ENABLING A CIRCULAR ECONOMY FOR E-WASTE IN PUNE CITY

Report by World Institute of Sustainable Energy

An Initiative Supported by U.S. Consulate General Mumbai
ENABLING A CIRCULAR ECONOMY FOR E-WASTE IN PUNE CITY

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Report by

WORLD INSTITUTE OF SUSTAINABLE ENERGY

An Initiative Supported by

THE OHIO STATE UNIVERSITY
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In 1972, Donella and Denis Meadows and their team guided by Jay Forrester from the Massachusetts Institute of Technology, prepared a path-breaking (and highly debated) report for the Club of Rome. The report concluded that business-as-usual, unhindered extraction of our natural resources to cater to the ever-increasing consumption patterns of our burgeoning population would lead to total collapse of growth and our ecosystem in the future. Forty-seven years later, the message of this report rings glaringly true. The Global Resources Outlook 2019—a UNEP report—states that since the 1970s, the world population has doubled and the gross domestic product has increased fourfold, resulting in the tripling of our natural resources extraction: from 27 billion tons in 1970 to 92 billion tons in 2017. This unrestricted extraction has further led to increased production and consumption of electrical and electronic equipment, resulting in the generation of 44.7 million metric tons of e-waste in 2016, equivalent to 4,500 Eiffel towers (Global Waste Monitor, 2017). There is therefore an urgent need to move away from the current ‘cradle-to-grave’ economy of unrestricted growth and proliferation of waste to one where sustainability of resources is key, and waste is reduced, reused, refurbished, repaired, and recycled, forming a ‘cradle-to-cradle’ or circular economy.

Moving in tandem with this urgent need, the U.S. Consulate in Mumbai organized a joint U.S. India conference in 2017, announcing a grant competition for waste management innovation in India. The focus of the competition was to assess the current status of waste management in India—under any one of the different waste management topics presented—and explore innovative solutions that could be tested and adopted in the country, sharing global best practices and experiences in the process. WISE was awarded the seed grant for the topic, Enabling a Circular Economy for E-waste in Pune City. The grant proposal was evaluated, awarded, and monitored on behalf of the U.S. Consulate General, Mumbai, by The Ohio State University.

This report brings to the fore WISE’s observations and key findings garnered from one-on-one interactions and group discussions with concerned stakeholders on the current e-waste management system and practices in Pune city. It highlights the challenges and issues faced by the various players in the e-waste sector viz. government authorities, members of the formal and informal sectors such as civil society organizations, private entrepreneurs, citizens’ groups, rag pickers, etc., and end-users (household consumers) at the governance, technical, infrastructural, information and financial levels. A comprehensive action plan developed by WISE provides practical and innovative strategies and solutions to enable a circular economy for e-waste management in Pune city.

It is hoped that the report and action plan will pave the way for better and informed decisions and actions by policy-makers and concerned stakeholders for developing a circular model framework for e-waste management in Pune city that can be replicated and emulated in other Indian cities as well. WISE plans to submit the report to the Pune Municipal Corporation, the nodal authority for e-waste management in Pune city, for implementation and necessary action.

Praveena Sanjay
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World Institute of Sustainable Energy
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<th>Description</th>
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<tbody>
<tr>
<td>CAGR</td>
<td>Compound Annual Growth Rate</td>
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<tr>
<td>CEW</td>
<td>Covered Electronic Waste</td>
</tr>
<tr>
<td>CMDA</td>
<td>Computer and Media Dealers Association</td>
</tr>
<tr>
<td>CPCB</td>
<td>Central Pollution Control Board</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tubes</td>
</tr>
<tr>
<td>EÅF</td>
<td>Elektronikåtervinningsföreningen (Electronics Recycling Association)</td>
</tr>
<tr>
<td>EEE</td>
<td>Electrical and Electronic Equipment</td>
</tr>
<tr>
<td>EIB</td>
<td>European Investment Bank</td>
</tr>
<tr>
<td>EPA</td>
<td>Environment Protection Agency</td>
</tr>
<tr>
<td>EPR</td>
<td>Extended Producer Responsibility</td>
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<tr>
<td>EWRA</td>
<td>Electronic Waste Recycling Act</td>
</tr>
<tr>
<td>EWX</td>
<td>E-Waste Exchange</td>
</tr>
<tr>
<td>FICCI</td>
<td>Federation of Indian Chambers of Commerce and Industry</td>
</tr>
<tr>
<td>HW</td>
<td>Hazardous Waste</td>
</tr>
<tr>
<td>HWM</td>
<td>Hazardous Waste Management</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>KC</td>
<td>Kabadiwala Connect</td>
</tr>
<tr>
<td>LHRA</td>
<td>Law for the Recycling of specified kinds of Home Appliances</td>
</tr>
<tr>
<td>LPUR</td>
<td>Law for the Promotion of Effective Utilization of Resources</td>
</tr>
<tr>
<td>MeitY</td>
<td>Ministry of Electronics and Information Technology</td>
</tr>
<tr>
<td>MoEFCC</td>
<td>Ministry of Environment, Forest and Climate Change</td>
</tr>
<tr>
<td>MPCB</td>
<td>Maharashtra Pollution Control Board</td>
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<tr>
<td>MSW</td>
<td>Municipal Solid Waste</td>
</tr>
<tr>
<td>NCR</td>
<td>National Capital Region</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>PBB</td>
<td>Polybrominated biphenyl</td>
</tr>
<tr>
<td>PBDE</td>
<td>Polybrominated diphenyl ethers</td>
</tr>
<tr>
<td>PMC</td>
<td>Pune Municipal Corporation</td>
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<tr>
<td>PMR</td>
<td>Pune Metropolitan Region</td>
</tr>
<tr>
<td>PRO</td>
<td>Producer Responsibility Organization</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl chloride</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
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<tr>
<td>RoHS</td>
<td>Restriction of Hazardous Substances</td>
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<td>SPCB</td>
<td>State Pollution Control Board</td>
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<tr>
<td>TSDFs</td>
<td>Treatment, Storage, and Disposal Facilities</td>
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<tr>
<td>USD</td>
<td>United States Dollar</td>
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<tr>
<td>UW</td>
<td>Universal Waste</td>
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<tr>
<td>WEEEE</td>
<td>Waste Electrical and Electronic Equipment</td>
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EXECUTIVE SUMMARY

The electrical and electronics market in India is surging ahead. A recent report by the Associated Chambers of Commerce and Industry of India (ASSOCHAM) states that the demand for electronic products is expected to grow at a CAGR of 41 percent during 2016-2020 to reach USD 400 billion by 2020. In the wake of major initiatives announced by the Government of India for the electronics manufacturing industry, such as announcement of INR 7.45 billion for the sector, and the Make in India and Digital India initiatives, India’s domestic production is expected to grow at a CAGR of 27 percent from 2016 to 2020 and reach USD 104 billion in 2020, as compared to the CAGR of 9.6 percent during 2010-2016.

So, while on one hand the electronics sector is booming, on the other hand, rapid technological upgradation and obsolescence of electrical and electronic equipment (EEE), and increase in purchasing power of consumers has led to unrestricted consumption of EEE and subsequent increase in the generation of electronic or e-waste. According to another ASSOCHAM-NEC report, India accounted for 2 million metric tons of global e-waste in 2016 and ranked fourth in the world after China, the United States, and Japan in e-waste generation. Within the country, the state of Maharashtra ranked first in e-waste generation (at 19.8 percent) in 2016.

Pune is the cultural and educational capital of Maharashtra, considered as one of the eight largest metropolitan cities in the country. 2016 figures from the Pune Municipal Corporation (PMC) show that the city of Pune generated around 16,425 tons of e-waste/annum, of which, only a miniscule amount of 8.46 tons per annum was received and sent for recycling by PMC. Given that Pune city is one of the largest industrial and IT hubs in the county, there is an urgent need for increasing the potential for e-waste recycling, thereby reducing e-waste generation on a massive scale. It was with this broad aim in mind that the World Institute of Sustainable Energy (WISE), with financial support from the U.S. Consulate General, Mumbai, and The Ohio State University, set forth to conduct a detailed study on the e-waste scenario in Pune city. The study assesses in detail, the challenges and lacunae that are present in the current e-waste management system in Pune city, at multi-administrative as well as multi-stakeholder levels, through one-on-one meetings and group discussions.

The main objective of the study is to capture at least 60 percent of the e-waste generated in the city in the next two years by enabling a circular economy for e-waste in the city. The action plan developed by WISE hopes to achieve this.

SUMMARY OF KEY OBSERVATIONS AND FINDINGS

CHALLENGES FACED BY MPCB/PMC STAKEHOLDERS (AT THE GOVERNANCE LEVEL)

- Lack of proper guidelines and regulations, targets/benchmarks and timelines for e-waste collection and management.
- Current mandate segregates wet waste and dry waste. No guidelines/mandate to segregate e-waste, resulting in mixing of e-waste with dry waste and increasing difficulties in segregation and recycling.
MPCB has defined rules for IT e-waste. But rules for household e-waste are absent. Monitoring is present only for ‘bulk companies’ but not for households.

Section 2 of the MPCB rules provides list of equipment that are categorized under e-waste. Certain common categories such as batteries, power banks, etc., are absent from the list resulting in mismanagement of such e-waste.

There are no proper guidelines and compliance for formal monitoring and evaluation and hence, imposition of penalties for poor performance is not possible. This is a major gap.

Poor monitoring by PMC/MPCB due to lack of capacity building and suitable staff/manpower/dedicated cell for monitoring e-waste management in Pune city.

Lack of coordination between MPCB, PMC, the NGOs and recyclers leading to haphazard functioning and ineffective facilitation of e-waste collection, recycling, monitoring and reporting.

Lack of capacity building of all stakeholders, starting from PMC. However, training would be irrelevant without putting a proper e-waste management system in place.

CHALLENGES FACED BY THE FORMAL AND INFORMAL SECTORS (AT THE TECHNICAL, INFRASTRUCTURAL, FINANCIAL, INFORMATION LEVELS)

Temporary e-waste collection centers (Aarogya Kothis) set up by PMC inadequate to house huge amounts of e-waste. Lack of proper centralized/decentralized warehousing facilities for storage of e-waste.

Lack of knowledge and implementation of suitable business models for e-waste recycling by the formal sector.

Lack of suitable financial incentives for e-waste collection and recycling, resulting in lack of interest by the recyclers in e-waste. Also, costs pertaining to transportation of e-waste are extremely high. Recyclers thus focus mainly on IT equipment, which is a more profitable business.

Acute shortage of funds for information campaigns and awareness drives from the government, resulting in NGOs (who form a major part of the formal sector in Pune city) depending mainly on corporate social responsibility funding from private players.

Sector dominated by informal collectors due to lack of proper guidelines to make the shift from the informal to the formal sector. In addition, in the absence of compliance, sectoral inefficiency is very high.

Lack of capacity building and training resulting in hazardous dismantling and recycling of e-waste by the informal sector leading to harmful health and environmental impacts.

CHALLENGES FACED BY END USERS (INFRASTRUCTURAL AND INFORMATION LEVELS)

Lack of awareness regarding the existence of PMC’s 177 temporary e-waste collection centers (Aarogya Kothis) by the citizens of Pune city.

Lack of manpower at PMC's Aarogya Kothis. Stakeholders affirm that manned collection centers witness more e-waste collection than unmanned ones, as citizens are explained about what to do and how to donate their e-waste.

Lack of proper collection bins at prime locations in the city to facilitate e-waste collection by the citizens.
Overall, lack of citizens’ awareness and knowledge gap regarding e-waste collection initiatives/drives by the formal sector, policy and regulation, etc., a major hindrance in the sector.

SUMMARY OF STRATEGIES AND ACTIONS

Based on the findings, WISE has developed a comprehensive action plan that provides strategies with specific timelines. A summary is provided below. In Chapter 3 of the report, these strategies are accompanied by a detailed action plan for the short-term (to be carried out in the next two years to enable capturing at least 60 percent of e-waste in the city) and the long-term (to be carried out in the next five years), along with stakeholders who need to implement them.

