of five years from the date of its issue and shall be accompanied with a copy of the field inspection report signed by that Board indicating the adequacy of facilities for dismantling or recycling of e-waste and compliance to the guidelines specified by Central Pollution Control Board from time to time;
(v) the concerned State Pollution Control Board may refuse, cancel or suspend an authorisation granted under these rules, if it has reasons to believe that the authorised dismantler or recycler has failed to comply with any of the conditions of authorisation, or with any provisions of the Act or rules made thereunder, after giving an opportunity to the dismantler or recycler to be heard and after recording the reasons thereof;
(vi) an application for the renewal of authorisation shall be made in Form - 4 before one hundred and twenty days of its expiry and the concerned State Pollution Control Board may renew the authorisation for a period of five years after

examining each case on merit and subject to the condition that there is no report of violation of the provisions of the Act or the rules made there under or the conditions specified in the authorisation;

(vii) the Dismantler and Recycler shall maintain records of the e-waste purchased, processed in Form-2 and shall file annual returns of its activities of previous year in Form-3 to the concerned State Pollution Control Board on or before 30th day of June of every year;

(viii) the Central Government and the Central Pollution Control Board may issue guidelines for standards of performance for dismantling and recycling processes from time to time.

(4) **Procedure for grant of authorisation to refurbisher.** – (i) every refurbisher of e-waste shall make an application, with in a period of one hundred and twenty days starting from the date of coming into force of these rules, in Form 1 (a) in triplicate to the concerned State Pollution Control Board accompanied with a copy of the following documents for the grant or renewal of authorisation, namely:-

(a) consent to establish granted by the concerned State Pollution Control Board under the Water (Prevention and Control of Pollution) Act, 1974, (25 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (21 of 1981);
(b) certificate of registration issued by the District Industries Centre or any other government agency authorised in this regard;
(c) proof of installed capacity of plant and machinery issued by the District Industries Centre or any other government agency authorised in this behalf.

(ii) the concerned State Pollution Control Board, on being satisfied that the application is complete in all respects and complies with the guidelines prescribed by Central Pollution Control Board from time to time, may grant one time authorisation in Form 1 (bb) to such applicants stipulating therein necessary conditions as deemed necessary for carrying out refurbishing activities in the authorised place only;

(iii) the concerned State Pollution Control Board shall dispose of the application for authorisation within a period of one hundred and twenty days from the date of the receipt of such application complete in all respects;

(iv) the concerned State Pollution Control Board may refuse, cancel or suspend a authorisation granted under these rules, if it has reasons to believe that the authorised refurbisher has failed to comply with any of the conditions of authorisation, or with any provisions of the Act or rules made thereunder, after giving an opportunity to the refurbisher to be heard and after recording the reasons thereof;

(v) the Refurbisher shall maintain records of the e-waste purchased and refurbished in Form-2 and shall file annual returns of its activities of previous year in Form-3 to the concerned State Pollution Control Board on or before 30th day of June of every year.

14. Power to suspend or cancel an authorisation.- (1) The State Pollution Control Board may, if in its opinion, the holder of Manufacturer or Dismantler or Recycler or Refurbisher Authorisation has failed to comply with any of the conditions of the authorisation or with any provisions of the Act or these rules and after giving a reasonable opportunity of being heard and after recording reasons thereof in writing

cancel or suspend the authorisation issued under these rules for such period as it considers necessary in the public interest and inform Central Pollution Control Board within ten days of cancellation;

(2) The Central Pollution Control Board, if in its opinion, the holders of the Extended Producer Responsibility- Authorisation has failed to comply with any of the conditions of the authorisation or with any provisions of the Act or these rules and after giving a reasonable opportunity of being heard and after recording reasons thereof in writing cancel or suspend the Extended Producer Responsibility- Authorisation issued under these rules for such period as it considers necessary in the public interest and inform State Pollution Control Boards or Pollution Control Committees within ten days of cancellation;

(3) Upon suspension or cancellation of the authorisation, the Central Pollution Control Board or State Pollution Control Board may give directions to the persons whose authorisation has been suspended or cancelled for the safe storage and management of the e-waste and such persons shall comply with such directions.

CHAPTER IV

15. Procedure for storage of e-waste. - Every manufacturer, producer, bulk consumer, collection centre, dealer, refurbisher, dismantler and recycler may store the e-waste for a period not exceeding one hundred and eighty days and shall maintain a record of collection, sale, transfer and storage of wastes and make these records available for inspection:

Provided that the concerned State Pollution Control Board may extend the said period up to three hundred and sixty five days in case the waste needs to be specifically stored for development of a process for its recycling or reuse.

CHAPTER V

REDUCTION IN THE USE OF HAZARDOUS SUBSTANCES IN THE MANUFACTURE OF ELECTRICAL AND ELECTRONIC EQUIPMENT AND THEIR COMPONENTS OR CONSUMABLES OR PARTS OR SPARES

16. Reduction in the use of hazardous substances in the manufacture of electrical and electronic equipment and their components or consumables or parts or spares. – (1) Every producer of electrical and electronic equipment and their components or consumables or parts or spares listed in Schedule I shall ensure that, new Electrical and Electronic Equipment and their components or consumables or parts or spares do not contain Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyls and polybrominated diphenyl ethers beyond a maximum concentration value of 0.1% by weight in homogenous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers and of 0.01% by weight in homogenous materials for cadmium.

(2) Components or consumables or parts or spares required for the electrical and electronic equipment placed in the market prior to 1st May, 2014 may be exempted from the provisions of sub-rule (1) of rule 16 provided Reduction of Hazardous Substances compliant parts and spares are not available.

(3) The applications listed in Schedule II shall be exempted from provisions of sub-rule (1) of rule 16.

(4) Every producer of applications listed in Schedule II shall ensure that the limits of hazardous substances as given in Schedule II are to be complied.
(5) Every producer shall provide the detailed information on the constituents of the equipment and their components or consumables or parts or spares alongwith a declaration of conformance to the Reduction of Hazardous Substances provisions in the product user documentation.
(6) Imports or placement in the market for new electrical and electronic equipment shall be permitted only for those which are compliant to provisions of sub-rule (1) and sub rule (4) of rule 16.
(7) Manufacture and supply of electrical and electronic equipment used for defence and other similar strategic applications shall be excluded from provisions of sub-rule (1) of rule 16.
(8) Every producer while seeking Extended Producer Responsibility - Authorisation will provide information on the compliance of the provisions of sub-rule (1) of rule 16. This information shall be in terms of self-declaration.
(9) Central Pollution Control Board shall conduct random sampling of electrical and electronic equipment placed on the market to monitor and verify the compliance of Reduction of Hazardous Substances provisions and the cost for sample and testing shall be borne by the Producer. The random sampling shall be as per the guidelines of Central Pollution Control Board.
(10) If the product does not comply with Reduction of Hazardous Substances provisions, the Producers shall take corrective measures to bring the product into compliance and withdraw or recall the product from the market, within a reasonable period as per the guidelines of the Central Pollution Control Board.
(11) Central Pollution Control Board shall publish the methods for sampling and analysis of Hazardous Substances as listed in sub-rule(1) of rule 16 with respect to the items listed in Schedule I and II and also enlist the labs for this purpose.

CHAPTER VI

MISCELLANEOUS

17. **Duties of authorities. -** Subject to other provisions of these rules, the authorities shall perform duties as specified in Schedule IV.

18. Annual Report. – (1) The concerned State Pollution Control Board shall prepare and submit to the Central Pollution Control Board an annual report with regard to the implementation of these rules by the 30th day of September every year in Form-5.
(2) The Central Pollution Control Board shall prepare the consolidated annual review report on management of e-waste and forward it to the Central Government along with its recommendations before the 30th day of December every year.

19. **Transportation of e-waste.** –The transportation of e-waste shall be carried out as per the manifest system whereby the transporter shall be required to carry a document (three copies) prepared by the sender, giving the details as per Form-6:

Provided that the transportation of waste generated from manufacturing or recycling destined for final disposal to a treatment, storage and disposal facility shall follow the provisions under Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.

20. Accident reporting.- Where an accident occurs at the facility processing e-waste or during transportation of e-waste, the producer, refurbisher, transporter, dismantler, or recycler, as the case may be, shall report immediately to the concerned State Pollution Control Board about the accident through telephone and e-mail.

21. Liability of manufacturer, producer, importer, transporter, refurbisher, dismantler and recycler.- (1) The manufacturer, producer, importer, transporter, refurbisher, dismantler and recycler shall be liable for all damages caused to the environment or third party due to improper handling and management of the e-waste;

(2) The manufacturer, producer, importer, transporter, refurbisher, dismantler and recycler shall be liable to pay financial penalties as levied for any violation of the provisions under these rules by the State Pollution Control Board with the prior approval of the Central Pollution Control Board.