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<th>Challenge</th>
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<th>Long-term</th>
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<tr>
<td>1</td>
<td>Lack of defined guidelines, targets and benchmarks for e-waste management.</td>
<td>• Frame guidelines that would detail the specific roles and responsibilities of the stakeholders, their functioning, rules and regulations, punitive action, if any, and integrating these into a circular economy framework.</td>
<td>• Set targets and benchmarks for e-waste generation and resource efficiency in Pune city.</td>
</tr>
</tbody>
</table>
| 2  | Lack of awareness and knowledge amongst Pune citizens regarding e-waste collection, handling and management. | • Awareness campaigns targeting focused groups at the industrial and corporate level, academic level, household level, etc. to be devised and implemented.  
• Coordination between PMC, NGOs and citizens' voluntary groups for developing a long-term action plan for awareness generation in Pune city. | • Providing adequate funding for implementation of such awareness campaigns.  
• Critical information on e-waste to be made available in the public domain using the print, digital, electronic and social media, in coordination with PMC, NGOs and voluntary groups. |
| 3  | Lacunae in the functioning of the E-waste cell at PMC and MPCB            | • Strengthening manpower of the e-waste cell at PMC and MPCB.  
• Capacity building of the e-waste cell by industry/ academic experts. | • Development of online certificate courses for developing and upgrading skills.  
• Provision of adequate funding for the smooth functioning of the cell. |
| 4  | Inadequate Infrastructure and logistics for e-waste management activities | • Renovation of existing storage/collection centers to provide more space for storage.  
• Provision of manned collection centers with weighing scales to keep track of quantity of e-waste collected.  
• Place e-waste collection bins in prime public locations (shopping malls, parks, events etc.) for facilitating collection.  
• Improve transportation services for e-waste collection. | • Establishment of permanent infrastructure for facilitating and enhancing e-waste collection, storage, and recycling.  
• Establishment of formal recycling infrastructure to reduce illegal and unhealthy practices of recycling and shift to a circular economy.  
• Provision of adequate funding for establishment of infrastructure and logistical support. |
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<th>Long-term</th>
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| 5. | Huge dominance of informal sector thus creating a 'parallel' e-waste management system and unnecessary, additional channels of e-waste collection. | • Strengthening of the existing informal sector through adequate training and the advantages of moving to the formal sector.  
• New entrepreneurs to be incentivized and encouraged to enter the business under various government schemes.  
• PMC to facilitate and promote licensing of informal collectors, provide information on avoiding penalties. | • Channelization of funds to attract informal collectors to integrate with the formal sector.  
• Government measures to provide job opportunities, train and support daily wage workers to integrate into the formal sector.  
• Development of suitable business models to encourage informal to formal sector integration. |
| 6  | Lack of appropriate reporting, monitoring and evaluation mechanism in MPCB and PMC | • Dedicated staff for monitoring e-waste at MPCB and PMC.  
• Proper coordination between PMC and MPCB for facilitating data sharing and reporting.  
• Proper coordination between MPCB and stakeholders for strengthening monitoring and evaluation. | • Need for centralized online system to monitor, report, review data, and facilitate information and communication.  
• Setting up of a centralized grievance redressal cell for the stakeholders to improve the monitoring and evaluation mechanism. |
| 7  | Unsafe and unhealthy dismantling and recycling practices causing threat to health, society and the environment | • Development of suitable guidelines (under the overarching E-waste guidelines) for monitoring and evaluation.  
• Educating the informal sector on the hazards of unsafe e-waste management practices and conducting studies on their harmful impacts. | • More stringent regulations for prohibiting child labor in the sector.  
• Processing and recycling to develop a more effective and circular e-waste economy |
| 8  | Lack of funding and subsidy schemes for the formal sector                  | • Introduce innovative schemes and incorporate more e-waste management activities under CSR.                                               | • Create financial models and long-term funding opportunities and schemes for e-waste management.                                           |
| 9  | Unsustainable lifestyle practices leading to over consumption of natural resources and EEE | • Awareness campaigns on social and moral obligations and responsibilities towards sustainable production and consumption of resources.  
• Awareness campaigns on moving from the ‘3Rs’ (reduce, reuse, recycle) to the ‘5Rs’ (reduce, reuse, refurbish, repair, recycle) way of life. | • Change in consumer behavior and mindset of policy makers, industry, and common citizens on unsustainable consumerism. |
SUMMARY OF RECOMMENDATIONS AND SUGGESTIONS

1. Baseline study for Pune city to assess and evaluate the total consumption of resources (EEE) and the related e-waste generated and enable setting up of suitable benchmarks and targets for reducing e-waste generation.

2. Long-term resource efficiency strategy for Pune city that would aim to reduce the use of new (natural) resources in manufacturing as well as reduce consumption of EEE by consumers.

3. Impact assessment studies to assess and analyze the health, environmental and economic impacts of improper e-waste dismantling and recycling by the informal sector.

4. Capacity building / training programs and workshops for the formal and (especially) informal sectors on the negative health and environmental impacts of handling, dismantling, and recycling e-waste in an improper and unscientific manner.

5. Studies to develop appropriate business and financial models for a circular, e-waste economy that would attract more funding from public and private institutions into the sector.

6. Studies, conferences, seminars, community drives and workshops to educate citizens on unsustainable consumerism and change consumer mindsets towards adopting a better and more sustainable lifestyle.

7. Feasibility studies to assess the possibilities of designing ‘product service systems’ that would integrate products, services, supporting networks and infrastructure, to reduce waste and form a circular economy.

8. In-depth research and studies to aid the transition from a resource-intensive and wasteful economy to a resource efficient and zero-waste future.
OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

The proposed study focuses on analyzing the current scenario of e-waste management and drafting an implementation strategy (with global best practices and case studies) to enable a circular economy for e-waste in Pune city involving all concerned stakeholders. The broad objective of the project is to draft a strategic action plan for Pune city (replicable nationwide) to capture at least 60 percent of the e-waste generated in the next two years.

SCOPE

The study is focused mainly on Pune city and its e-waste lifecycle system, right from collection of e-waste to the recycling phase. It focuses on all the major stakeholders involved in the lifecycle, from government bodies to the formal sector (largely comprising NGOs and voluntary citizens’ groups) to the informal sector of rag pickers and kabadiwalas, to the recyclers, and end-users.

Where end users are concerned, the focus of the study is mainly on household consumers. Bulk consumers such as IT companies and electronic producers have been kept out of the ambit of the study, owing to time constraints and difficulties in gaining access to them and the required data.

METHODOLOGY

The project was carried out at a multi-stakeholder level (as detailed in the scope) and multi-administrative level viz. at the governance, technical, infrastructural, financial and information levels in a phased manner, starting with current scenario assessment, strategic action plan preparation, and knowledge management. Activities carried out in each phase are as stated below:

Current Scenario Assessment

- Assessment of the challenges, gaps, issues present in the e-waste management system currently present in Pune city.
- Assessment of the current practices and methods adopted by the stakeholders and analysis of their effectiveness at different levels viz. governance, technical, financial, etc.
- Assessment of the circular economy framework for e-waste, both at the global and national level, with the objective of extrapolating best practices in the model e-waste framework for Pune city.
- Analysis of health and environmental risks associated with unscientific e-waste handling.
- Analysis of current system and loss in value due to rudimentary techniques and improper handling of e-waste.

Strategic Action Plan preparation
• One-on-one discussions and roundtable meets with stakeholders comprising waste collectors, municipal authorities, NGOs, recyclers and dismantlers, established and non-established supply chain entities, etc.
• Interaction with domestic consumers to understand their awareness levels.
• Implementation strategy and Action Plan that aims to provide focused strategies and detailed action points to be carried out within the short term (two years) and long term (five years) by the concerned stakeholders.

**Knowledge Management**

• Action plan – Wide dissemination of the Action Plan through different channels including WISE and The Ohio State University websites, their association websites, stakeholder websites, through emails blasts, through the social media, etc.
• Knowledge dissemination through focused group meetings to ensure smooth implementation of the plan.
E-WASTE AND THE CIRCULAR ECONOMY: AN INTRODUCTION

1.1 GLOBAL OVERVIEW OF E-WASTE

The current age of smart products and information technology is a rapidly booming one. The electronics industry has emerged as the fastest growing segment today, both in terms of production and exports. According to the Global Electronic Components Market 2019 Research Report, over the last five years, the global consumer electronics manufacturing industry has grown at an annual rate of 1.1 percent to USD 1.3 trillion, including a 2.7 percent increase in 2018 alone (1). Innovative products, attractive prices, growing household incomes and increased consumption have led to the growth of the consumer electronics market. From 2019 to 2024, the global market for electronic components is predicted to grow at a compound annual growth rate (CAGR) of 5.6% (2).

Globally, the information technology market is expected to reach around USD 8 trillion by 2022, growing at a CAGR of 9 percent. Drivers of growth include increased economic and technological development, and increased consumer demand (3).

This increased use of electrical and electronic equipment (EEE) has resulted in huge amounts of e-waste being generated worldwide (brief description of e-waste provided in Box 1.1). According to the Global E-waste Monitor 2017, 44.7 million metric tons (Mt) of e-waste was generated globally in 2016 which accounts for 6.1 kg e-waste per inhabitant.\(^1\) E-waste generation is expected to grow to 52.2 Mt in 2021, with an annual growth rate of 3-4%. Figure 1.1 depicts the global e-waste generation trend and corresponding e-waste generation per inhabitant. Of the total e-waste generated, 80% (35.8 Mt) is undocumented, of which 4% (1.7 Mt) is dumped as residual waste (in developed economies), while the remaining 76% (34.1 Mt) is unknown. Category-wise e-waste generation in 2016 is depicted in Figure 1.2 (4).

---

\(^1\) Worldwide, only 41 countries collect statistics on e-waste which has resulted in a huge gap in data availability on global e-waste.
BOX 1.1: WHAT IS E-WASTE?

According to the Global E-waste Monitor 2017, e-waste or electronic waste refers to all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use. It includes wide range of products – almost any household or business item with circuitry or electrical component with power or battery supply. It covers six waste categories:

- **Temperature exchange equipment**: Commonly referred to as cooling and freezing equipment, they include refrigerators, freezers, air conditioners, heat pumps.
- **Screens, monitors**: Televisions, laptops, monitors, notebooks and tablets.
- **Lamps**: Fluorescent lamps, high intensity discharge lamps, and LED lamps.
- **Large Equipment**: Washing machines, clothes dryers, dish washing machines, electric stoves, large printing machines, copying equipment, and photovoltaic panels.
- **Small Equipment**: Vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments.
- **Small IT and Telecommunication Equipment**: Mobile phones, global positioning systems, pocket calculators, routers, personal computers, printers, telephones.

Each product of the six e-waste categories has a different lifetime profile implying different waste quantities, different economic values, different potential environmental and health impacts, if recycled improperly. Consequently, the collection and logistical processes and recycling technologies differ in each category.

**Figure 1.1: E-waste Generation Worldwide and per Inhabitant (2014-2021)**

Region-wise, Asia generated the highest e-waste in 2016 while Oceania generated the least. However, if we consider the per capita waste generation figures, Oceania accounts for the highest e-waste in 2016 and Africa the lowest per capita waste in the same year. Table 1.1 summarizes the region-wise, e-waste generation and collection in 2016.

Table 1.1: Region-wise, E-Waste Generation and Collection in 2016

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Africa</th>
<th>Americas</th>
<th>Asia</th>
<th>Europe</th>
<th>Oceania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries in region</td>
<td>53</td>
<td>35</td>
<td>49</td>
<td>40</td>
<td>13</td>
</tr>
<tr>
<td>Population in region (millions)</td>
<td>1,174</td>
<td>977</td>
<td>4,364</td>
<td>738</td>
<td>39</td>
</tr>
<tr>
<td>WG (kg/inh)</td>
<td>1.9</td>
<td>11.6</td>
<td>4.2</td>
<td>16.6</td>
<td>17.3</td>
</tr>
<tr>
<td>Indication WG (Mt)</td>
<td>2.2</td>
<td>11.3</td>
<td>18.2</td>
<td>12.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Documented to be collected and recycled (Mt)</td>
<td>0.004</td>
<td>1.9</td>
<td>2.7</td>
<td>4.3</td>
<td>0.04</td>
</tr>
<tr>
<td>Collection Rate (in region)</td>
<td>0%</td>
<td>17%</td>
<td>15%</td>
<td>35%</td>
<td>6%</td>
</tr>
</tbody>
</table>


1.1.1 GLOBAL REGULATORY FRAMEWORK FOR E-WASTE

Brief History and Evolution

The first regulation for proper disposal of e-waste globally was established in 1976 by the United States for the US citizens. Called the Resource Conservation and Recovery Act (RCRA), the main objectives of the Act were to protect the health of humans as well as the environment from the obvious hazards of waste disposal, conserve energy and natural resources, and aid in reducing the amount of waste being generated in the USA. This was followed by the Basel treaty which was adopted in 1989 by the United Nations Environment Program and enforced in 1992 (5). The objective of the Basel convention was to restrict the transboundary movement of hazardous waste and protect the environment and human health from the dangers posed by such waste. The treaty identifies the kinds of wastes that are considered hazardous and thus subject to the rules under the Basel convention.
Global E-waste Regulations by Top Five E-waste Generating Countries

The top five e-waste generating countries in 2016 were China, the United States, Japan, India and Germany. Brief description of global legislation by these countries to tackle the menace of e-waste is delineated below (6). Details of India’s legislation and regulations are provided in Section 1.2.1.

**China:** The Chinese government has enacted regulations to manage e-waste starting in 2000, when it issued the Catalogue for Managing the Import of Waste, aiming to suspend the import of e-waste. Later in 2006, China implemented the Technical Policy on Pollution Prevention and Control of WEEE (2006) to set the principles of “3R” (reduce, reuse, recycle), as well as the provision for environment-friendly collection, reuse, recycling, and disposal of WEEE. In 2007, the authorities issued and promulgated the Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products (2007) that set the standards for eco-friendly product design and put restrictions on the use of hazardous substances (6) (7).

In 2008, the government issued administrative measures on pollution of WEEE with the aim to prevent pollution caused by the disassembly, recycling and disposal of e-waste. In addition, the government issued a license scheme for WEEE recycling companies and in 2011, brought out the Regulation on Management of Recycling and Disposal of Waste Electrical and Electronic Equipment (2011) which made WEEE recycling mandatory. This regulation also implemented extended producer responsibility and set up a fund to support WEEE recycling. Finally, in 2018, the government suspended import of all wastes including WEEE that took effect in January 2018 (7).

**United States of America:** Only two federal level regulations related to e-waste have been implemented so far in the United States, namely, the Resource Conservation and Recovery Act, 1976 (RCRA), and the Environment Protection Agency’s (EPA) cathode ray tubes (CRT) rules. While RCRA requires both individuals and firms handling, disposing or shipping hazardous wastes to obtain permission from EPA and/or the importing country, the CRT rules regulate the export of unsorted CRT glass and CRTs commissioned for recycling. Apart from federal regulations, 28 states have enacted laws for e-waste management in the country (6).

**Japan:** Japan has limited number of regulations aimed at e-waste. The first is the Law for the Promotion of Effective Utilization of Resources (LPUR) that was enacted in 2000 and the second is the Law for Recycling of specified kinds of Home Appliances (LRHA). The first law (revised in 2001) aims to voluntarily help manufacturers to recycle goods and reduce the generation of waste and the second law (which came into effect in 2009), imposed more regulation on recycling efforts of both consumers and manufacturers of home appliances (6).

**Germany:** Germany adopted the WEEE directive in 2003. In 2005, the WEEE transformed into ElectroG Law. Later, the ElectroG law was amended to adopt the WEEE II – the amended directive enacted in 2012. Germany instituted a mechanism called “divided product responsibility” by which the main responsibility of disposal of e-waste lies on to public sector recycling companies and e-waste device manufacturers. Public sector recycling companies are required to establish e-waste recycling centers and accept e-waste in these centers at free of cost. Manufacturers are free to provide their own recycling mechanisms (8).

Additionally, retailers with a sale area for electrical and electronic equipment (EEE) larger than 400 square meters are obliged to take back EEE with edge length less than 25 centimeters (0:1 take-back). In case of
EEE with edge length of more than 25 centimeters, the retailer is obliged to take back the old device if the customer is buying a new equivalent type of EEE (1:1 take-back). The same rules apply to long distance retailers with storage area larger than 400 square meters. Consumers are required by law to take their electrical and electronic waste to such facilities (8).

The restriction on hazardous substances (RoHS) directive governs the use of certain environmentally hazardous substances in electrical and electronic devices. This directive was transposed into a German law in 2013 to place restrictions on the use of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE) in new electrical and electronic devices (8).

### 1.2 OVERVIEW OF E-WASTE IN INDIA

According to a report by Assocham India, the country accounted for 2 million metric tons of global e-waste generated in 2016 and ranks fourth in the world in cumulative production of e-waste after China, USA, and Japan (9). E-waste in India is growing at a CAGR of about 30 percent (10). Of the 2 MT generated in 2016, the country recycled only 5-10 percent of the e-waste through the formal sector. State-wise distribution of e-waste in India is depicted in Figure 1.3.

**Figure 1.3: State-wise Distribution of E-waste in India in 2016**

```
<table>
<thead>
<tr>
<th>State</th>
<th>E-waste Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madhya Pradesh</td>
<td>7.6%</td>
</tr>
<tr>
<td>Gujarat</td>
<td>8.8%</td>
</tr>
<tr>
<td>Karnataka</td>
<td>8.9%</td>
</tr>
<tr>
<td>Delhi</td>
<td>9.5%</td>
</tr>
<tr>
<td>West Bengal</td>
<td>9.8%</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>10.1%</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>12.5%</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>13%</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>19.8%</td>
</tr>
</tbody>
</table>
```

*Source: Electricals and Electronics Manufacturing in India, Assocham-NEC, 2018.*

As can be seen from Figure 1.3, Maharashtra ranks first in total e-waste generated in the country (19.8%), followed by Tamil Nadu (13%), and Andhra Pradesh (12.5%). The difference between Maharashtra and
Tamil Nadu is almost 6.8% more. As can be seen, nearly 75% of the total e-waste generated in the country is contributed by the top six states viz. Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal and Delhi.

1.2.1 REGULATORY FRAMEWORK FOR E-WASTE MANAGEMENT IN INDIA

Brief History and Evolution

One of the first legislations to tackle the menace of e-waste in India was the Environment (Protection) Act, 1986, an umbrella act which covered hazardous waste and provided broad guidelines to address it. Then in 1989, the country enacted the Hazardous Wastes (Management and Handling) Rules, 1989 (11). Framed under the Environment (Protection) Act of 1986 (referred to as HWM Rules 1989), the Rules provide for the control of generation, collection, treatment, transport, import, storage and disposal of waste. The rules are implemented through the state pollution control boards (SPCBs) and pollution control committees in the states and union territories.

In 1992, India became a signatory to the Basel Convention on the control of trans-boundary movement of hazardous wastes and disposal. The country ratified and acceded to it in 1992. The ratification of this convention obliges India to address the problem of trans-boundary movement and disposal of dangerous hazardous wastes through international cooperation (5).

In 1995, publication of Guidelines for Safe Road Transport of Hazardous Chemicals that established basic rules for hazardous goods transport and provide for establishment of a Transport Emergency Plan and for provisions on identification and assessment of hazards was put into place. The National Environmental Tribunal Act, 1995, provides for expeditious remedies to parties injured by environmental crimes. Legislation on the Community’s Right to Know, 1996, was later adopted to provide more access to information regarding potential hazards from industrial operations. This was followed by the Bio-Medical Wastes (Management and Handling) Rules, 1998, which provides a ten category listing of biomedical waste that controls generation, collection, treatment, transport, import, storage and disposal of wastes (6).

Amendments to the HWM Rules, 1989, were introduced in 2000 and 2002, widening the definition of hazardous waste and harmonizing the hazardous waste list with that of the Basel Convention. This was followed by the enactment of the Municipal Solid Wastes (Management and Handling) Rules, 2000, that provides for collection, segregation, storage, transportation processing and disposal of municipal solid wastes. In 2001, the Batteries (Management and Handling) Rules, was enacted (12), which applied to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer and bulk consumer involved in the manufacture, processing, sale, purchase, and use of batteries or components thereof.

Under the Environmental Protection Act 1986, the E-waste (Management and Handling) Rules, 2011 were enacted and became effective in 2012. These rules were brought into force to enable recovery and/or reuse of useful material from e-waste, thereby reducing hazardous waste disposal and enabling safe and environment-friendly handling, transporting, storing, and recycling of e-waste. For the first time in 2011, the concept of Extended Producer Responsibility (EPR) was introduced which made manufacturers liable for safe disposal of electronic goods (13).
Thereafter, the E-Waste (Management) Rules, 2016 was enacted in supersession of the 2011 rules. The said rules introduced the concept of the Producer Responsibility Organization (PRO), which would take the responsibility for collection and channelization of e-waste generated, and would be funded collectively or individually by producers/manufacturers (13).

**E-Waste (Management) Amendment Rules, 2018**

E-waste management rules 2018 amended the targets of e-waste collection by the producers under the Extended Producer Responsibility. Year-wise targets are provided for collection of e-waste and the targets are also applicable to new producers who entered the market recently. The rules also highlighted that the cost of sampling of electrical and electronic equipment will be borne by the government. However, in case the producer does not comply with the reduction of hazardous substances standards, then the cost of RoHS testing will be borne by the producer (14).

**Extended Producer Responsibility (13)**

As per E-Waste Management Rules 2016 (13), the Extended Producer Responsibility is the responsibility of every producer of electrical and electronic equipment to channelize e-waste to an authorized dismantler/recycler, and to ensure environmentally sound management of such waste. EPR authorization is mandatory and has to be obtained by all the producers, including importers, e-retailers/on-line sellers/e-bay etc., of EEE. A producer can implement its EPR either through take-back system or by setting up collection centres or both, for channelization of e-waste/end-of-life products to authorized dismantlers/recyclers.

The producers are required to have arrangements with authorized dismantlers/recyclers either individually or collectively or through a Producer Responsibility Organization (PRO) or e-waste exchange system as spelt in their EPR Plan (see Box 1.2 for details) which is approved/authorized by the Central Pollution Control Board (CPCB). Selling or placing of EEE in the market by any producer without EPR authorization shall be considered as violation of the Rules and causing damage to the environment, which shall attract provisions under the Environment Protection Act, 1986 (13).

<table>
<thead>
<tr>
<th>BOX1.2: EXTENDED PRODUCER RESPONSIBILITY PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producers should submit their own EPR plans for seeking EPR authorization. The Plan should comprise the following.</td>
</tr>
<tr>
<td>- Details of scheme/incentive for returning of e-waste by consumers/bulk consumers whether through dealers or buy-back arrangements or take-back systems or exchange scheme for channelization of e-waste.</td>
</tr>
<tr>
<td>- If producer is opting to manage its EPR responsibility through PRO, then details of PRO’s organizational structure and system of collection and channelization to the authorized dismantlers/recyclers of e-waste.</td>
</tr>
<tr>
<td>- If e-waste exchange is part of channelization then the details thereof.</td>
</tr>
<tr>
<td>- If producer is opting for ‘deposit refund scheme’ (DRS) or exchange scheme for collection and channelization of e-waste, then the details of mode of refund of the deposited amount taken from the consumer or bulk consumer at the time of sale has to be specified, along with interest that becomes due at the prevalent rate, for the period of the deposit, at the time of take-back of the end-of-life products.</td>
</tr>
</tbody>
</table>

Producers of item code CEEWS (fluorescent and other mercury containing lamp) may provide list of waste deposition centres or collection points financed by them as per their obligation under rule 17 (1) of the Solid Waste (Management) Rules 2016 for channelizing such wastes to recyclers or treatment, storage and disposal facilities (TSDFs).

1.2.2 Institutional Framework for E-Waste Management in India

Electrical and electronic waste is mostly managed by civil society organizations and the private sector in India. The government is the legislative body and passes laws for proper management of e-waste. A typical lifecycle process for e-waste management is depicted in Figure 1.4 (15), while the roles of the various institutional players are enumerated in Figure 1.5. In India, 95 percent of e-waste is managed by the informal sector, with only 5 percent accounted for by the formal sector. Roles and responsibilities of the sectors are provided in Box 1.3.

Figure 1.4: Typical E-waste Management Supply Chain

Source: E-waste in India; CEAMA, APCO.

BOX1.3: ROLES AND RESPONSIBILITIES OF THE FORMAL AND INFORMAL SECTORS (16)

**Formal Sector:** With increase in the number of e-waste across the country, a strong formal sector for e-waste management is emerging in India. The formal sector operates through the value chain in scientific ways. They also take care of environmentally sound segregation and recycling practices so that environmental and health hazards are avoided. They help in enhanced resource recovery from used products. However, investment in machinery and improved working conditions leads to higher costs incurred by the formal sector which makes them uncompetitive with the informal sector.

**Informal Sector:** The informal sector feeds the maximum e-waste to the e-waste management value chain in India. Collection is the stage where the informal sector is most active. They also take part in other phases of the value chain, namely, segregation, dismantling, recycling. However, the informal sector practices in unscientific manner exposing the sector workers and others to environmental and health hazards. Due to low cost of activities practiced by the informal sector, most often the informal sector becomes more competitive as compared to the formal sector.

Source: E-waste Recycling in India: Bridging the gap between the informal and the formal sector.
Figure 1.5: Various Stakeholders and their Roles in E-Waste Management

**ROLES**

- Formulation of policies, rules and regulations, undertaking industrial skills development activities, monitor safety and health of workers
  - Government

- Monitoring implementation of government rules and guidelines; tracking e-waste generation and processing
  - Pollution control board or equivalent

- Production and sale of EEE including import, export and use of equipment for re-use from repair of WEEE/E-waste
  - Manufacturers, importers, exporters and retailers (brand new/second hand)

- Consumption of electrical and electronic equipment in households, offices and industries
  - Consumers such as households, offices and industries

- Collection of end-of-life electrical and electronic equipment including transfer to treatment/disposal sites, import/export
  - Consumers, importers, exporters, collectors, traders, dismantlers, waste treatment operators

- Treatment/disposal of e-waste like repair, decontaminating, dismantling, shredding, recycling, landfill and incineration
  - Traders, dismantlers, waste treatment operators, recyclers

**STAKEHOLDERS**

*Source: E-waste in India, CEAMA, APCO; The Big "w" Impact, Assocham-EY, 2019.*
1.3 HEALTH AND ENVIRONMENTAL IMPACTS OF E-WASTE

E-waste consists of extremely hazardous materials such as lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardents, beryllium, antimony, etc. (17). Dumping of such hazardous material in open dumpsites is common in India, which gives rise to serious issues such as groundwater contamination, air pollution and poor health (11).

1.3.1 HEALTH IMPACTS OF E-WASTE

Health impacts (17) (18) of various substances contained in e-waste are summarized in Table 1.2.