22. Appeal.- (1) Any person aggrieved by an order of suspension or cancellation or refusal of authorisation or its renewal passed by the Central Pollution Control Board or State Pollution Control Board may, within a period of thirty days from the date on which the order is communicated to him, prefer a appeal in Form 7 to the Appellate Authority comprising of the Environment Secretary of the State.

(2) The Appellate Authority may entertain the appeal after expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

(3) Every appeal filed under this rule shall be disposed of within a period of sixty days from the date of its filing.

23. The collection, storage, transportation, segregation, refurbishment, dismantling, recycling and disposal of e-waste shall be in accordance with the procedures prescribed in the guidelines published by the Central Pollution Control Board from time to time. Implementation of e-waste (Management and Handling) Amendment Rules, 2011 shall be in accordance with the guidelines prescribed by the Central Pollution Control Board from time to time.

24. Urban Local Bodies (Municipal Committee or Council or Corporation) shall ensure that e-waste pertaining to orphan products is collected and channelised to authorised dismantler or recycler.

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SCHEDULE I

[See rules 2, 3(j), 3(y), 3(aa) and 3(ff); 5; 9; 11(10); 13 (1) (i), 13 (1) (vii) and 16(1), 16(11)]

Categories of electrical and electronic equipment including their components, consumables, parts and spares covered under the rules

Sr. No.	Categories of electrical and electronic equipment	Electrical and electronic equipment code
i.	**Information technology and telecommunication equipment :**	
	Centralised data processing: Mainframes, Minicomputers	ITEW1
	Personal Computing: Personal Computers (Central Processing Unit with input and output devices)	ITEW2
	Personal Computing: Laptop Computers(Central Processing Unit with input and output devices)	ITEW3
	Personal Computing: Notebook Computers	ITEW4
	Personal Computing: Notepad Computers	ITEW5
	Printers including cartridges	ITEW6
	Copying equipment	ITEW7
	Electrical and electronic typewriters	ITEW8
	User terminals and systems	ITEW9
	Facsimile	ITEW10
	Telex	ITEW11
	Telephones	ITEW12
	Pay telephones	ITEW13
	Cordless telephones	ITEW14
	Cellular telephones	ITEW15
	Answering systems	ITEW16
ii.	**Consumer electrical and electronics:**	
	Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology)	CEEW1
	Refrigerator	CEEW2
	Washing Machine	CEEW3
	Air-conditioners excluding centralised air conditioning plants	CEEW4
	Fluorescent and other Mercury containing lamps	CEEW5

SCHEDULE II

[See rules 16 (3), 16 (4) and 16 (11)]

Applications, which are exempted from the requirements of sub-rule (1) of rule 16	
	Substance
1	Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):
1(a)	For general lighting purposes <30 W : 2.5 mg
1(b)	For general lighting purposes ≥ 30 W and <50 W : 3.5mg
1(c)	For general lighting purposes ≥ 50 W and <150 W : 5mg
1(d)	For general lighting purposes ≥150 W : 15 mg
1(e)	For general lighting purposes with circular or square structural shape and tube diameter ≤17 mm : 7mg
1(f)	For special purposes:5 mg
2(a)	Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp):
2(a)(1)	Tri-band phosphor with normal life time and a tube diameter < 9mm (e.g. T2): 4mg
2(a)(2)	Tri-band phosphor with normal life time and a tube diameter ≥ 9 mm and ≤ 17 mm (e.g. T5): 3 mg
2(a)(3)	Tri- band phosphor with normal life time and a tube diameter >17 mm and ≤ 28 mm(e.g. T8): 3.5 mg
2(a)(4)	Tri-band phosphor with normal life time and a tube diameter >28 mm (e.g. T 12):3.5 mg
2(a)(5)	Tri-band phosphor with long life time (≥25000 h):5mg
2(b)	Mercury in other fluorescent lamps not exceeding(per lamp):
2(b)(1)	Linear halophosphate lamps with tube >28 mm (e.g. T 10 and T12):10 mg
2(b)(2)	Non-linear halophosphate lamps(all diameters):15mg
2(b)(3)	Non-linear tri-band phosphor lamps with tube diameter >17 mm(e.g.T9): 15 mg
2(b)(4)	Lamps for other general lighting and special purposes (e.g. induction lamps):15mg
3	Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL)for special purposes not exceeding (per lamp):
3(a)	Short length(≤ 500 mm):3.5mg
3(b)	Medium length(>500 mm and≤1500 mm): 5mg
3(c)	Long length(>1500 mm): 13mg
4(a)	Mercury in other low pressure discharge lamps (per lamp): 15mg
4(b)	Mercury in High Pressure Sodium(vapour) lamps for general lighting purposes not exceeding (per burner)in lamps with improved colour rendering index Ra>60:

4(b)-I	P ≤155 W : 30 mg
4(b)-II	155 W < P ≤405 W : 40 mg
4(b)-III	P >405 W: 40 mg
4(c)	Mercury in other High Pressure Sodium(vapour)lamps for general lighting purposes not exceeding (per burner):
4(c)-I	P≤155 W:25mg
4(c)-II	155 W < P ≤ 405 W:30 mg
4(c)-III	P >405 W:40 mg
4(d)	Mercury in High Pressure Mercury (vapour) lamps (HPMV)
4(e)	Mercury in metal halide lamps (MH)
4(f)	Mercury in other discharge lamps for special purposes not specifically mentioned in this Schedule
5(a)	Lead in glass of cathode ray tubes
5(b)	Lead in glass of fluorescent tubes not exceeding 0.2% by weight
6(a)	Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0.35% lead by weight
6(b)	Lead as an alloying element in aluminium containing up to 0.4% lead by weight
6(c)	Copper alloy containing up to 4% lead by weight
7(a)	Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead)
7(b)	Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signalling, transmission, and network management for telecommunications
7(c)-I	Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound.
7(c)-II	Lead in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher
7(c)-III	Lead in dielectric ceramic in capacitors for a rated voltage of less than 125 V AC or 250 V DC
8(a)	Cadmium and its compounds in one shot pellet type thermal cut-offs
8(b)	Cadmium and its compounds in electrical contracts
9	Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75% by weight in the cooling solution
9(b)	Lead in bearing shells and bushes for refrigerant-containing compressors for heating, ventilation, air conditioning and refrigeration (HVACR) application.

11(a)	Lead used in C-press compliant pin connector systems
11(b)	Lead used in other than C-press compliant pin connector systems
12	Lead as a coating material for the thermal conduction module C- ring
13(a)	Lead in white glasses used for optical applications
13(b)	Cadmium and lead in filter glasses and glasses used for reflectance standards.
14	Lead in solders consisting of more than two elements for the connection between the pins and the package of microprocessors with a lead content of more than 80% and less than 85% by weight
15	Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages.
16	Lead in linear incandescent lamps with silicate coated tubes
17	Lead halide as radiant agent in high intensity discharge (HID) lamps used for professional reprography applications.
18(a)	Lead as activator in the fluorescent powder (1% lead by weight or less) of discharge lamps when used as specialty lamps for diazoprinting reprography, lithography, insect traps, photochemical and curing processes containing phosphors such as SMS ($(Sr, Ba)_2Mg\ Si_2O_7$:Pb)
18(b)	Lead as activator in the fluorescent powder (1% lead by weight or less) of discharge lamps when used as sun tanning lamps containing phosphors such as BSP ($Ba\ Si_2O_5$:Pb)
19	Lead with PbBiSn-Hg and PblnSn-Hg in specific compositions as main amalgam and with PbSn-Hg as auxiliary amalgam in very compact energy saving lamps (ESL)
20	Lead oxide in glass used for bonding front and rear substrates of flat fluorescent lamps used for Liquid Crystal Displays (LCDs)
21	Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses
23	Lead in finishes of fine pitch components other than connectors with a pitch of 0.65 mm and less
24	Lead in solders for the soldering to machined through hole discoidal and planar array ceramic multilayer capacitors
25	Lead oxide in surface conduction electron emitter displays (SED) used in structural elements, notably in the seal frit and frit ring.
26	Lead oxide in the glass envelope of black light blue lamps
27	Lead alloys as solder for transducers used in high-powered (designated to operate for several hours at acoustic power levels of 125 dB SPL and above) loudspeakers
29	Lead bound in crystal glass

30	Cadmium alloys as electrical/mechanical solder joints to electrical conductors located directly on the voice coil in transducers used in high-powered loudspeakers with sound pressure levels of 100 dB(A) and more
31	Lead in soldering materials in mercury free flat fluorescent lamps (which e.g. are used for liquid crystal displays, design or industrial lighting)
32	Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes
33	Lead in solders for the soldering of thin copper wires of 100 µm diameter and less in power transformers
34	Lead in cermet-based trimmer potentiometer elements
36	Mercury used as a cathode sputtering inhibitor in DC plasma displays with a content up to 30 mg per display
37	Lead in the plating layer of high voltage diodes on the basis of a zinc borate glass body
38	Cadmium and cadmium oxide in thick film pastes used on aluminium bonded beryllium oxide
39	Cadmium in colour converting II-VI LEDs (<10 µg Cd per mm^2 of light-emitting area) for use in solid state illumination or display systems.

SCHEDULE III

[See rules 5 (1) (a) and 13 (1) (ii)]

Targets for Extended Producer Responsibility - Authorisation

No.	Year	E-Waste Collection Target (Number/Weight)
(i)	During first two year of implementation of rules	30% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
(ii)	During third and fourth years of implementation of rules	40% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
(iii)	During Fifth and Sixth years of implementation of rules	50% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
(iv)	Seventh year onward of implementation of rules	70% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.

SCHEDULE IV

[See rule (17)]

LIST OF AUTHORITIES AND CORREPONDING DUTIES

Sr. No	AUTHORITY	CORRESPONDING DUTIES
1.	Central Pollution Control Board, Delhi	(i) Grant and Renewal of Extended Producer Responsibility - Authorisation and monitoring of its compliance. (ii) Maintain information on Extended Producer Responsibility - Authorisation on its web site. (iii) Set and revise targets for collection of e-waste from time to time. (iv) Coordination with State Pollution Control Boards (v) Preparation of Guidelines for Environmentally Sound Management of e-waste. (vi) Conduct random check for ascertaining compliance of the e-waste rules and identification of such importers or producers who have not applied for Extended Producer Responsibility authorisation or are not complying with RoHS provision. Wherever necessary, Central Pollution Control Board will seek the help of customs department or any other agency of the Government of India. (vii) Conduct random inspection of dismantler or recycler or refurbisher. (viii) Documentation, compilation of data on e-waste and uploading on websites of Central Pollution Control Board (ix) Actions against violation of these rules. (x) Conducting training programmes. (xi) Submit Annual Report to the Ministry. (xii) Enforcement of provisions regarding reduction in use of hazardous substances in manufacture of electrical and electronic equipment. (xiii) Interaction with IT industry for reducing hazardous substances. (xiv) Set and revise targets for compliance to the reduction in use of hazardous substance in manufacture of electrical and electronic equipment from time to time. (xv) Any other function delegated by the Ministry under these rules from time to time.
2.	State Pollution Control Boards or Committees of Union territories	(i) Inventorisation of e-waste. (ii) Grant and renewal of authorisation to manufacturers, dismantlers, recyclers and refurbishers. (iii) Monitoring and compliance of Extended Producer Responsibility - Authorisation as directed by Central Pollution Control Board and that of dismantlers, recyclers and refurbishers authorisation. (iv) Conduct random inspection of dismantler or recycler or refurbisher. (v) Maintain online information regarding authorisation granted to manufacturers, dismantlers, recyclers and refurbishers.

Sr. No	AUTHORITY	CORRESPONDING DUTIES
		(vi) Implementation of programmes to encourage environmentally sound recycling. (vii) Action against violations of these rules. (viii) Any other function delegated by the Ministry under these rules.
3.	Urban Local Bodies (Municipal Committee or Council or Corporation)	(i) To ensure that e-waste if found to be mixed with Municipal Solid Waste is properly segregated, collected and is channelised to authorised dismantler or recycler. (ii) To ensure that e-waste pertaining to orphan products is collected and channelised to authorised dismantler or recycler.
4.	Port authority under Indian Ports Act, 1908 (15 of 1908) and Customs Authority under the Customs Act, 1962 (52 of 1962)	(i) Verify the Extended Producer Responsibility - Authorisation. (ii) Inform Central Pollution Control Board of any illegal traffic for necessary action. (iii) Take action against importer for violations under the Indian Ports Act, 1908/Customs Act, 1962.

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List of Publications

Borthakur, Anwesha., Govind, Madhav. (2017). Emerging Trends in Consumers' E-waste Disposal Behaviour and Awareness: A Worldwide Overview with Special Focus on India. *Resources Conservation & Recycling (Elsevier)*. 117 (B): 102–113.

Borthakur, Anwesha. (2017). "Electronic Waste in Urban India: A Major Sustainability Challenge". In: J. Mukherjee (Eds), *Sustainable Urbanization in India: Challenges and Opportunities*. Singapore: Springer. DOI: 10.1007/978-981-10-4932-3. ISBN: 978-981-10-4931-6

Borthakur, Anwesha., Govind, Madhav. (2017). How well are we managing E-Waste in India: Evidences from the city of Bangalore. *Energy, Ecology & Environment (Springer)*. (Accepted for publication).

Borthakur, Anwesha., Singh, Pardeep. (2017). Researches on Informal E-waste Recycling Sector: It's Time for a 'Lab to Land' Approach. *Journal of Hazardous Materials (Elsevier)*. 323: 730–732.

Borthakur, Anwesha., Singh, Pardeep. (2016). E-waste in the Era of a Digitally Empowered India: A Real Challenge (A Glance at the World). *Waste Management (Elsevier)*. 58: II.

Borthakur, Anwesha. (2016). Health and Environmental Hazards of Electronic Waste in India. *Journal of Environmental Health (Publisher: National Environmental Health Association, USA)*. 78 (8): 18-23.

Borthakur, Anwesha. (2016). Policy implications of E-waste in India: A Review. *International Journal of Environment and Waste Management (Inderscience)*. 17(3/4): 301-317.

Borthakur, Anwesha. (2015). Generation and Management of Electronic Waste in India: An Assessment from Stakeholders' Perspective. *Journal of Developing Societies (Sage Publication)*. 31(2):220-248.

Borthakur, Anwesha. (2015). Changes in Composition of EEEs and its Impacts on E-Waste. *ICE - Waste and Resource Management*. 168(4):186–193.

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Review

Emerging trends in consumers' E-waste disposal behaviour and awareness: A worldwide overview with special focus on India

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ABSTRACT

E-waste is a complex stream of toxic waste which requires specific handling considerations. Effective and responsible management of E-waste is a global concern today. Considering the depth of the E-waste problem, this paper is an attempt to review two key elements greatly accountable for influencing sustainable E-waste management initiatives: Consumers' E-waste 1) 'Disposal Behaviour' and 2) 'Awareness'. Taking into account the locale specific characteristics of consumers' E-waste disposal behaviour and awareness, we have attempted to perform an extensive review on the global context and identify the measures adopted by the consumers of different countries to dispose off their E-waste. We observe significant differences in consumers' E-waste disposal behaviour not only 'between' the developed and developing countries, but also 'within' these countries. The paper further especially explains the complexities in India's E-waste management system due to its multifaceted socio-economic, cultural and other associated connotations influencing consumers' disposal behaviour and awareness. We conclude that global experiences on consumers' E-waste disposal behaviour and awareness could be helpful for a particular country to devise inclusive E-waste management strategies to adequately address their current E-waste crisis.

Contents

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1. Introduction

Electronic Waste (E-waste) or Waste Electrical and Electronic Equipments (WEEE) has become a major concern in the contemporary world. The rapid growth of E-waste is influenced by fast technological progresses and innovations, rapid changes in information and communication technologies (ICT), economic growth, electrical and electronic equipments (EEEs) becoming a major component of our day-to-day life, increasing versatility of most electronic devices, and the downward trend in prices (Yoshida et al., 2016; Umair et al., 2015; Yla-Mella et al., 2014). For instance, about 5.6 billion mobile phones were in-use in the world as of 2012 (Schnoor, 2012) with the potential for further growth in the near future. Moreover, the rapid advance in technology, consumer demand/attitudes and strong incentives for consumption bring about a drastically reduced lifespan and faster replacement rates of most EEEs, the consequence of which is the rising quantity of E-waste (Gu et al., 2016; Thavalingam and Karunasena 2016; Ozkir et al., 2015; Paiano et al., 2013; Rubin et al., 2014). It represents 1–3% of global municipal waste production of 1636 million tonnes per year (Mallawarachchi and Karunasena, 2012) with a potential to increase by 3–5% every year (Agamuthu et al., 2015). E-waste, today, is a more than $7 billion industry (Grant and Oteng-Ababio, 2012). A joint report by United Nations Environment Programme (UNEP, 2007) and United Nations University (UNU) predicts that by the year 2020, a growth of 500% would be observed in India with respect to E-waste from old computers. During the same time, an overwhelming 7 times and 18 times increase in E-waste production would be observed from discarded mobile phones in China and India respectively (Lu et al., 2015). Likewise, Yu et al. (2010) forecast that by 2016–2018, obsolete Personal Computers (PCs) produced in developing countries will surpass that of the developed countries. E-waste from PCs in developing countries will arrive at 400–700 million units, significantly higher than that of developed countries at 200–300 million units. Such results call for immediate attention from policymakers and research communities of the developing world towards addressing their E-waste problem in an adequate detail.