Table 1.2: Health Hazards caused from Chemicals present in E-waste

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Source in Electronic Product</th>
<th>Health Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>Cathode Ray Tubes (CRTs), printed circuit boards, etc.</td>
<td>Very hazardous in event of ingestion, hazardous in event of skin and eye contact, and inhalation. Causes damage to the blood, kidneys, lungs, nervous system, liver and mucous membranes.</td>
</tr>
<tr>
<td>Barium</td>
<td>Front panel of CRTs</td>
<td>Short-term exposure causes muscle weakness and damage to heart, liver and spleen. It also produces brain swelling after short exposure.</td>
</tr>
<tr>
<td>Beryllium</td>
<td>Motherboards of Computers</td>
<td>Carcinogenic (causing lung cancer), and inhalation of fumes and dust can cause chronic beryllium disease or berylicosis and skin diseases such as warts.</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Chip resistors and semiconductors</td>
<td>Has toxic, irreversible effects on human health and accumulates in kidney and liver. Has toxic effects on the kidney, the skeletal system and the respiratory system, and is classified as a human carcinogen.</td>
</tr>
<tr>
<td>Copper</td>
<td>Used as a conductor</td>
<td>Very hazardous in case of ingestion, in contact with the eyes and when inhaled. An irritant of the skin and toxic to lungs and mucous membranes. Repeated or prolonged exposure can produce target organs damage.</td>
</tr>
<tr>
<td>Dioxins</td>
<td>Created when electronics are burnt in open air</td>
<td>Highly toxic and can cause chlor-acne, reproductive and developmental problems, damage the immune system, interfere with hormones and cause cancer.</td>
</tr>
<tr>
<td>Hexavalent Chromium</td>
<td>Used as corrosion protection of untreated and galvanized steel plates and a decorator or</td>
<td>Damages kidneys, the liver and DNA. Asthmatic bronchitis has been linked to this substance. Causes irritation of the respiratory system (asthma) and skin, liver and kidney damage, increased or reduced blood leukocytes,</td>
</tr>
<tr>
<td>Chemical</td>
<td>Source in Electronic Product</td>
<td>Health Concerns</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hardener for steel housings</td>
<td>eosinophilia, eye injury, and is a known carcinogen (lung cancer).</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>Solder of printed circuit boards, glass panels and gaskets in computer monitors</td>
<td>Causes damage to central and peripheral nervous systems, blood systems and kidneys, and affects the brain development of children.</td>
</tr>
<tr>
<td>Mercury</td>
<td>Relays, switches and printed circuit boards</td>
<td>Elemental and methyl-mercury are toxic to the central and peripheral nervous system. Inhalation of mercury vapour can produce harmful effects on the nervous, digestive and immune systems, lungs and kidneys, and may be fatal. The inorganic salts of mercury are corrosive to the skin, eyes and gastrointestinal tract, and may induce kidney toxicity if ingested.</td>
</tr>
<tr>
<td>Polyvinyl Chloride</td>
<td>Cabling and computer housing plastics contain PVC for its fire-retardant properties</td>
<td>Produces dioxins when burnt; causes reproductive and developmental problems, immune system damage and interferes with regulatory hormones.</td>
</tr>
<tr>
<td>Brominated Flame Retardant</td>
<td>Plastic housing of electronic equipment and circuit boards</td>
<td>Disrupts endocrine system functions.</td>
</tr>
</tbody>
</table>


### 1.3.2 ENVIRONMENTAL IMPACTS OF E-WASTE

Apart from health hazards, there are certain environmental hazards that emanate from unscientific management of e-waste. These are given below.

**Impact on Soil and Vegetation**

Soil contamination occurs through direct contact with contaminants from e-waste, its recycling and disposal, or from indirect contact through irrigation from contaminated water. Improper disposal of certain heavy metals such as lead, cadmium, arsenic, etc., and flame retardants leads to leaching into the soil and causing contamination of the crops and ground water (19).

Poor dismantling processes and extraction techniques of precious metals could cause mercury amalgamation or cyanide leaching, resulting in making the soil toxic. Unscientific dismantling could also lead to dispersion of toxic particles in the atmosphere which ultimately re-settle into the soil. The subsequent increase in toxicity levels in the soil leads to harming the micro-organisms in the soil and plants, as well as animals and wildlife that rely on these plants for food. For e.g. Lead can coat the surface of
leaves, causing reduction in the rate of photosynthesis that could lead to permanent damage or death of the plants (19).

A survey of an informal e-waste processing site in Mandoli, Delhi, showed extremely high concentration of heavy metals in the soil. Concentration of lead was the highest (2,645.31 mg/kg), followed by zinc (776.84 mg/kg), copper (115.50 mg/kg), arsenic (17.08 mg/kg), selenium (12.67 mg/kg) and cadmium (1.29 mg/kg). Heavy metals were also observed in the vegetation (20).

**Impact on Air**

Air contamination occurs due to improper dismantling, causing large amounts of dust and other particulates to be released into the environment causing air pollution. Burning of cathode ray tubes used to display images results in severe toxic fumes being emitted into the air. Lead levels in air near informal recycling sites in Guiyu, China, were found to be three times more than those in European sites, leading to severe air pollution (19) (20).

**Impact on Surface / Ground Water and Related Ecosystem**

Surface water contamination occurs due to presence of poorly constructed landfills and improper recycling and disposal of e-waste, causing the chemicals to leach into the nearby water bodies such as streams, lakes, ponds and rivers, resulting in acidification and toxification of the water. Heavy metals also seep into the ground water causing severe contamination that could lead to long-term damage of the surrounding ecosystem, making restoration unlikely or even impossible (19).

Fish are hugely impacted by heavy metals such as mercury, leading to tissue and gill damage as well as erratic movements among many species of fish. A study in local ponds near a solid waste site in Kolkata, India, found that PCB levels in fish were 33,000 pg/g lipid weight in Pond 1 located 4 km away and 4,400 pg/g lipid weight in Pond 2 located 3 kms away. These levels are extremely high as compared to reference samples of healthy ponds, which was 1,900 pg/g lipid weight (20). Cadmium from one mobile phone is said to pollute 600 cubic metres of water (19).

1.4 ‘CRADLE TO GRAVE’ TO ‘CRADLE TO CRADLE’: NEED FOR A CIRCULAR ECONOMY FOR E-WASTE

As of December 2019, the current world population is around 7.8 billion. According to the United Nations, this figure is expected to increase to 8.6 billion in 2030 and 9.8 billion in 2050. ‘The World Count’ (a ‘live’ web counter), states that the amount of natural resources present on the earth is enough to satisfy the needs of only (about) 2 billion people (21). Based on current, unrestricted consumption patterns, the World Economic Forum opines that we will soon need three times the amount of natural resources we consume today. This would require the creation of three more planets (21).

In view of the growing dependence on and increased, unrestricted consumption of the latest, high-tech gadgets, electrical and electronic equipment, the overall generation of e-waste is expected to increase much more in future. In addition, besides the health and environmental impacts of e-waste, the raw material or
natural resources present in e-waste has tremendous economic impact. The total value of all raw materials present in e-waste was estimated at approximately 55 billion Euros in 2016, more than the 2016 Gross Domestic Product of most countries (4). In contrast, the value of secondary raw materials after waste management is just a fraction of the value of its components or the price of used appliances.

Given the above circumstances, there is an urgent need to shift from the current traditional paradigm of unrestricted consumption and proliferation of waste to a new development paradigm where economic growth goes hand-in-hand with environmental and social development (constituting the three pillars of sustainable development) and embraces the concept of resource sufficiency and reduced waste, by adopting the philosophy of a ‘circular economy’ (21).

The circular economy is one that is restorative and regenerative in nature. It aims to keep the products, components and materials at their highest utility and value at all times. While our current production and consumption patterns follow the ‘cradle to grave’ approach, which gives due consideration to the 3Rs of ‘reduce, reuse, and recycle’, it does not consider the finiteness of resources and the need to ‘put back’ into the natural environment what has been taken (21). The circular economy aims to decouple economic development from our natural resources, thus taking a ‘circular’ approach or a ‘cradle-to-crade’ approach. This would entail increasing the longevity of the product and minimising waste through the process of sharing, renting, repair and reuse by following the 5Rs of ‘reduce, reuse, refurbish, repair and recycle’, thus forming a ‘closed-loop’ system (21). The main features of a circular economy are as follows (22):

- Products are so designed that they are easily recycled, reused, disassembled and remanufactured.
- A circularity in flow of technical and biological materials is promoted within and beyond the product’s value chain and after its useful life.
- It puts emphasis on continuous innovation to extract maximum value from all resources being used and ideally nothing is called waste.
- In a circular economy, products, services and every instance of material usage are designed to remain in the value chain for the longest period possible.
- Ideally the total energy requirement in a circular economy is met from renewable sources such as wind and solar.
- There is net job creation as repair, maintenance and refurbishment require more manpower compared to automation in new resource extraction.

Thus the circular economy seeks to eliminate any kind of waste, where waste refers to ‘underutilization of resources’ in an economy. There are four distinct types of waste that a circular model seeks to eliminate (23):

1. Wasted resources – material or energy that cannot be regenerated over time.
2. Wasted capacities – products and assets that are not utilized fully.
3. Wasted lifecycles – products reaching end-of-life prematurely due to planned obsolescence or lack of second life options.
4. Wasted embedded values – components, materials and energy not recovered from waste streams.

A FICCI-Accenture study has envisaged that high potential value can be realized by eliminating these four types of wastes through the adoption of a circular business model. Figure 1.6 shows the size of this business opportunity using circular business models (23).
The FICCI-Accenture study shows that India can save around half a trillion dollars worth of its GDP, if it takes the circular economy route (23). Under the business-as-usual model, FICCI and Accenture show that approximately USD 697 billion of India’s GDP is at risk. Under the technology-improved scenario, around USD 382 billion of India’s GDP is at risk, which can be safeguarded by adoption of circular business models (Figure 1.7).

**Figure 1.6: Value Realization Potential from Circular Business Models by 2030**

![Value Realization Potential from Circular Business Models by 2030](source)

**Figure 1.7: Reward for Adoption of Circular Economy in India**

![Reward for Adoption of Circular Economy in India](source)
A CASE FOR CIRCULAR ECONOMY FOR E-WASTE IN PUNE CITY:
KEY OBSERVATIONS AND FINDINGS BY WISE

2.1 GLOBAL OVERVIEW OF E-WASTE PUNE: A BRIEF OVERVIEW

Pune is a bustling city in the western Indian state of Maharashtra. Also called “Queen of the Deccan,” it is the cultural and educational capital of Maharashtra. The Pune Metropolitan Region (PMR), initially defined in 1967, has grown to 7,256 km² made up of the ten talukas of the Pune district (1). The twin cities of Pune and Pimpri-Chinchwad along with the three cantonment areas of Pune, Khadki and Dehu Road form the urban core of the PMR, which also includes seven municipal councils and 842 villages.

Pune is also known as the "Oxford of the East" due to the presence of several well-known educational institutions, management schools, training centers, etc., that attract students and professionals from India and overseas. A sprawling complex of industrial suburbs has developed around the city. Pune is considered to be the eighth largest metropolitan economy of India with key sectors including IT, manufacturing and education. It houses some of the internationally popular automobile companies like Mahindra & Mahindra, General Motors, Volkswagen, Renault and others. Pune Municipal Corporation (PMC) is the civic body responsible for local governance. It is in charge of the civic needs and infrastructure of the metropolis, which is spread over an area of 331.26 sq. km and has 3.8 million residents (2). This population is growing rapidly owing to Pune's well-established industrial and educational set-up, and the booming IT sector in the city.

<table>
<thead>
<tr>
<th>Pune City</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State</strong></td>
</tr>
<tr>
<td><strong>District</strong></td>
</tr>
<tr>
<td><strong>Latitude</strong></td>
</tr>
<tr>
<td><strong>Longitude</strong></td>
</tr>
<tr>
<td><strong>Population</strong></td>
</tr>
<tr>
<td><strong>Pincode</strong></td>
</tr>
</tbody>
</table>

*Source: Wikipedia, 2019*
## 2.2 PUNE AND THE CURRENT E-WASTE MANAGEMENT SCENARIO

### 2.2.1 BACKGROUND AND STATISTICS

Pune city has got a huge, growing market for electronic waste. Growth in the IT and communication sector, increase in purchasing power of end users, and rapid obsolescence of electrical and electronic products is forcing consumers to discard old EEE products very quickly, exponentially increasing their discarding rate. Statistics of e-waste in Pune city for 2016 is given in Table 2.1

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Amount / Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total e-waste generated (as in 2016)</td>
<td>16,425 tons/annum</td>
</tr>
<tr>
<td>Total quantity of waste received and sent for recycling by PMC (as in 2016)</td>
<td>8.64 tons/annum</td>
</tr>
<tr>
<td>Storage facilities for e-waste (as in 2019)</td>
<td>177 temporary centers (Aarogy Kothis) across PMC area (3)</td>
</tr>
</tbody>
</table>

*Source: Pune Municipal Corporation, 2019.*

### 2.2.2 CURRENT E-WASTE MANAGEMENT SYSTEM IN PUNE CITY

In accordance to E-Waste Management Rules, 2016, the Central Pollution Control Board (CPCB) prepared guidelines on implementation of e-waste rules and handed it over for implementation to the State Pollution Control Board, the Maharashtra Pollution Control Board (MPCB). MPCB is the regulatory body for the state of Maharashtra and responsible for monitoring and reviewing e-waste handling and management as per the rules. It is also responsible for granting and renewing authorization, monitoring the compliance of the various provisions and conditions of authorization, forwarding applications for import as per rules and reviewing matters pertaining to identification and notification of disposal sites.