According to Khetriwal et al. (2009), the deficits in previous studies directly addressing policy makers' concerns makes E-waste management a difficult task. For instance, publics' awareness and their active participation are essential for the success of E-waste management initiatives. While many studies on E-waste issues have been published in the last decade, only a few of them addresses publics' E-waste disposal behaviour and awareness. There is little understanding on how the awareness level affects the disposal behaviour and sustainable management of E-waste in a particular country or community. In India, although local organizational consumers of ICT (in the form of 'bulk' consumers of EEEs) create the majority of E-waste (MoEF, 2008), the factors determining their E-waste decisions (such as when EEEs turn into E-waste, and whether or not it is sent for recycling) are not well understood (Heeks et al., 2014). It is imperative to comprehend consumers' knowledge and awareness levels on their EEEs as they are the ones who eventually become the producers of E-waste in a particular commune (Kwatra et al., 2013). Xu et al. (2014) suggest that legal advocacy, environmental knowledge, consumers' behavioural attitude, their subjective norms, perceived behavioural control and previous recycling experiences directly influence E-waste management activities in a particular city. From this perspective, it is unlikely to have a comprehensive E-waste management initiative without the contribution of 'consumers' who form an integral part of an E-waste management system.

Thus, this paper is an attempt to look into consumers' E-waste disposal behaviour and associated awareness in a global context with special emphasis on India. We try to problematize this issue by addressing queries such as: What are the different modes of E-waste disposal practiced by the consumers of diverse countries? Do consumer's awareness level and disposal pattern differ from one country to another? Do differences exist only 'between' the developed and developing countries or variations also persist 'within' the developed or developing nations? What are the different factors that affect the consumers' behaviour towards E-waste disposal? Does awareness level among consumers shapes their disposal behaviour? What are the different ways or means consumers usually adopt to minimise the problems of E-waste? Is there any socio-cultural/gender difference in E-waste disposal behaviour?

2. Context of the study and methodology

Consumption, disposal behaviour/culture and public awareness coupled with motives for economic development are the main factors influencing E-waste generation in any country (Lu et al., 2015). Understanding consumers' behaviour is central in improving any E-waste collection initiatives (Saphores et al., 2012) and its overall sustainable management. The current literature on consumers' attitudes towards E-waste disposal primarily comprises of literatures investigating the experiences of disposal behaviour which is nothing but the factors that persuade the decision of the consumers whether to store, donate, sell, discard, or recycle an electronic product (Dindarian et al., 2012). In depth researches on the topic have attracted insufficient attention (Song et al., 2012a). A glimpse of the literatures published during the period between 1994 and 2014 best clarifies the reason behind our consideration of the topic. A bibliometric analysis on the trends in global E-waste Research was carried out with 'Scopus' database using different search queries. It has been observed that consumers' E-waste disposal behaviour and awareness have been an ignored area of E-waste research for

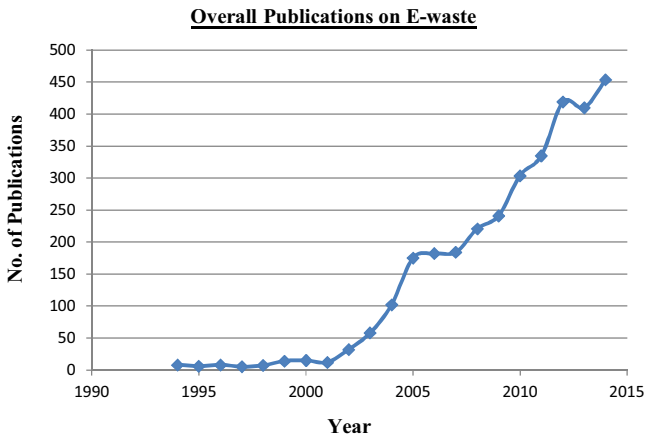

Fig. 1. Graph showing the growth of overall publications on 'E-waste' from 1994 to 2014.
Source: Scopus, 2015

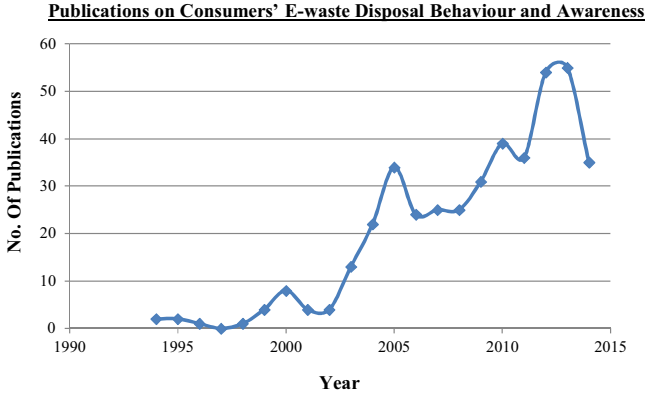

Fig. 2. Graph showing the growth of publications on 'Consumers' E-waste Disposal Behaviour and Awareness' from 1994 to 2014.
Source: Scopus, 2015

a long period of time. The topic has gained research interest and momentum only recently with a number of publications coming up from diverse research groups.

A general investigation in 'Scopus' using a broad search query on 'E-waste' reports 3192 research documents published during the period of 20 years, from 1994 to 2014 (as illustrated in Fig. 1). It has been observed that researches on E-waste has experienced an exponential growth in the last decade with the trend appear to continue in the near future. Whereas a specific search using the query on E-waste with 'Consumer' or 'Awareness' shows 419 research papers published during the same period (as illustrated in Fig. 2). The purpose of using the word 'consumer' instead of phrases such as 'consumer disposal' is to, first, have a wider range of papers so that no paper on the topic is left behind. This broad array of papers is subsequently narrowed down. Therefore, these 419 papers are further individually verified in order to check the authenticity related to our topic of concern by reading at least the abstract (and the full text whenever felt essential) of each paper. It has been observed that although the words 'consumer' and 'awareness' appears in the title, abstract or keywords of a number of papers on E-waste; the overall issues addressed in those papers do not serve our purpose of identifying researches on consumers' E-waste disposal behaviour and awareness.

After thorough investigation of the individual papers, only 52 papers are found to have satisfactorily dealt with consumers' E-waste awareness and disposal behaviour in diverse countries (see Table 1). Thus, a relative lack of adequate research interest on the topic has been observed as compared to other E-waste issues such as recycling of E-waste, chemical analysis and pollution studies, microbial studies, lifecycle assessment, health impact studies of E-waste constituents and so on. Such an inadequate consideration on this important aspect of E-waste management has been a motivation for us to explore the consumers' E-waste disposal behaviour and awareness on a global scale with special focus on India. Fig. 3 shows the countries considered for this paper with their respective per capita E-waste generation (Table 2).

3. Consumers' E-waste *disposal behaviour and awareness*: evidences from some countries

It is essential to identify consumers' E-waste disposal behaviour in a particular country in order to spot relevant weaknesses existing in the system which facilitates in designing management solutions and awareness-raising campaigns (Perez-Belis et al., 2015). Most European or North American consumers who recycle believe that they are reversing or at least mitigating environmental degradation by recycling their goods (Dauvergne and LeBaron, 2013). However, with financial profits playing a major part, incentives for participating in recycling activities in developing economies like India and China are entirely different from that of developed countries. Thus, scenarios vary across countries and it is essential to assess consumers' disposal behaviour and awareness in individual countries in order to address the global E-waste crisis adequately and effectively.