Pune Municipal Corporation (PMC) is the urban local body responsible for end-to-end solid waste management in the city. PMC currently has a small e-waste cell. But due to the lack of suitable guidelines and regulations, the role of the cell is not defined and there is no dedicated manpower to carry out the responsibilities appropriately. PMC has designated 177 temporary collection centers to collect e-waste across Pune city. Due to lack of awareness amongst citizens, very little e-waste is collected which is not monitored appropriately, in the absence of guidelines. While NGOs, cooperative societies, voluntary organizations have been actively conducting drives for awareness and collection of e-waste in the city, much more needs to be done in terms of mass awareness, framing guidelines, monitoring, reviewing, capacity building, training, etc. Bulk consumers, bounded by EPR and other CSR mandates, are following safe practices for managing e-waste, but domestic consumers and small scale organizations are still not able to channelize e-waste properly. A brief overview of the current institutional set-up for e-waste management in Pune is provided in Figure 2.1 and the existing lifecycle process is shown in Figure 2.2.
Figure 2.1. Current Institutional Set-up for E-waste Management in Pune City

Legislative Body

Ministry of Environment, Forest & Climate Change

State Government

Central Pollution Control Board

State Pollution Control Board

Urban Local Body (PMC)

Private Sector

NGOs

Voluntary Initiatives

Collectors, Dismantlers, Recyclers, Housing Societies

Creates Legislation

Oversees implementation of legislation

Funding, R&D, Monitoring and Regulation

Issues permits for waste management

Source: WISE, 2019.
As can be seen from Figure 2.2, the current system is governed by operational inefficiency at different stages of e-waste management giving space to a parallel system of informal collectors and dismantlers. The formal sector collectors and recyclers, without adequate support from the government, find it difficult to sustain their business, owing to high costs involved in campaigning and awareness activities, storage, logistics and manpower. At the macro level, the main challenges faced by the current e-waste management system in Pune city are as below.

- Lack of awareness, high rate of generation of e-waste, lack of infrastructure and lack of funding to formalize the e-waste process.
- Pune city’s solid waste management system has to bear an extra 30% load of e-waste not being separated, collected or recycled by government institutions (5). This segregation and separation is critical and needs urgent action.
- No proper monitoring and reporting mechanism in place for evaluating the efficacy of the e-waste management system. In addition, no data available in the public domain on e-waste generated.
- Sector dominated by informal collectors. In absence of compliance and guidelines, sectoral inefficiency is high.
- Active social organizations in e-waste collection facing survival issues due to lack of funding, no support, no proper storage facilities, etc.
2.3 MAJOR NGOs AND PRIVATE ENTREPRENEURS INVOLVED IN E-WASTE MANAGEMENT IN PUNE CITY

The WISE project team interacted with major NGOs and private associations actively involved in e-waste collection and spreading awareness in Pune city. Major NGOs/private agencies and their initiatives are given below.

2.3.1 SWACH PUNE SEVA SAHAKARI SANSTHA LTD.

SWaCH is India’s first wholly-owned cooperative of self-employed waste collectors and other urban poor. It is an autonomous enterprise that provides front-end waste management services to the citizens of Pune.

E-waste is collected through donations, direct collection, and drop-off at centers as well as through awareness and collection drives. In 2012, the Maharashtra Pollution Control Board authorized SWaCH to collect and channelize e-waste as per the E-Waste (Management) Rules, 2012 (6). Through SWaCH, bulk generators such as schools, colleges, universities, companies, NGOs and other entities, send their e-waste for recycling to MPCB-authorized recycling centers. SWaCH has set up e-waste collection bins in private and government organizations, schools and colleges, and residential societies and commercial establishments. Citizens can also drop off their e-waste at the SWaCH office at designated centers or opt to have it collected directly from their homes.

Information Literature for Awareness Drives

Source: SWaCH, 2019.

SWaCH collects old electronic/electrical items, furniture, bicycles, kitchen utensils, etc. They repair and re-use what they can and dismantle and recycle the rest. By organizing V-Collect events, SWaCH channelizes most of these items towards recycling and re-use, and away from the dumps. As Pune city’s first MPCB-authorized e-waste collection agency, SWaCH and its PRO partner ‘Karo Sambhav Pvt. Ltd.’ enable organizations to meet regulatory requirements for the safe disposal of IT e-waste, ensuring that it is
recycled responsibly (using the best available technology in India), and that it is handled, dismantled and recycled in an environmentally sound and socially responsible manner (6). These efforts are backed by the International Finance Corporation, as well as by industry giants like Dell, HP and Lenovo to help control India’s escalating e-waste problem. SWaCH, even after being backed by strong corporations, faces basic issues of storage and logistics in e-waste management. The NGO seeks more support from the government to make its model more sustainable in the long run.

### 2.3.2 POORNAM ECOVISION FOUNDATION

Poornam Ecovision Foundation is a social enterprise working for sustainable development since 2012. Poornam delivers solutions in fields like solid waste management, sustainable agricultural development, renewable energy management, and environmental management. Volunteer engagement is associated with all these verticals. Poornam is working extensively in collection of e-waste, plastic waste and toys from residential colonies and institutions in and around Pune. Reusable electronic goods are used for betterment of people being served in different organizations in the city. Remaining e-waste and plastic waste is channelized to authorized recyclers/processors for safe disposal. Poornam has so far collected 67 tons of e-waste (7).

**Snapshots of Poornam Ecovision Foundation’s Collection and Awareness Drives**

![Snapshots of Poornam Ecovision Foundation’s Collection and Awareness Drives](image)

*Source: Poornam Ecovision foundation, 2019.*

The Foundation conducts various awareness initiatives such as e-waste management awareness initiatives for schools, colleges, societies and slums. These awareness sessions are supported by Cummins Foundation, Pune, a CSR initiative of Cummins India Ltd.

### 2.3.3 JANWANI

Janwani was established in the year 2006. Its Governing Board comprises philanthropists from Pune city with rich and diverse sectoral experience. Since its inception, 'Janwani' has kept its approach city-centered, collaborative, analytical and data driven. It has implemented various projects on the environment, governance, heritage, traffic and transportation and urban planning to make Pune the most livable city’ in
the country. Janwani is implementing three major projects on solid waste management like e-waste collection, segregated garbage management in Pune city with its partners the Pune Municipal Corporation, Pune Cantonment Board, Adar Poonawalla Clean City Initiative, Cummins India Ltd. & Persistent Systems (8).

In 2016-17, Janwani in partnership with the PMC, Swach Cooperative (waste-pickers organization) and Cummins India Ltd created a zero garbage ward model, located in the southern part of Pune. The role of Janwani as a facilitator was to create awareness about segregation and increase collection of garbage. Various programs helped convey the message effectively to various strata of society. The programs included rallies, puppet shows, street plays, cleanliness drives, film shows, and poster exhibitions, etc. Even after being an active player in Pune’s e-waste management for over a decade, Janwani is still battling for administrative support from regulatory authorities for logistics and storage facilities. They find it difficult to transport e-waste collected from different parts of the city to the storage facility (which is at their office) and then further connecting it with recyclers. It is only due to support from CSR initiatives, that they are still able to continue their awareness and collection activities.

2.3.4 CUMMINS INDIA FOUNDATION

Cummins India Ltd, is a group of complementary business units that design, manufacture, distribute and service engines and related technologies, including fuel systems, air handling, filtration, emission solutions and electrical power generation systems. Cummins India Foundation was instituted in 1990 to channelize their commitment towards corporate social responsibility. All its initiatives, both in the local community and in other parts of India where Cummins operates, fall under the three key focus areas of higher education, energy and environment, and social justice and infrastructure. As part of its CSR activities, Cummins team and PMC are working with authorized recyclers for ensuring eco-friendly processing of e-waste. Cummins’ volunteers spread awareness regarding e-waste pollution and need for recycling in schools, housing societies and colleges in Pune city. Cummins’ recently inaugurated their own permanent center for e-waste in Kothrud area (9).
Box 2.1: VOLUNTARY INITIATIVES BY COMPANIES AND CITIZENS IN PUNE CITY

CMDA Pune E-waste 365 Model: CMDA (Computer and Media Dealers Association) is planning to start e-waste collection activities in Pune region. This activity will be a round the clock, 365 days in a year initiative, backed by the authorized recyclers. The entire activity will be carried out by adhering to the Govt. of India’s EPR norms for disposal of e-waste. To take this initiative ahead, 20 collection centers covering maximum area of Pune is being planned. E-waste collection bins will be placed at all prominent places and appeals to corporate companies and citizens to bring their e-waste to these places will be made. Centers will receive the goods and give them receipt for the same. Currently, 375 members and business owners are part of this initiative (10).

Local Citizens' Initiative: Groups of citizens in few localities have set-up local e-waste collection centers in public areas in consensus with PMC by integrating with authorized recyclers. Not only do they collect and transport e-waste to the designated centers for recycling but also conduct awareness drives at society level, schools, colleges, etc.

These citizens groups have been successfully running this program for over six years and have managed to expand and integrate more citizens in this noble cause.
Glimpses of Awareness Drives and Information Literature of different NGOs in Pune City
2.4 THE WISE FIELD STUDY: OBSERVATIONS AND KEY FINDINGS

The WISE project team carried out surveys and field studies at different levels of the e-waste management system to assess and analyze the actual functioning of the key players in e-waste collection, dismantling and recycling, and bring to the fore challenges and issues restricting effective management of e-waste in Pune city. The key players interviewed one-on-one and through round table discussions included representatives and officers of the Pune Municipal Corporation, members of the formal sector (NGOs, citizens groups, private sector) and informal sector (kabadiwalas/rag pickers), and household members or end users of electrical and electronic equipment.

2.4.1 KEY OBSERVATIONS AND FINDINGS FROM PUNE’S INFORMAL AND FORMAL SECTORS

The Informal Sector

The waste collectors or rag pickers or kabadiwalas as they are called locally, are the current dominant sector and account for collecting 95% of the e-waste in the city. The waste then flows down to scrap dealers where they are dismantled into different components manually using unscientific and unhealthy methods. After segregating the useful components, the scrap dealers give away the unwanted waste to plastic/glass recyclers, throw it or burn it using unscientific methods.

The e-waste produced in domestic, small and medium sectors mainly end up with the informal recyclers where recycling is done in a hazardous manner, causing danger not only to the environment, but also to the people involved in the recycling activity, due to the release of toxic chemicals into the air, soil and water, along with poor working conditions. In the existing system, the e-waste collected by the rag pickers or the kabadiwalas end up in the hands of informal recyclers through local waste marts and informal dealers. It is therefore necessary to develop a new pathway or system that would ensure that e-waste ends up with authorized collectors and recyclers only, so as to ensure a safe and sustainable way of e-waste recycling.

The WISE team closely interacted with the kabadiwalas of Kalyani Nagar, a key locality in Pune city, well-known for its voluntary citizen’s initiatives for e-waste collection and recycling. It was observed that this community of rag pickers had a close-knit network, comprising a team of 10-15 rag pickers, who collected all types of waste (including a small share of e-waste), and worked under a local dealer who provided them with a small cart for collection.
There are around 500+ illegal dealers active in Pune city who channelize their activities through these rag pickers. They usually collect 8-10 kg of e-waste per person per month. They are not aware of health or environmental implications of dismantling e-waste in an unscientific manner since they are poorly educated and not trained for this work. The rag pickers deposit the waste at the dealer's warehouse or small storage facility and are paid on a daily basis at pre-fixed rates. Their monthly income is barely USD 130-140.

Few requirements as expressed by the kabadiwalas are below.

- They expressed keen interest in being part of the formal chain and to work as licensed collectors since currently they are doing it illegally and sometimes are penalized for the same.
- They expressed the need for initiatives to be taken by regulatory authorities to integrate them into the formal chain and assure them of healthy and secure work conditions.

**The Formal Sector**

Only a handful of formal e-waste collecting and dismantling centers are functioning in Pune city today. According to the Maharashtra Pollution Control Board, there are 76 authorized e-waste recyclers/dismantlers in the state of Maharashtra (11). A set capacity is allotted as per authorization/registration (Mt/annum) to each recycler by MPCB. There are 22 registered e-waste recyclers/dismantlers in and around Pune with processing capacity of close to 10,000 Mt/annum (11).
**WISE’s Participation in E-waste Drives: Key Findings**

As part of the field study, the WISE team collaborated with members of the formal sector, namely Janwani and Poornam EcoVision Foundation, and participated in community collection drives for e-waste. These drives were financed under the corporate social responsibility initiative by Cummins (India) Pvt. Ltd. Typically, activities for collection drives such as getting the required permissions from societies / apartments starts two weeks in advance, followed by awareness sessions and door-to-door campaigns. Actual collection drives are mostly on Sundays from 0900 hrs. to 1300 hrs. WISE participated in over 10 such drives and analyzed data from about 100 drives undertaken in different localities in Pune city. The summary of the e-waste collected at these drives is given in Table 2.2 and Figure 2.3 respectively.

**Table 2.2: Summary of E-waste collected from Drives in Pune City**

<table>
<thead>
<tr>
<th>No</th>
<th>E-waste component</th>
<th>Quantity collected (kg)</th>
<th>Share in total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Computer equipment</td>
<td>1,623</td>
<td>31.98</td>
</tr>
<tr>
<td>2</td>
<td>Cameras and accessories</td>
<td>101</td>
<td>1.99</td>
</tr>
<tr>
<td>3</td>
<td>Mobile phones and accessories</td>
<td>310</td>
<td>6.11</td>
</tr>
<tr>
<td>4</td>
<td>Electrical medical devices, telescopic devices</td>
<td>215</td>
<td>4.24</td>
</tr>
<tr>
<td>5</td>
<td>Electrical toys etc.</td>
<td>235</td>
<td>4.63</td>
</tr>
<tr>
<td>6</td>
<td>Electrical appliances (non-repairable) TV, fridge, washing machine, fans, ovens etc.</td>
<td>1,058</td>
<td>20.85</td>
</tr>
<tr>
<td>7</td>
<td>Entertainments (Radio, tape recorders, DVD players etc.)</td>
<td>505</td>
<td>9.95</td>
</tr>
<tr>
<td>8</td>
<td>Lighting equipment (CFL, LEDs)</td>
<td>79</td>
<td>1.56</td>
</tr>
<tr>
<td>9</td>
<td>Electrical wires, cables and adapters</td>
<td>495</td>
<td>9.57</td>
</tr>
<tr>
<td>10</td>
<td>Others</td>
<td>454</td>
<td>8.94</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>5,074</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Source: Janwani, 2019.*
As can be seen from Table 2.2 and Figure 2.5, computer equipment account for the maximum share of e-waste generated in Pune city (32%), followed by large electrical appliances (22%) and electronic (entertainment) devices (10%).

### 2.4.2 KEY OBSERVATIONS AND FINDINGS FROM END USERS (HOUSEHOLD CONSUMERS) IN PUNE CITY

WISE undertook an online questionnaire survey, to assess the level of EEE consumption patterns, knowledge and awareness of e-waste awareness and disposal techniques among the household users. Different categories of consumers were considered based on their standard of living. The analysis showed that most of the people are not aware of the hazardous materials present in the electronics products and only a few actually knew the practices adopted to recycle this waste. In household disposal of e-waste in Pune, most of the waste is either sold to 
*<b>kabadiwalas</b>* for a price or disposed with the domestic waste, which places additional burden on PMC for segregating the waste.

About 130 people participated in the online survey which captured the usage pattern of around 500 people (including their family members) as the participant filled in the response on behalf of their family’s consumption and handling pattern.

(Survey form available at: [https://docs.google.com/forms/u/1/d/1XDd4ygqO-UxqgKSsYlbrSzQq-OI.NBDt3DGLfZb0Fsxk/edit#responses](https://docs.google.com/forms/u/1/d/1XDd4ygqO-UxqgKSsYlbrSzQq-OI.NBDt3DGLfZb0Fsxk/edit#responses))
Below are the key observations and findings of the survey.

- 97% of the respondents confirmed necessity/convenience as the reason for purchasing electronic equipment.

- 61% of the respondents stated that their preference of purchase is always new equipment over used ones.

- Close to 80% of the respondents stated that they prefer to repair and reuse equipment when broken or damaged. There was a mixed response from the remaining 20% who preferred to sell it off to scrap dealers, store at home/throw away and buy new ones.
A little more than 80% of the respondents stated that unused electronics can be resourceful as it can be repaired and/or reused and can also be sold to scrap dealers or some associations.

Around 95% of the respondents are aware of the health and environmental hazards of improper handling of e-waste.
- 55% of the respondents expressed interest in recycling the unused electronic equipment and contribute towards protection of the environment.

- 67% of the respondents are aware of the informal and formal chain for e-waste handling.

- 85% of the respondents rely on the Internet and their peers as the first source of information on recycling.
Close to 50% of the respondents are ignorant about local initiatives or e-waste policies and legislation.

- 72% respondents leaned towards the option of repair compared with replacing the equipment with new ones and 27% attributed their choice to availability of spare parts.

2.4.3 KEY OBSERVATIONS AND FINDINGS FROM STAKEHOLDERS’ ROUNDTABLE MEET

Apart from one-on-one discussions and meetings, a roundtable meet of the concerned stakeholders was organized to understand the operational challenges and hurdles in the system and to come up with an action plan to solve these problems. The meeting was held at the World Institute of Sustainable Energy, Pune on 2 December 2019 and was attended by representatives of the Pune Municipal Corporation, social organizations supporting and active in the cause such as SWaCH, Poornam Ecovision Foundation, Janwani, and Adar Poona Wala, recyclers such as Cerebra Green, and citizen volunteers and end users.
High-level discussions facilitated identification of key issues / challenges on the existing e-waste management system in Pune city. These are given below.

At the Governance Level

Pune Municipal Corporation

- Current mandate segregates wet waste and dry waste. No guidelines/mandate to segregate e-waste, resulting in mixing of e-waste with the dry waste and increasing difficulties in segregation.
- In the absence of proper guidelines and compliance, imposition of penalties for poor performance is not possible. This is a major gap.
- Currently, there is no proper monitoring and evaluation mechanism in place. This has resulted in poor functioning of the staff, free reign to the informal sector, etc.
- Lack of suitable baseline targets and timelines for e-waste collection.
- PMC’s current role in e-waste management should be that of a monitoring body. But this is not the case due to lack of guidelines and regulations, lack of capacity building and lack of suitable staff/manpower or a dedicated cell for monitoring e-waste management in Pune city.
- Lack of coordination between PMC, the NGOs and recyclers leading to haphazard functioning and ineffective facilitation of e-waste collection, recycling, monitoring and reporting.

Maharashtra Pollution Control Board

- MPCB has defined rules for IT e-waste. But rules for household e-waste are absent. Monitoring is present only for ‘Bulk companies’ but not for households.
- Section 2 of the MPCB rules provides list of equipment that can be categorized under e-waste. Certain categories such as batteries, power bank which have now become quite common electronics at household level are absent from the list and put under hazardous waste category.
- MPCB provides for ‘filing of annual returns’ of e-waste via ‘Form 6’ for recyclers and dismantlers. This is the final hand-over document submitted to the Board. But there is no transparency and the said data is not available in the public domain.
At the Information, Infrastructural, Technical, and Financial Levels

**End-Users (Household Consumers)**

- Lack of awareness regarding the existence of PMC’s 177 temporary e-waste collection centers (*Aarogya Kothis*) by the citizens of Pune city. Overall, lack of citizens’ awareness and knowledge gap a major hindrance in the sector.
- Lack of manpower at the collection centers (*Aarogya Kothis*). Stakeholders affirm that manned collection centers witness more e-waste collection than unmanned ones.
- Lack of proper collection bins at prime locations in the city that would facilitate e-waste collection.

**Formal and Informal Sectors**

- Temporary facilities set up by PMC extremely inadequate to house huge amounts of e-waste.
- Lack of either centralized or decentralized warehousing facilities for storage of e-waste.
- Lack of knowledge and implementation of suitable business models for e-waste recycling.
- Costs pertaining to transportation of e-waste is extremely high resulting in lack of interest of recyclers in e-waste. Also, recyclers focus mainly on IT equipment (which is more profitable) as household e-waste is difficult to dismantle.
- Lack of suitable financial incentives for e-waste collection and recycling, resulting in lack of interest by the recycling sector.
- Acute shortage of funds for information campaigns and awareness drives. As a result, NGOs have to mainly depend on CSR funding.
- Lack of capacity building of all stakeholders, starting from PMC. But training would be irrelevant without putting a proper e-waste management system in place. This needs to be priority.
3

CIRCULAR STRATEGY FOR PUNE CITY: BEST PRACTICES AND ACTION PLAN FOR E-WASTE MANAGEMENT

This chapter features a holistic mix of global best practices and specific case studies and business models from India that provide critical insights and offer a suitable pathway for moving towards a circular economy in e-waste management. While this literature review reflects strategies at a broader, macro level, the action plan developed by WISE, with key inputs from the stakeholders in e-waste management, provides detailed and comprehensive strategies and actions with specific timelines to accomplish tasks and enable a circular economy for e-waste management in Pune city.

3.1 GLOBAL BEST PRACTICES

SWEDEN

Sweden has a mature recycling system with the highest e-waste recycling rates in the world – at 51.6 percent. There are two parallel e-waste collection systems in Sweden:

1) Producer responsibility for e-waste was introduced in 2001. To push this policy, the cooperation called “Elretur” comprising producers and local authorities was established. The operator takes the responsibility to manage the collection and recycling systems for e-waste and it has contracts with every local authority to collect e-waste from residents (1).

2) In 2008, Swedish Association of Recycling Electronic Products started another system called EÅF. EÅF collects e-waste through their member stores from residents.

In accordance with the provision of the ordinance of producer responsibility, collection of e-waste is coordinated with municipal authorities and private transportation companies. Once the goods arrive at the recycling center the e-waste is sorted in six categories:

(i) Miscellaneous e-waste
(ii) Fridge and freezer
(iii) White goods (except [iii])
(iv) Batteries
(v) Fluorescent Lights
(vi) Light bulbs
Figure 3.1: Framework of E-waste Management in Sweden

Source: WISE, 2019

Boliden Electronic Scrap Recycling – A Case Study

The case in point aims to increase electronic scrap recycling capacity at the Rönnskär copper smelter in Sweden. The project site recycles e-scrap of some 45,000 tons per year, and after the expansion, this capacity is expected to reach some 120,000 tons per year. The promoter is a private company not operating in the utilities sector, and is thus not covered by the EU Directives on procurement. The company is expected to obtain equipment and services for the project from amongst the few specialized engineering companies, using international negotiations. This procedure, which is usual in this industry, would be in the best interest of the project and in line with the European Investment Bank's (EIB) procurement policy for private industry projects. EIB has granted a fund of 85 million Euro to this project (2).

Best Practices by PRO in Sweden

According to the Sweden WEEE directive, producers of EEE have the duty to channelize e-waste to proper recyclers. EEE manufacturers and trade organizations thus came together to form El-Kresten a producer responsible organization (PRO). Collection and transportation of e-waste is handled by El-Kresten. Producers/ manufacturers who want to sell EE equipment in Sweden have to provide funds and El-Kresten uses these funds to collect and transport e-waste. El-Kresten provides nationwide collection and recycling system for e-waste and has around 1000 collection points. El-Kresten has maintained data of e-waste handled in its overall operational life and made it available on its portal for all the stakeholders (1).
CALIFORNIA

The State of California splits the responsibility of e-waste management between municipality and consumer. The Electronic Waste Recycling Act (EWRA) of 2003 is a California law to reduce the use of certain hazardous substances in certain electronic products sold in the state. The Act turned into law in September 2003. The Act also requires retailers to collect an electronic waste recycling fee from consumers who purchase devices covered under the Act. E-waste is categorized as hazardous waste and falls under category of universal waste, thus banned from general landfill disposal. Universal waste could be disposed in the trash under some circumstances, however this is no longer the case as all e-wastes are now banned from being disposed into the trash. Electronic Device Recycling Research and Development Act distributes grants to universities, government labs and private industries for research in developing projects in line with e-waste recycling and refurbishment (3).

Regulation and policies for e-waste management in California are given below.

- Electronic Hazardous Waste (E-Waste), California Dept. of Toxic Substances Control.
- Hazardous Waste Management, County of San Diego.
- Universal Waste, California Dept. of Toxic Substances Control.
- PPM 516-9, Environmental Pollution.
- PPM 516-14, Hazardous Waste Disposal.

California have launched a portal named CalRecycle (3). California’s Department of Resources Recycling and Recovery brings together the state’s recycling and waste management programs under the portal. CalRecycle administers and provides oversight for all of California’s state-managed non-hazardous waste handling and recycling programs. CalRecycle is known mostly for overseeing beverage container and electronic-waste recycling. Its vision is to inspire and challenge Californians to achieve the highest waste reduction, recycling and reuse goals in the nation. CalRecycle provides training and ongoing support for local enforcement agencies, who regulate and inspect California’s active and closed solid waste landfills, as well as materials recovery facilities, solid waste transfer stations, compost facilities, and more. The permitting and inspection processes help CalRecycle fulfill its mission to protect the health and safety of Californians and the environment. CalRecycle has a budget of approximately USD 1.4 billion (3).

CalRecycle has a directory to find organizations that recover materials from unwanted electronics. People need to contact the organization ahead of time who then confirms its services and any potential charges.