3.1. The Asian context

3.1.1. China

A preferable disposal habit among the Chinese consumers is to sell their obsolete electronic appliances due to the 'norms of viewing these products as tradable properties and the prosperity of second-hand markets' (Chi et al., 2014:91). The study by Li et al. (2012) on the behaviours of urban residents towards discarding E-waste in households in Baoding, China reveals that most often E-waste is sold to the hawkers omnipresent in the area from where these obsolete electronics are directed into the secondhand marketplace to be refurbished, and eventually resold. This is a common practice in the whole country (Chi et al., 2014) with collection and recovery enterprises its key actors (Mo et al., 2009). Accounting for 52% of total disposals, 'malfunction' is observed to be the major reason for discarding of EEEs. Unlike European and North American countries where products once discarded are considered 'waste' having no value, "waste" is considered very valuable in China. Consequently a large informal and formal waste processing market exists in the country with aims to 'capture any value that is present in what people and companies throw away' (Veenstra et al., 2010:451). A general reluctance exist among Chinese consumers to pay for disposal services and waste recycling or for extra consumer responsibility, particularly when consumers can be financially benefitted by selling their out-of-use EEEs (Hicks et al., 2005).

3.1.2. Japan

The legal situation in Japan on E-waste is analogous to the conditions in the European Union to a certain extent (Zoeteman et al., 2010). From the year 2001, policymakers in Japan propagated a comprehensive array of laws, rules and regulations to convert E-waste into resources (Oguchi et al., 2008; Kirby and Lora-Wainwright 2015). The Home Appliance Recycling Law (2001), for instance, allows consumers to return their obsolete EEEs to manufacturers for recycling (Oguchi et al., 2012). E-waste is largely collected by retailer shops from the consumers and subsequently transported to selected stockyards. In other cases, consumers

Table 1
Articles focused on Aspects of Consumers' E-Waste Disposal Behaviour and Awareness.

Reference	Aspect Addressed		Location
	Consumer Disposal Behaviour	Public Awareness	
Tsamo (2014)	•	•	Cameroon
Yu et al. (2014)		•	China
Yla-Mella et al. (2014)	•		Finland
Kwatra et al. (2013)	•	•	India
Xu et al. (2014)	•		China
Ercan and Bilen (2014)		•	Turkey
Zhong et al. (2014)	•		China
Massawe et al. (2014)	•		USA
Shumon and Ahmed (2013)	•		Malaysia
Cruz-Sotelo et al. (2013)	•		Mexico and Spain
Edumadze et al. (2013)	•	•	Ghana
Tocho and Waema (2013)	•	•	Kenya
Chibunna et al. (2013)	•	•	Malaysia
Dixit and Vaish (2013)	•		India
Ciocoiu et al. (2013)	•		Romania
Kaushal and Nema (2013)	•		India
Milovantseva and Saphores (2013)	•		USA
Dwivedy and Mittal (2013)	•	•	India
Anuj et al. (2013)	•		India
Afroz et al. (2013)	•	•	Malaysia
Ho et al. (2013)	•		Malaysia
Hanafi et al. (2013)	•		Indonesia
Achillas et al. (2012)		•	Greece
Subramanian et al. (2012)	•		India
Li et al. (2012)	•		China
Lee and Sundin (2012)		•	Sweden
Song et al. (2012a,b)	•		Macau
Dindarian et al. (2012)	•		UK
Agarwal et al. (2012)	•		India
Rode (2012)	•		India
Fraige et al. (2012)	•	•	Jordan
Chen and Yee (2011)		•	Malaysia
Hanafi et al. (2011)	•		Indonesia
Koloseni and Shimba (2011)	•		Tanzania
Gutierrez et al. (2011)	•		Spain
Ciocoiu et al. (2011)	•		Romania
Lozano et al. (2010)	•		Spain
Jang and Kim (2010)	•		Korea
Ansari et al. (2010)	•	•	Bangladesh
Gutierrez et al. (2010)	•		Spain
Kahhat and Williams (2010)	•		Peru
Davis and Herat (2010)		•	Australia
Nnorom et al. (2009)	•	•	Nigeria
Kunacheva et al. (2009)		•	Thailand
Davis and Wolski (2009)	•		Australia
Tanskanen and Butler (2007)	•		Finland and US
Abeliotis et al. (2006)		•	Greece
Papaoikonomou et al. (2006)		•	Greece
Huang et al. (2006)	•	•	China
Peralta and Fontanos (2006)	•		Philippines
Cairns (2005)	•		USA
Darby and Obara(2005)	•	•	UK

directly get their E-waste to the designated stockyards or to the municipalities close-by, where, municipalities are accountable for the transportation of E-waste to the stockyards (Menikpura et al., 2014). All these initiatives result in Japan being only second to the EU in absolute volumes of E-waste recycled, achieving a 70% recovery of households' E-waste generation (Zoeteman et al., 2010). Nevertheless, one of the major reasons behind half of the out-of-use home appliances in Japan being exported as secondhand items was observed to be the fact that the consumers are obliged to pay the recycling and transportation costs when they discard their obsolete electronics. Consumers can avoid paying the recycling and transportation expenses if they sell their obsolete home appliances to exporters (Shinkuma and Huong, 2009). Such recyclable resource's outflow can weaken Japan's domestic system for recycling (Sugimura and Murakami, 2016).

3.1.3. Korea

Consumers in Korea are responsible for the collection fee of their E-waste and have two options: (1) paying no collection fee if the consumer decides to buy a new replacement product, in this case the retailers, producers or suppliers collect the E-waste (Jang, 2010), or (2) paying a collection fee to the local government collection system (Kahhat et al., 2008). Some municipalities or local governments initiated the collection of E-waste from households at designated areas or curb side collection containers or door-to-door free of charge (Kim et al., 2013). On a weekly basis, local E-waste transporters, contracted and authorised by the local governments, collect E-waste and dispatch it either to private E-waste recycling facilities, off-site treatment facilities, producer recycling centres, or local reuse centres. There are approximately 60 E-waste storage centres across the country established by several importers

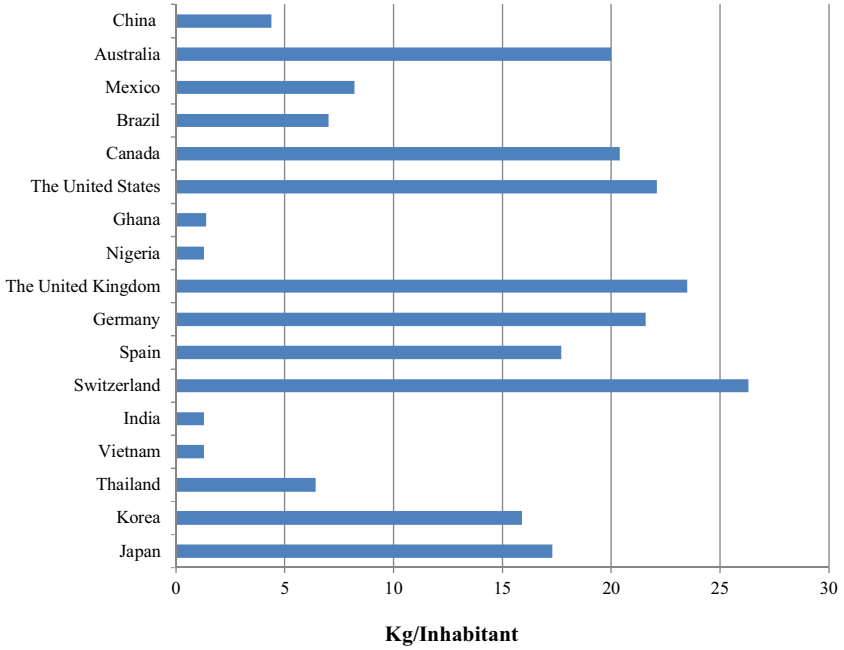

Fig. 3. Countries Considered and Their Respective Domestic E-waste Generation in the Year 2014.
Source: Baldé et al. (2014)

Table 2
A Comparative Analysis of the Countries Considered.

Sr. No	Country	Obsolete EEEs Considered as		Dominance of Sector		Presence of Specific E-waste Legislation	
		'Waste'	'Valuables'	Formal	Informal	Yes	No
1.	China		√		√	√	
2.	Japan	√		√		√	
3.	Korea		√	√		√	
4.	Thailand		√		√		√
5.	Vietnam		√		√		√
6.	India		√		√	√	
7.	Switzerland	√		√		√	
8.	Spain	√		√		√	
9.	Germany	√		√		√	
10.	UK	√		√		√	
11.	Nigeria		√		√		√
12.	Ghana		√		√		√
13.	USA	√		√		√	
14.	Canada	√		√		√	
15.	Brazil		√	√		√	
16.	Mexico		√		√		√
17.	Australia	√		√		√	

and manufacturers of consumer EEEs (Jang, 2010). Nevertheless, some obsolete electronics are often viewed as potentially valuable resources by residents in Korea and thus, many of them are stored at the household level. An estimated 28 million obsolete and used mobile phones were kept stored in Korean households as of the end of 2006 (Jang, 2010).