For compliance purpose CalRecycle mandates that all members fill up 3 forms (3):

1) Form 220: Annual Covered Electronic Waste (CEW) Net cost report (Summary report)
2) Form 220A: Collector Net cost sheet (collection, consolidation and transportation)
3) Form 220B: Recycler Net cost worksheet (recycling activities and weight canceled)

Net cost report is submitted annually to CalRecycle by recyclers and collectors regarding CEW. Revenue, weight of e-waste and cost linked to CEW should be included in the report, which must be backed by proof of cost and revenue (3).
GERMANY

Germany generates 30 million tons of garbage per year, out of which e-waste accounted for 836 tons in 2017, which is equal to 9 kg per inhabitant. The Waste Electrical and Electronic Equipment (WEEE) Directive was adopted in 2003 with the intention of instituting harmonized European regulations for electrical and electronic waste. The directive was switched to German law by adoption of the 2005 Elektro- und Elektronikgeräte-Gesetz (ElektroG) law. An amended version of the directive, known as WEEE II, was enacted in October 2015. Product stewardship in the sphere of waste management is governed by the Waste Management Act (KrWG), particularly its provisions concerning the development of long-lasting products, the use of secondary raw materials for manufacturing, and recycling end-of-life products in an eco-friendly manner. If there is break of law by any manufacturer, a fine upto EUR 100,000 can be imposed (4).

In 2017, Germany attained 45 percent collection rate. The country is planning to collect waste of electrical and electronic equipment (WEEE) nationwide, free of charge and close to households. Along with door-to-door collection, illegal collection and export of WEEE will be checked and all operators in the waste management chain must comply with their obligations to report quantities placed on the market and collected. There must also be more continuous information on the part of manufacturers, public disposal companies and distributors about legal ways of returning WEEE and consumer information about the reasons for the separate collection of WEEE, such as the conservation of resources or the reduction of pollutant emissions (4).

Various registrations and certifications apply to private and public industries, producers, transporters, waste disposal and recycling businesses and local authorities. Today, the waste sorting process involves carefully distinguishing between waste to be disposed and materials to be recycled, and raw materials to be re-used. The disposal of non-recyclable waste is highly regulated. Businesses treating hazardous products are obliged to report the waste to the competent authority and obtain authorization (4).

Digitization of E-waste Collection and Reporting

Germany is moving in the right direction: an electronic record procedure has been a legal requirement for hazardous waste since 2010. All documents must be processed 100 percent digitally so as to eliminate disruption in switching from one media to another and to ensure the integrity of information from the start of its journey to the end.

Tens of thousands of businesses are concerned by this requirement, and a number of them rely on the eANV portal, an eWaste platform from Axians, which can be used to complete the whole administrative process: registration, certification, compliance with legislation, authentication, and electronic signatures (4) (5).
In a push for sustainability, medals for winners in the Tokyo Olympics and Paralympics 2020 (gold, silver and bronze) will be made out of e-waste consisting of discarded smartphones, laptops and electronic waste. The London games used 9.5 kg of gold, 1210 kg of silver, and 700 kg of copper to make their medals. By comparison, Japan discards 650,000 tons of small electronics and home appliances every year. That results in 142 kg of gold, 1565 kg of silver, and 1,112 tons of copper through electronics in 2014. This idea gained momentum when a group of students concerned regarding sustainability started an online petition (6).

While the scheme has only been set up to acquire the metal quantities required, the main goal behind is to increase awareness amongst Japanese citizens about recycling and sustainability concepts. From the official site of Tokyo 2020, data collected shows that 100 percent target was achieved in March 2019. Details are given below (6).

Project period: 1 April 2017 to 31 March 2019
Total devices collected: 1621
Collection by municipal authorities: 78,985 tons
Shops (mobile phones only): 6.21 million pieces
Metals collected: Au: 32 kg; Ag: 3,500 kg; CuSn: 2,200 kg
3.2 KEY CASE STUDIES FROM INDIA

Sanshodhan: An E-waste Exchange Program

Founded by Economist Saraswati Devi, Sanshodhan E-waste Exchange Private Limited is among the few NGOs in India having a female founder. The NGO partnered with the state government of Telangana to assist in the implementation of ‘E-waste (Management) Rules 2016 and Amendments 2018’. Sanshodhan Digital-PRO innovation allows users to dispose their e-waste in ‘one click’, through the E-Waste Exchange (EWX) platform which is being incubated at T-Hub, India’s leading incubator by the Telangana government (7).

EWX enables large businesses and bulk electronic and electrical producers to implement a door-to-door collection. The approach is marked by use of the Internet, as well as the incentive to comply with government regulations by ensuring that e-waste is efficiently disposed to the authorized dismantler/recycler (7).

One-stop services provided by EWX for the state government, producers, groups of industries, bulk consumers and individuals are:

- Circular Economy Standard E-Waste Management - RE-CIRCULATETM
- E-Waste Inventorization
- E-Waste Channelization for Safe & Environment Friendly Recycling
- Development of Extended Producer Responsibility (EPR) Plan and Assistance for EPR Compliance
- Establishing E-Waste Recycling Unit
- Knowledge & Advisory Services: Transform Waste to Wealth

While disposing e-waste to Sanshodhan, donation of Rupees 2 can be contributed towards preventing child labour in the dismantling process. Recently Sanshodhan was awarded the Circular Economy People’s Choice Award by the World Economic Forum (7).

Students Awareness Program by Ministry of Electronic and Information Technology

The Ministry of Electronics and Information Technology (MeitY), Government of India, has initiated the campaign “Awareness Program on Environmental Hazards of Electronic waste” on 31 March, 2015. This project is under the ‘Digital India’ initiative of the Government of India. The project is expected to have far reaching and significant impacts on the growth of the country as it focuses on reuse and recycling of e-waste, which has the potential to conserve natural resources (8). The project has three components viz. content development, inventory assessment and awareness generation amongst different stakeholders.
The project will help in effective implementation of E-waste (Management) Rules, 2016. MeitY has played a key role in spreading of knowledge regarding e-waste rules in the past and wishes to engage all key stakeholders during this exercise (8).

A city in each of the 10 identified states viz. Madhya Pradesh, Uttar Pradesh, Jharkhand, Orissa, Goa, Bihar, Puducherry, West Bengal, Assam and Manipur were covered in Phase I. In Phase II, the same has been enhanced to covered more than 30 cities across 30 states and union territories in India. The activities include organizing awareness workshops for localities, schools, colleges, bulk consumers (including corporate and government sectors), informal sector, dealers, refurbishers, manufacturers, etc., so as to build capacities of the target groups to channelize e-waste in a manner that the rules are effectively implemented. Suitable course curriculum has also been framed for schools/colleges. To better understand the mission, the local language guide will also be published. This project has also stressed on adopting best practices for e-waste recycling available globally, so that the unorganized sector can generate jobs as well as viable business prospects, thereby mitigating the impact of improper recycling on the environment (9).

**Cashify: A Unique E-waste Management Program**

*Source: Cashify website*

Manak Waste Management Private Limited, doing business as Cashify, provides online based services. The company assists users to sell their old and used gadgets including mobile phones, laptops, tablets, gaming consoles, and televisions. Cashify serves customers in India and has been rated as the third fastest growing tech start-up in the country by Deloitte in their annual ‘Technology Fast 50’ 2018 report (10).

Cashify has plans to expand its offline kiosk model from current sixteen areas in Delhi-NCR region to a total of 50, by the end of the year. Cashify has also launched allied services such as Express Smartphone Screen
Repair, which is present in six cities and is already expanding rapidly. Thus, by collecting cellphones and laptops directly from the customer, the informal sector is bypassed (10).

**Kabadiwala Connect**

*Kabadiwala* Connect (KC), is a social enterprise based in Chennai determined to change the informal ecosystem of urban waste. Aiming to decrease the amount of waste sent to landfills by 70 percent, KC provides an end-to-end technology platform that leverages the informal ecosystem consisting of waste collectors by making them more accessible to small and medium waste generators, and to the government and private enterprises, who have the capabilities to process and recycle the waste (11).

Buying e-waste from bulk waste generators like factories or industrial establishments that generate enough waste consistently makes financial sense to middlemen and social enterprises. But it does not amount to much at an aggregate level. About 68 percent of the waste generated in Chennai, for example, is post-consumer waste from households but it is generated in smaller disaggregated units. In cities in Europe and North America, household waste is segregated at the source and recovered through curbside collection so that only the stuff that has zero value goes into the landfill. Such a system does not exist in Indian cities (11).

*Sourc*e: https://nextbillion.net/from-trash-to-resource-how-technology-can-help-informal-waste-pickers-solve-indias-recycling-problem/
KC’s business-to-consumer app, Recykle, helps households to connect with local *kabadiwalas*, channelling waste from households directly to the *kabadiwala*, partially solving the problem of visibility. KC also facilitates this process by providing resources for users, and answering any questions that they may have through the app itself. Another business-to-business platform includes a survey app to connect to bigger buyers, a logistics platform and a dashboard that can potentially be used by municipalities, management companies, residences and corporations to efficiently manage their waste at all stages (11).

Most research on the informal ecosystem of waste has focussed on the waste picker and been largely ethnographic in nature. It is here that KC’s approach diverges from the conventional. Rather than approaching the informality as a problem and developing a new system for waste management, KC uses its technology platform to leverage the already existing informal infrastructure towards a more efficient waste management system (11).

**Chintan Environment and Research Group – A business model for informal sector integration into the formal sector**

Chintan is an NGO located in Lajpat Nagar, New Delhi. Its approach is to build networks, conduct one-on-one discussions and facilitate debates and discussions among dismantlers. This resulted in the emergence of grassroots leaders within the community. Chintan has been supporting Safai Sena, an association of waste-pickers, doorstep waste collectors, itinerant buyers, small junk dealers and other types of waste recyclers, since its establishment in 2001 and registration in 2009 (12).

One of its aims is to work towards the recognition of the work of waste recyclers and to provide safer and more secure work conditions. The association is comprised of approximately 12,000 recyclers, mostly waste pickers, small waste traders and itinerant buyers. E-waste is collected both from bulk waste generators such as call centres as well as from households. Much of this e-waste is collected by itinerant buyers and sold to dealers. This is where an opportunity for Safai Sena to expand its work presented itself. (12).

Chintan organized the informal sector through the following ways:

- Conducting workshops on various topics such as the Delhi Master Plan, need for space for recycling work, ideas of rights, and health etc.
- Organizing workshops comparing recycling practices in India versus other countries.
- Identifying community leaders.
- Training the community leaders on how to gather more e-waste workers, how to explain the issue and how to organize a meeting.

**3.3 Financial Models for E-waste Management in Pune City**

**Model 1: E-waste Fees through the Electricity Bill**

Development of suitable financial models will go a long way in ensuring a sustainable value chain for e-waste management. For Pune city, a blended financial model is being suggested. In this model, both consumers and producers pay for different stages of the e-waste management value chain. Figure 3.2 represents the financial model envisaged for Pune city (13).
In order to make e-waste collection sustainable, the e-waste producers and collectors should be paid for the e-waste they are providing. This is done through a closed loop finance flow system. In this system, users of EEE pay fees as a percentage of electricity bill amount to the DISCOM. The DISCOM then channelizes this fee to a central body authorized to manage the fund (may be PMC). The central body then channelizes this fund to the collectors for purchasing e-waste from the users and transports the waste to the nearest collection point. A portion of this amount goes to the consumer, another portion to the recycler for transporting the waste, and the remaining is kept by the collector as his compensation. The amount to be paid to the e-waste generator will be pre-fixed by the central body, which will be competitive to the price paid by the informal sector. Payment of excess fee along with the electricity bill is logically justified as people paying higher fees may be (presumably) consuming more electricity because of the use of electronic and electrical equipment (13).
On the other side of the model, the producers of EEE contribute to a pool of funds managed by a central body. The central body then uses this fund for developing the collection points, and transport of e-waste from collection points to the recycling facilities. The recyclers receive funding from the central body to recycle the products and provide the usable spare parts recovered from e-waste to the producers of EEE. The remaining spare parts go to the scientific landfill (13).

**Model 2: E-waste Fees to the Sellers**

In this model consumers pay a fee along with the product price while purchasing the product. Then the seller pays the fees to a central body and the central body disburses funds for required activities (Figure 3.3) (13).

![Figure 3.3: Financial Model 2 for E-waste Management in Pune City](image)

Payment of fees is justified on the grounds that whosoever uses the electronic goods is responsible for its safe post-life treatment. Part of the fees is paid back to the consumers (by the collectors) when they give e-waste to the collectors (13).
### 3.4 ACTION PLAN FOR ENABLING A CIRCULAR ECONOMY FOR E-WASTE IN PUNE CITY

For a circular economy to function effectively, it is essential that an effective system be put in place first, with all the concerned stakeholders coordinating and participating at every step of the e-waste management process. In addition, policies, guidelines and regulations need to be enabled/amended to convert the current ‘cradle-to-grave’ system into a ‘cradle-to-cradle’ economy. Keeping this in mind, the following action plan has been developed for Pune city with specific timelines that include both short-term actions (to be carried out in the next two years to enable capturing at least 60% of e-waste in the city) and long-term actions (to be carried out in the next five years), for enabling a circular economy. This strategy is a participatory effort and has been derived through deliberations and discussions with the key stakeholders involved.

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| 1  | Lack of defined guidelines, targets and benchmarks for e-waste management.  | • Frame guidelines that would detail the specific roles and responsibilities of the stakeholders, their functioning, rules and regulations, punitive action, if any, and integrating these into a circular economy framework.  
• Setting up targets and benchmarks for e-waste generation and resource efficiency in Pune city.                                                                                                     | • Draft detailed guidelines by local think tanks (such as WISE) in coordination with PMC and concerned stakeholders.  
• Constitution of an Expert Committee comprising experts from the government, industry and academia, for providing suitable guidance in drafting the guidelines.  
• Conduct a baseline study (by a local think-tank) to assess and evaluate the total consumption of resources (EEE) and the related e-waste generated.  
• Set benchmarks and monthly/yearly targets for reducing e-waste.  
• Expert Committee to provide suitable guidance in this endeavor.  
• Periodic review of the guidelines and amendments to make it commensurate with the advancements in technology and overall functioning of the e-waste management system.  
• Develop a long-term resource efficiency strategy that would gradually eliminate e-waste.  
• Transition gradually into a circular economy by achieving the targets set. | • Local think-tanks, PMC, NGOs, voluntary groups, industry, academia, government.  
• Local think-tanks, PMC experts from the industry, government, academia, etc.                                                                                   |
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| 2. | Lack of awareness and knowledge amongst Pune citizens regarding e-waste collection, handling and management. | • Awareness campaigns targeting focused groups at the industrial and corporate level, academic level, household level, etc. to be devised and implemented.  
• Coordination between PMC, NGOs and citizens’ voluntary groups for developing a long-term action plan for awareness generation in Pune city.  
• Providing adequate funding for implementation of such awareness campaigns.  
• Critical information on e-waste to be made available in the public domain using the print, digital, electronic and social media, in coordination with PMC, NGOs and voluntary groups. | • Weekly drives targeting a particular household locality each week.  
• Fortnightly drives targeting schools and colleges.  
• Weekly door-to-door awareness for e-waste collection and segregation.  
• Design and development of printed literature such as leaflets, brochures, pamphlets, comprising details of e-waste collection and segregation, its health and environmental impacts, etc., for distribution and dissemination to the target groups.  
• Development of advertising and promotional clips (with the help of celebrities) for dissemination on TV.  
• Advertising and promotional jingles on the radio.  
• Promotion of advertisements through the social media such as WhatsApp.  
• Street plays during major public events and gatherings. | • PMC to make provision for a dedicated budget for implementation of these activities.  
• Formation of a Coordination Committee for overseeing implementation of the long-term action plan.  
• Engaging publicity outdoor partners for maximizing reach of the awareness campaigns across the city.  
• Map collection/storage centers of PMC (Aarogya Kothis) and location of collection bins kept in public places on Google Maps.  
• Map location of all NGOs, recyclers involved in e-waste management on Google Maps.  
• Provide detailed list of collectors and recyclers (name, address, location) on PMC website and respective websites of NGOs and recyclers.  
• Have a dedicated website/section dedicated to e-waste on the PMC website comprising all the vital information.  
• Development of interactive mobile app by PMC providing information on collection drives, details of collection centers, recyclers, etc. | PMC, NGOs, industry, think-tanks, housing society committees, voluntary citizens’ groups, print and digital media groups. |
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| 3. | Lacunae in the functioning of the E-waste cell at PMC and MPCB              | • Strengthening manpower of the e-waste cell at PMC and MPCB.  
• Capacity building of the e-waste cell by industry/academic experts.  
• Development of online certificate courses for developing and upgrading skills.  
• Provision of adequate funding for the smooth functioning of the cell. | • Deploy dedicated manpower from within the government itself in the short term to coordinate the activities of the cell.  
• Organize seminars, workshops, training programs, site visits, etc. to develop knowledge and skills of the staff.  
• Facilitate online certificate courses for members of the cell. | PMC, MPCB, public and private academic institutions, industry experts. |
| 4. | Inadequate Infrastructure and logistics for e-waste management activities    | • Establishment of permanent infrastructure for facilitating and enhancing e-waste collection, storage, and recycling.  
• Improving transportation services for e-waste collection.  
• Establishment of formal recycling infrastructure to reduce illegal and unhealthy practices of recycling and shift to a circular economy.  
• Provision of adequate funding for establishment of infrastructure and logistical support. | • Renovation of existing storage/collection centers to provide more space for storage.  
• Provision of manned collection centers with weighing scales to keep track of quantity of e-waste collected.  
• Place e-waste collection bins in prime public locations (shopping malls, parks, events etc.) for facilitating collection.  
• Provision of dedicated vehicles to collect e-waste from dispersed locations across the cities. | PMC, PROs, transportation agencies, recyclers. |
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| 5  | Huge dominance of informal sector thus creating a ‘parallel’ e-waste management system and unnecessary, additional channels of e-waste collection. | - Strengthening of the existing formal sector through adequate funding.  
- Channelization of funds to attract informal collectors to integrate with the formal sector.  
- Government measures to provide job opportunities, train and support daily wage workers to integrate into the formal sector.  
- Development of suitable business models to encourage informal to formal sector integration. | - Frequent interactions to educate rag pickers regarding unsafe practices.  
- New entrepreneurs to be incentivized and encouraged to enter the business under various government schemes.  
- PMC to facilitate and promote licensing of informal collectors, provide information on avoiding penalties. | PMC, PRO, local think tanks, government and private organizations, NGOs.                                                                                                                                  |
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|    | Lack of appropriate reporting, monitoring and evaluation mechanism in MPCR and PMC | • Need for centralized online system to monitor, report, review data, and facilitate information and communication.  
• Availability of the centralized data as a repository bank for access in the public domain.  
• Dedicated staff for monitoring e-waste at MPCR  
• Proper coordination between PMC and MPCR for facilitating data sharing and reporting.  
• Proper coordination between MPCR and stakeholders for strengthening monitoring and evaluation.  
• Setting up of a centralized grievance redressal cell for the stakeholders to improve the monitoring and evaluation mechanism. | • Setting up of a Monitoring Committee comprising members from MPCR, PMC, NGOs and collectors. It should ensure coordination and facilitate a more formalized and structured method for e-waste monitoring.  
• Recruitment of external IT consultant for development of the centralized database, portal, app, etc.  
• A dedicated desk for MPCR in the PMC office to facilitate coordination between the two organizations. | PMC, MPCR IT consultant/staff, NGOs, local think tanks (guidance). |

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| No | Challenges                                                                 | Strategies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Action plan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Stakeholders involved in Implementation                                                                 |
|----|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7. | Unsafe and unhealthy dismantling and recycling practices causing threat to health, society and the environment | • Development of suitable guidelines (under the overarching E-waste guidelines) for monitoring and evaluation.  
• Educating the informal sector on the hazards of unsafe e-waste management practices and conducting studies on their harmful impacts.  
• More stringent regulations for prohibiting child labor in the sector.  
• Encouraging R&D in e-waste processing and recycling to develop a more effective and circular e-waste economy | • Organization of training programs and workshops on a regular basis, in different wards in the city for the informal sector on the hazards of unsafe and unscientific e-waste handling.  
• Preparation and circulation of safe practices handbook (by a think-tank in coordination with experts, NGOs, etc.).  
• CPCB/MPCB, in consensus with MoEFCC and MeitY to come up with guidelines to mandate certain percentage of usage of recycled material in manufacturing at the national level.  
• Environmental Impact assessment to be conducted by National Green Tribunal (at the national level) or suitable think-tanks (at the city level) on the negative impacts of hazardous e-waste management practices.  
• Raids should be conducted on establishments to check for unsafe practices of e-waste handling and recycling and punitive action should be adhered to.  
• Channelize funds from the government, international collaboration/funds for R&D purpose. | PMC, MPCB, think-tanks and academia, NGT, NGOs, MoEFCC, MeitY, Research organizations. |
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| 8.  | Lack of funding and subsidy schemes for the formal sector | • Creation of funding opportunities and schemes for e-waste management by the government.  
• Encouragement for incorporating e-waste management activities under CSR. | • Allocation of a proportion of corporate social responsibility fund for e-waste management activities.  
• Introduction of incentives and schemes by PMC to promote safe practices of e-waste handling and recycling. | • PMC to set up dedicated budget for e-waste management.  
• Manufacturers to contribute to a centralized fund to provide financing to formal collectors.  
• Creation of a long-term fund for formal collectors.  
• Development of suitable business models to promote public-private partnership for funding. | Manufacturers, government, PMC, corporates. |
| 9.  | Unsustainable lifestyle practices leading to overconsumption of natural resources and EEE. | • Awareness on social and moral obligations and responsibilities towards sustainable production and consumption of resources.  
• Awareness on moving from the ‘3Rs’ (reduce, reuse, recycle) to the ‘5Rs’ (reduce, reuse, refurbish, repair, recycle) way of life. | • Awareness campaigns through print media, digital media, social media, radio.  
• Advertisements/hoardings in popular public places such as shopping malls, bus stops, buses, railway stations, etc.  
• Direct campaigns in schools, colleges and universities to generate awareness on the importance of a circular economy. | • Change in consumer behaviour and mindset through community drives, workshops organized by think-tanks, and national level conferences need of the hour to educate policy makers, industry and the common citizens on unsustainable consumerism. | NGOs, think-tanks, CSOs, print and digital media, publicity managers, consumer forums, think-tanks. |

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4 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

WISE’s field study, one-on-one interaction with key stakeholders, and detailed assessment of the current e-waste management system in Pune city has shown the presence of major lacunae at different levels of the e-waste management system. These exist at multi-administrative levels viz. governance, infrastructural, technical, financial and information levels, and at multi-stakeholder levels viz. government bodies, informal and formal sectors, and end-users (household consumers) levels. Details are given in Section 2.4, Chapter 2, of this report.

Further discussions and deliberations with the key stakeholders resulted in WISE developing a detailed action plan that provides comprehensive strategies and actions with specific timelines. These include both short-term actions (to be carried out in the next two years to enable capturing at least 60% of e-waste in the city) and long-term actions (to be carried out in the next five years), for enabling a circular economy for Pune city. Details are given in Section 3.4, Chapter 3, of this report. The chapter also features a holistic mix of global best practices and specific case studies and financial models from India that provide critical insights and offer a suitable pathway for moving towards a circular economy in e-waste management in Pune city.

In conclusion, Figure 4.1 provides a visual representation of the model, circular economy framework envisaged for Pune city, while Figure 4.2 depicts the flow of processes (carried out by the concerned stakeholders) in the circular economy framework, to accomplish tasks and enable a circular economy for e-waste management in Pune city.
Figure 4.1: Circular Economy Model Framework Envisaged for Pune City

Source: WISE, 2019.
4.2 RECOMMENDATIONS AND SUGGESTIONS

Based on the Action Plan, key recommendations and suggestions for further action and/or study are given below.

1. Drafting detailed and comprehensive guidelines for streamlining the e-waste management process in the city, prescribing rules and regulations, punitive action, if any, defining and elaborating the roles and responsibilities of each of the stakeholders and their functioning, and integrating these into a circular economy framework. The work could be entrusted to a local NGO or think-tank.

2. Need for a baseline study to be conducted for Pune city by local think-tanks that would assess and evaluate the total consumption of resources (EEE) and the related e-waste generated, thus enabling the setting up of suitable benchmarks and targets for reducing e-waste generation. Such a study would also be relevant for set targets at the national level.
3. Development of a long-term resource efficiency strategy for Pune city (again by local think-tanks) that would gradually strive for a circular economy, reducing the use of new resources in production by manufacturers as well as reducing consumption of EEE by consumers.

4. Like the Renewable Purchase Obligation (RPO), which mandates that power purchased by an obligated entity should have a certain percentage of renewable energy, similarly, the Central Pollution Control Board / Maharashtra Pollution Control Board needs to come up with suitable guidelines for mandating a certain percentage of recycled, e-waste to be reused in manufacturing. This will enable strengthening of formal e-waste sector.

5. Conducting impact assessment studies by local think-tanks to assess and analyze the health, environmental and economic impacts of improper e-waste recycling by the informal sector in Pune city, and at the broader level in the country.

6. Organization of capacity building training programs and workshops by PMC, in collaboration with local think-tanks and NGOs, for the formal and (especially) informal sectors, on the negative health and environmental impacts of handling, dismantling, and recycling e-waste in an improper and unscientific manner.

7. Carrying out studies by local think-tanks to develop appropriate business and financial models for a circular, e-waste economy that would attract more funding from private institutions into the sector.

8. Undertaking studies and organizing conferences, seminars, community drives and workshops by local think-tanks (in collaboration with concerned stakeholders), on educating citizens on unsustainable consumerism and changing consumer behavior towards adopting a better and more sustainable lifestyle.

9. Carrying out feasibility studies by think-tanks to assess the possibilities of designing ‘product service systems’ that would integrate products, services, supporting networks and infrastructure, to reduce waste and form a circular economy.

10. Conducting in-depth research and studies by think-tanks for adopting the ‘cradle-to-cradle’ approach that would enable decoupling resource use and environmental degradation from economic activity and human well-being (doing more with less for longer), and aid the transition from resource-intensive growth to a resource efficient and sustainable future.
CHAPTER 1


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**CHAPTER 2**


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**CHAPTER 3**

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