3.1.4. Thailand

Complementing a major characteristic of emerging economies in Asia, in Thailand too, more than half of the households simply keep stored their end-of-life EEEs at home in the absence of a proper collection mechanism. 11% of the population dispose of E-waste together with other waste and 35% perform some sorts of source-separation wherein unused EEEs are sold, given away, or traded in (Manomaivibool and Vassanadumrongdee, 2011). The primary reason for many Thais keeping their obsolete electronics in storage is their perception of its remaining value (Manomaivibool and Vassanadumrongdee, 2012). 'Donation' is a significant channel for disposal of obsolete items which complements the Buddhist concept of good deeds and thus, largely practiced across the country (Manomaivibool and Vassanadumrongdee, 2011).

3.1.5. Vietnam

Nguyen et al. (2009) observed that owing to the difficult past of the country as a war-torn nation, people in Vietnam traditionally keep their E-waste (which they consider valuable) at home. As a consequence, there is a delay in obsolete EEEs entering the E-waste stream and the amount of waste generated has always been quite small. In Vietnam, the producers have responsibility only for the E-waste from the production line but not for the appliances discarded by consumers. In the country, apart from a few announcements or declarations, presently no laws, rules and regulations exist

to exclusively deal with E-waste (Pariatamby and Victor, 2013), contributing largely to the success of the informal handling system.

3.2. The European context

3.2.1. Switzerland

Switzerland is the earliest country in the world to establish a formal management system for E-waste and today, is a leading country in E-waste collection (Duygan and Meylan, 2015). The pioneering Swiss E-waste management system is based on the principles of EPR—both operationally and legally (Sinha-Khetriwal et al., 2005), placing the financial and physical responsibilities for the eco-friendly E-waste recycling, treatment and disposal processes on EEE manufacturers and exporters (Wath et al., 2010). The fundamental reason for the success of E-waste management initiatives in the country has been its responsible, environmentally conscious and law abiding consumers who return their discarded appliances to the designated retail-outlets or collection points or directly transport E-waste to the recyclers at regular intervals. Further, SENS and SWICO (as the two Producer Responsibility Organizations in Switzerland), are the core of Swiss E-waste take-back system (Hischier et al., 2005) with over 90% of the E-waste from private consumers is collected and treated under the control of one of these two take back schemes (Savi et al., 2013). Financed by an Advanced Recycling Fee (ARF) that the consumers pay while purchasing their EEEs, comprehensive take-back and recycling systems have been established by both SENS and SWICO (Hischier et al., 2005). ARF is more of a consumer rather than a shareholder sponsored system, where a buyer is considerably keener on paying a small cost at the time of purchase of a product than paying for the discarding of an item that is worthless (Khetriwal et al., 2009).

3.2.2. Spain

Prior to the implementation of European Directive on WEEE (2003), 75% of large household electronic appliances in Spain were collected by retailers when consumers purchased a new model. The remaining 25% went to collection points or entered municipality take-back system and were subsequently transferred to the metal managers (Queiruga et al., 2012). A study by Perez-Belis et al. (2015) finds out that 67.1% of consumers dispose of their electrical and electronic toys alongside other waste portions in their domestic wastebins. Only 32.9% discard them at designated recycling points as per the WEEE Directive. Thus, light-weight and small EEEs are taken to selected collection outlets, transferred to metal managers or often just discarded at municipal solid waste containers and subsequently landfilled. As of 2010, Spain has a E-waste collection rate of only 3.3 kg/inhabitant/year, a figure that is way behind those of its European counterparts such as Norway (28.1 kg/inhabitant/year) or Switzerland (16.6 kg/inhabitant/year) (Perez-Belis et al., 2013). In Spain, Royal Decree (RD) 208/2005 on E-waste management transformed the European Directive into a national legislation (on February 25, 2005), thereby conveying that for all new EEEs, the producers are required to establish and finance individual or collective waste management systems to ensure that all products on the market were collected and recycled appropriately, without added cost to consumers (Queiruga et al., 2012).

3.2.3. Germany

In Germany, taking the obsolete electronics to designated collection locations is considered a household's statutory duty (Manomaivibool and Vassanadumrongdee, 2012). Else, the consumers have to pay in order to get their E-waste collected (Sthiannopkao and Wong, 2013). Nevertheless, Dimitrakakis et al. (2009) argues that the E-waste collection system in Germany is yet to be entirely successful in convincing consumers to handover their used EEEs through dedicated routes meant for addressing the E-waste crisis in the country. This often brings the whole E-waste collection schemes into question. For instance, in spite of the obligation for separate collection and sorting, analyses reveal that E-waste (especially small obsolete electronics) compose from 0.4% w/w up to 1.5% w/w of the household residual waste stream. In Germany, the EAR project (Elektro-Altgeräte Register Projektgesellschaft b.R.) acts as a E-waste clearing house between municipalities and producers, warranting monitoring and compliances so that producers accomplish their compulsions under the German Elektro Geräte Act (Widmer et al., 2005).

3.2.4. The United Kingdom (UK)

Working on consumers' behaviour in the UK, Dindarian et al. (2012) question the widely-held belief that E-waste is caused by a desire for the latest technology or innovation. Most of the consumers in Sharston and Manchester, for instance, expressed their willingness to purchase products with the same functionality once they dispose their faulty electronics. Many discarded EEEs are either in perfect working condition or have only minor defects. Nevertheless, those disposing their still operational products are willing to purchase updated products. Consumers are observed to have little knowledge of disposal routes for E-waste other than public recycling facilities. The EU's WEEE Directive (2003) was transposed into a UK law, 'WEEE Regulations 2006'. After the execution of this law, EPR regime has been stringently implemented in the country. For instance, under this regulation, the seller (irrespective of the product being sold directly or by internet, mail order or telephone) must provide a way for their customers to dispose of their old household EEEs when the seller sell them a new version of the same item.

3.3. The African context

3.3.1. Nigeria

In Nigeria, there is no well-established collection, separation, storage, transportation, recycling, disposal facilities and appropriate E-waste management program at present (Alabi and Bakare, 2011). E-waste handling system in the country is largely informal. Residents are found to be willing to support and pay for sound E-waste management in Okigwe and Isuikwuato towns (Nnorom et al., 2009). Consumers with higher income are observed to be more likely to participate voluntarily in E-waste recycling programs (Van Beukering and van den Bergh, 2006).

3.3.2. Ghana

In Ghana, consumers dispose of their E-waste through informal scrap collectors. E-waste collectors (mostly youth) execute door-to-door collections from different consumers such as private homes, institutions etc. Previously the collectors did not have to pay anything for obsolete EEEs which have changed with increasing competition fuelled by increasing youth unemployment and the entrance of collectors with more potential. As a result, today, the waste has begun to attract a competitive price with primary observations suggesting that a collector has to pay $1–2.5 for an obsolete desktop computer (Oteng-Ababio, 2012). Further, at Agbogbloshie in Accra (a globally infamous E-waste dumping site) heaps of inoperative old EEEs are continually being dumped without any consideration to the environmental hazards and threats to the people living in the vicinity (Asante et al., 2011). In a survey, Ghanaian participants displayed same level of awareness of the adverse environmental and health impacts of the current E-waste management practices in Agbogbloshie (Greater Accra), Koforidua (Eastern) and Kwadaso (Ashanti) irrespective of age, occupation or level of education attained (Agyei-Mensah and Oteng-Ababio, 2012). Edumadze

et al. (2013) observed that male students are more environmentally aware than their female compatriot in Ghana.

3.4. The North American context

3.4.1. The United States

In the US, E-waste generated at the household is considered, legally, a non-hazardous waste with its management remains largely a municipal responsibility and a state affair (Wagner, 2009). Storage remains the preferred method to manage end-of- life household electronics in the country, followed by disposal with only a small portion recycled (Lepawsky, 2012). More than 70% of obsolete consumer electronic devices are kept in storage on an average for 3–5 years (Kang and Schoenung, 2005). The financial accountability for management of E-waste is entrusted to the consumers, rather than to the producers (Lepawsky, 2012). As a consequence, 'extended consumers' responsibility (ECR)' is endorsed instead of EPR. The US Environmental Protection Agency's data shows that about 80% of US consumers are willing to pay a fee of less than $5 for recycling of obsolete electronics (Kang and Schoenung, 2006).

California (as the first state in the country to pass E-waste laws in 2003) requires a fee paid directly by the consumer in order to treat their obsolete electronics (Li, 2011). In an attempt to overturn this situation of allotting financial responsibility to consumers, Maine in 2004 became the first state in the US to adopt a household E-waste law with a producer responsibility provision by adopting a modified EPR approach. Maine's program is based on a shared responsibility in which all three primary stakeholders—the producer, the generator (the households or other consumers), and the municipality—share the E-waste management (primarily transportation and recycling) costs (Wagner, 2009). Although the U.S. consumers are offered a significant number of options to manage their E-waste, the approaches are not consistent with respect to the E-waste types accepted or by location (Townsend, 2011). For instance, computers and cell phones are often accepted at multiple drop-off locations, whereas, power tools, fans, and vacuum cleaners may have much fewer, if any, drop-off locations. The significance of 'convenience' and 'familiarity' with recycling are important factors determining consumers' behaviour in the country. People living in more than 5 miles distances away from the closest collection/drop-off center are less likely to recycle. 'Familiarity' with recycling paper, glass, plastics, or metal boosts the willingness to recycle E-waste (Saphores et al., 2006). Further, the gaps in regional and national policies puzzle the EEE producers and consumers and prolong potential detrimental environmental and human health impacts of hazardous E-waste management.

3.4.2. Canada

In Canada, both 'product stewardship' programs and ECR (Lepawsky, 2012) are used for E-waste management. ECR allocates financial responsibly of E-waste management mainly to its consumer citizens. Legislated environmental fees and/or public funds are generally utilized as a funding-base under a product stewardship program and it usually don't assign producers the financial responsibility (ECCC, 2013). Electronics Product Stewardship Canada (EPSC) had established this product stewardship programs in eight Canadian provinces— Quebec, Nova Scotia, PEI, British Columbia, Saskatchewan, Ontario, Manitoba, and Newfoundland and Labrador—in association with the Retail Council of Canada (RCC). Further, Alberta has an Electronics Recycling Administrative Policy under which an Advanced Disposal Surcharge (ADS) is collected on eligible EEEs sold to consumers. Each provincial program in Canada, excluding Ontario's (which let producers decide if such fees are hidden or visible), necessitates a system of consumer–citizens paying a visible fee to finance the E-waste recovery plans (Lepawsky, 2012).

3.5. The Latin American context

3.5.1. Brazil

Often obsolete computers with their peripherals are collected from the households, offices etc of consumer-citizens (de Oliveira et al., 2012). The most preferred method of E-waste disposal among Brazilian consumers in the city of Belo Horizonte-Minas Gerais was found to be 'donation' (Franco and Lange, 2011). Some take back and recycling programs are initiated by Motorola, Dell etc. In Brazil, the key complexity related to the execution of E-waste recycling practices is the collection system. It is because its efficacy depends not merely on the education plus support of the citizens, however also on collaboration amongst industrial waste producers, distributors and the local/national governments (Araujo et al., 2012).

3.5.2. Mexico

In Mexico, there is no formal E-waste collection program because of the absence of legal assurances on the liability of government, manufacturers/distributors, and the general public (Garcia et al., 2012). The immense majority of the 2443 Mexican municipalities do not have the human or economic means or legal infrastructures to tackle the urban solid waste crisis (de Oliveira et al., 2012), thereby making E-waste management a major challenge in the country. The study by Garcia et al., 2012 observed that there are 125 obsolete computers stored per 1000 houses with 99,000 obsolete computers stored in the study area of Northeast Mexico alone. The survey reported that obsolete computers have been stored for a mean of 1.8 years with a maximum of 8 years. Only 19% of the houses have disposed obsolete computers. Further, computers deemed obsolete by bulk consumers are important assets for internet kiosks and cafes that provide internet access to consumers with limited needs. Obsolete computers are not always disposed of for economic incentives. Instead, 'donation' of computers to friends and family members is a popular end-of-use management option with 20–36% of computers is donated in the country (Estrada-Ayub and Kahhat, 2014). Some corporations donate or sell old EEEs to schools, employees and other organisations.

3.6. Australian context

Australian National Television and Computer Recycling Scheme (NTCRS), a major outcome of National Product Stewardship Scheme, builds on existent recycling endeavours by local councils, charitable and other organisations to facilitate consumers (especially small businesses and householders) to drop-off their redundant computer products and televisions at certain collection locations free of charge across Australia. By 2021–2022, the NTCRS expects upto 80% enhancement in the recycling rate. There are more than 40 drop off points available in Queensland, Australian Capital Territory, Western Australia, South Australia, Victoria, and New South Wales since the NTCRS commenced in May 2012 (ABS, 2013). In Australia, there is a recycling fee applied when consumers buy new products. Consumer can recycle their EEEs through local municipalities and private collections organized by business association to collect E-waste. EPR and ARF are the most preferred finance scheme for consumers towards funding E-waste management (Davis and Herat 2010, 2008). Lack of awareness on E-waste was observed among Australian citizens (in 29 councils in Queensland) on issues about E-waste. Over 80% of the respondents from the councils indicated that they believed the public were only 'slightly aware' (40%) or 'not at all aware' (40%) of the problem (Davis and Herat, 2008).

4. Consumers' E-waste *disposal behaviour and awareness* in India

It is approximated that 75% of obsolete EEEs in India are stored due to ambiguity about how to manage them properly (Ramachandra and Varghese, 2004). A pervasive view of E-waste as a commodity causes a reluctance to dispose it off immediately (Sinha, 2008). As majority of consumers prefer to store their E-waste at home rather than returning it to the producers, it limits the successful implementation of reverse logistic approaches (Dixit and Badgaiyan, 2016) or EPR module. Dwivedy et al. (2015) argue that as consumers in India expect some kind of financial benefits while discarding their E-waste, the EPR model is likely to be unsuccessful since it inflicts cost to consumers. A study in the IT hub of Pune observed computer waste being stored for up to 14 years. Resulting in a longer average life, obsolete EEEs often changes many hands (frequently finds secondhand and even thirdhand users) in India before finally getting disposed off (Borthakur, 2014).

Nevertheless, most of the E-waste in India is disposed of either through auction (usually a route adopted by and limited to various Government establishments) or sold to the scrap dealers (kawariwalas) which in turn are sold to the recyclers in the informal sector (Raghupathy and Chaturvedi, 2013). Scrap dealers or 'kawariwalas', collect E-waste from diverse individual or bulk consumers and pass them to the recyclers. In contrast to developed countries such as Switzerland, where consumers pay a recycling fee, in India it is the waste collectors or the kawariwalas who pay consumers a positive price for their obsolete EEEs (Sinha-Khetriwal et al., 2005). This acts as an incentive for consumers to dispose their obsolete electronics through informal waste collectors. Informal collection of E-waste in India leads to higher collection rates and several social and economic benefits to the poor strata of the country (Pariatamby and Victor, 2013; Pandey and Govind, 2014).

Regarding the awareness, considerable fraction of middleclass population of Delhi, for instance, is still unaware of E-waste. However, on receiving information they could associate the repercussions of inappropriate E-waste management practices with harmful health outcomes (Kwatra et al., 2013). Unaware of the methods of disposal, many households and other institutes dispose their E-waste with regular household wastes in India (Borthakur, 2015). A significant portion of the E-waste produced in the Mumbai Metropolitan Area is disposed off in the regular bins which call for effective E-waste awareness campaigns among manufacturers and consumers (Rode, 2012). The study by Kwatra et al. (2013) observes the willingness of EEEs users in New Delhi to pay extra cost for appropriate E-waste management in the city with proper sharing of costs between consumers and producers. They believe that equal responsibilities rest on the shoulders of producers, consumers and governments for effective E-waste management in the city. For instance, even if government takes initiative to construct E-waste recycling facilities, existing literatures reveal that without appropriate consumers' awareness, a recycling system never achieves its utmost efficiency (Sarath et al., 2015). Thus, effectiveness of E-waste recycling is subjected to consumer participation, technical capacity, various national legislations etc (Li et al., 2015). The current E-waste situation in India necessitates the constructive involvement of its various stakeholders in terms of consumers' attitude and awareness, local governance, infrastructural capacity, dominance of the informal sector and so on.

5. Discussion

Significant differences exist in consumers' E-waste disposal behaviour and awareness across diverse countries. Understanding these dynamic and locale specific characteristics are fundamental in improving any E-waste management initiative. Nevertheless, considering the involvement of a large number of stakeholders (in the form of manufacturers, retailers, consumers, scrap dealers, recyclers etc) in the entire E-waste management process, an appropriate analysis of consumers' disposal behaviour and associated awareness is rather exigent.

5.1. Waste vs. valuables

Unlike developed countries, where products once discarded are considered 'waste' having no intrinsic value, 'waste' is considered valuable in developing countries. People in India, for instance, are reluctant to discard their obsolete electronics immediately without any financial incentive as E-waste is still considered a worthy commodity. Here electronic products often find different users before finally getting disposed off. It could be viewed on a positive light from environmental and health risk prospective as it delays the entry of E-waste into the toxic waste stream and contributes to waste minimization. The door-to-door scrap collection, where consumers are paid a decent price for their obsolete electronics, is a common practice in India. This leads to the growth of a large informal sector in the country where 95% of E-waste generated is taken care of (Chatterjee, 2012). On the contrary, considering their population size, the per capita E-waste generation is large in developed countries as compared to its developing counterparts (See Fig. 3). It says a lot about the disposable approach or culture of the people in some throwaway societies. Thus, the E-waste is observed differently in different countries, which in turn, are instrumental in shaping consumers' disposal behaviour.

5.2. Financing the E-waste management initiatives: the payment models

Not only between the developed and developing countries alone, variations concerning E-waste management initiatives are ubiquitous within the developed countries or within the developing countries as well. One such variation involves the allocation of responsibility to finance E-waste management programs. Currently, there are two main financial models adopted for E-waste management around the world: 'consumers pay' and 'manufacturers/producers pay' (Chi et al., 2014). EPR is widely practiced in developed countries such as Japan, Korea and EU member countries. However, ECR is extensively exercised in another set of developed countries such as the US and Canada where legislations around E-waste place financial responsibility for waste management chiefly on consumers and not on producers. Nevertheless, these two models have the potential to overlap with each other. In Switzerland, for instance, ARF is charged on all new appliances in order to finance the collection and recycling of E-waste. Therefore, although the Swiss system of E-waste management largely depends on EPR, consumers still pay the ARF. Further research in this area needs to be undertaken in order to establish or delineate these two payment models. Contrary to these two models, scrap dealers or 'kawariwalas' largely pay consumers a positive price for their obsolete electronics in countries such as India and China. This acts as an incentive to the consumers' to sell their discarded electronics to the scrap dealers and earn some financial profit. Such diversities in financing E-waste management initiatives by respective countries depict an interesting picture and calls for adequate addressing by the research community to identify appropriate policy for different countries.

5.3. The omnipresent ambivalence

Our analysis shows an omnipresent ambivalence towards sustainable management of E-waste across the globe. For instance, it

is estimated that 70–75% of obsolete electronic items are stored in countries like the US and India due to uncertainty of how to manage them appropriately. Mexico and India record E-waste being stored up to 8 years and 14 years respectively. The study by Yla-Mella et al. (2015) reveals that high consumer awareness in Finland on E-waste is yet to be translated into responsible recycling behaviour with 55% of respondents have two or more unused mobile phones at homes. Thus, perplexity on E-waste disposal is not confined to the developing nations alone and ubiquitous across countries. In such scenarios, effective implementation of E-waste management policies remains highly uncertain and challenging.

5.4. Factors influencing E-Waste disposal behaviour and awareness

One of the primary reasons behind the inadequate collection responses of E-waste by local governments is the lack of public awareness about the significance of proper E-waste disposal. The recycling attitudes of consumers are influenced by socio-cultural-economic conditions, having appropriate knowledge, facilities and opportunities recycle. For instance, Switzerland is considered a model for successful implementation of EPR regime and a sustainable E-waste management case. Despite undertaking similar initiatives, Spain records that 67.1% of its consumers dispose of their electrical and electronic toys together with other waste portions in domestic wastebins. In Spain, the per capita collection rate of E-waste is also far lower than its several European counterparts. Thus, consumers' awareness and access/opportunity to recycle determine their recycling behaviour (Baxter and Gram-Hanssen, 2016), which in turn, can be a challenging endeavour considering the time/efforts required and consumers' often prevalent out-of-sight-out-of-mind attitude (Mozo-Reyes et al., 2016). While some developing countries are engaged in extracting maximum financial benefits from their obsolete electronics, consumers in Thailand, Brazil and Mexico prefer 'donation' is a preferable mean to dispose their E-waste. Thus, consumers' behaviour is dynamic across countries and influenced by factors such as ideology of consumers, familiarity/convenience of recycling activities, age, gender, income and education among others. High educational level emerges to be currently the most significant factor in raising the potential of a household's willingness to pay for E-waste treatment in Baoding, China. Nigerian experience indicates that consumers with higher income are more likely to participate voluntarily in recycling programs. However, participants displayed same level of awareness of the adverse environmental and health impacts of the current E-waste management practices in Ghana irrespective of age, occupation or level of education attained. Although a study in Ghana indicates that male students are more environmentally aware than their female colleagues, some scholars concluded no meaningful relationships between environmental attitudes and gender. 'Convenience' (mainly in terms of distance) and 'familiarity' with recycling are important factors shaping consumers' behaviour in the US. Therefore, one pertinent option to boost consumers' recycling attitude is to increase the number of E-waste collection centres at close intervals. There is an ideological aspect involved with E-waste disposal too. While most European or North American consumers believe that they are mitigating environmental degradation by engaging in recycling activities, such an attitude is predominantly absent in countries like India or China. In these developing countries financial attributions largely determine consumers' E-waste disposal attitude. This makes E-waste management initiatives especially challenging for the developing world. Fig. 4 shows various economic, socio-cultural and infrastructural factors accountable for responsible E-waste disposal behaviour.

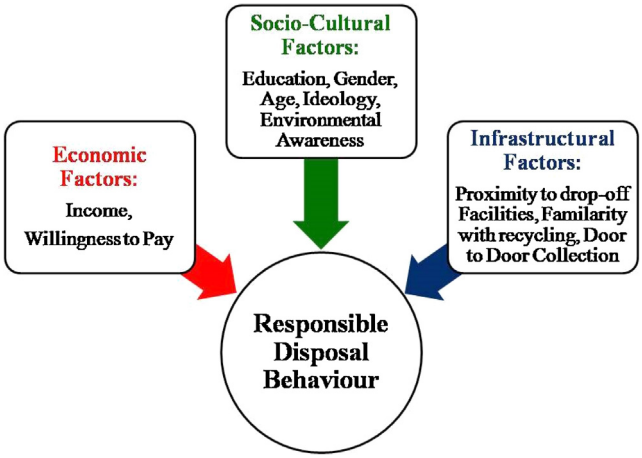

Fig. 4. Factors Affecting Consumers' E-waste Disposal Behaviour.

6. Conclusions and policy implications

In this review on consumers' E-waste disposal behaviour and awareness worldwide with special focus on India, we attempted to provide a comprehensive overview on the current global E-waste scenarios. It emerges that consumers' disposal behaviour and awareness are central to any successful E-waste management interventions without which no reuse/recycling efforts would be fully functional and satisfactory, no pollution abatement initiatives would be entirely successful, no policy instruments could be satisfactorily implemented, no detrimental health/environmental consequences of E-waste could be addressed sufficiently and chaotic dubious E-waste management processes would progress towards an erratic fate. Therefore, it is important to take into account the diverse global experiences and attempt to develop inclusive agendas to address the E-waste crisis of a particular country effectively. India's E-waste dilemma, for instance, has its own specific characteristics. The diverse socio-cultural, economic, political, technological, infrastructural and environmental considerations among its citizens pose serious challenges in formulating one, widely accepted and explicit E-waste management strategy. It is not at all possible to effectively imitate and reproduce a foreign country's E-waste management experience and implement it in Indian context. Nevertheless, India can learn from the individual country's E-waste experiences and formulate a comprehensive plan for sustainable E-waste management. For instance, learning from the US's experience and taking advantages of Indian consumers' 'familiarity' with recycling (the country has a long history of practicing recycling of glass, paper, metal, plastics etc), establishing E-waste drop-off centres at regular intervals for better 'convenience' has the potential to ensure responsible disposal behaviour. Further, a minimum ARF for new EEEs may be introduced in India based on the existing socio-economic status of the country. Paying an ARF in turn will encourage the producers to exercise EPR in the country. Learning from the Chinese experience where the laws on E-waste are increasingly executed stricter, it is important for India to stringently implement its existing E-waste (Management) Rules, 2016.

Consumers' E-waste disposal behaviour and awareness are dynamic across countries. Considering the complexity of the current global E-waste crisis, we propose that further research in this area in both developed and developing countries are essential in order to address the existing E-waste management problem in an adequate detail.

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