Socio-technological challenges in formalization of E-waste recycling in India

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E-waste is mainly recycled in two sectors: the informal and the formal sector. In the developed countries E-waste is processed by the formal sector while informal recycling is dominantly practiced in the developing countries like Africa, Nigia, Malaysia, China, and India. The main objective of this study is to explore the technologies used in recycling of E-waste in the formal sector in India and to identify the major challenges faced by the formal recyclers during operation. To have a better understanding of the recycling process and problems associated with formal E-waste recycling, two registered formal recycling organizations in Delhi-NCR, that is, Attero Recycling Pvt. Ltd. and SIMS Recycling Solutions were visited and interviewed. Secondary data regarding the techniques used for recycling and challenges faced by the other formal recyclers in India were also collected and analyzed to have a broader understanding of major issues related with E-waste recycling in the country.

The major findings of this study indicate that the formal recyclers have to face stiff competition from the informal recyclers who have a better approach to the consumers. Lack of awareness, strict implementation and monitoring are the major issues faced by these recyclers. Hence, the study suggests proper implementation of the law and raising awareness regarding the benefits of proper recycling of E-waste in the country.

11.1 Introduction

Sustainable E-waste recycling and management has emerged as a major environmental challenge especially in developing countries like Malaysia, Indonesia, Nigeria, India, and China in the last two decades. The developed countries, to a large extent, have been successful in overcoming this problem through proper implementation of E-waste management policies and formalization of recycling and material recovery process. In developing countries like India, the E-waste recycling is still dominantly performed in the informal sector due to availability of cheap labor, lack of awareness among people, and the ineffective implementation of the existing rules by the monitoring agencies/institutions. There are many social and

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environmental repercussions of informal processing of hazardous substances like E-waste. Since the informal sector is not registered, labor laws, occupational health standards, and the social security measures could not be extended to the workers involved in E-waste recycling. Moreover, the workers involved are not trained for handling such type of hazardous waste and fall to the consequences of improper dismantling and recycling. Though many awareness campaigns and efforts to educate the E-waste workers have been taken up by some NGOs working in this area, there is still rampant processing of E-waste in crude manner.

In pursuance of the E-waste (Management and Handling) Rules 2011 which came into effect from May 1, 2012, the state agencies (Central and State Pollution Control Boards) started the registration of companies interested in collection, dismantling, and recycling of E-waste in the country. Although the number of registered recyclers/collectors has grown throughout the country, the major portion of E-waste is still flowing to the informal sector.

As per the CPCB latest data (2016), there are 178 registered E-waste recyclers/dismantlers spread throughout the country with their total capacity of approximately 438,086 MT of recycling annually (Table 11.1). The total E-waste generated (internally and also imported) in India was 332,979 MT in 2007 which increased up to 713,770 MT in 2015 and it is projected that by 2025 the volume of E-waste in India would be 1,851,337 MT (Chatterjee, 2011). It is not only the shortage of the recycling capacity of the formal sector, it has been also reported that most

Table 11.1 Registered formal recyclers/dismantlers in India with permitted recycling capacity (as on December 29, 2016).

S. No.	State	No. of registered recyclers/dismantlers	Total permitted capacity of in (metric ton per year)
1	Chhattisgarh	02	1650
2	Gujarat	12	37,262.12
3	Haryana	16	49,981
4	Karnataka	57	44,620.5
5	Maharashtra	32	47,810
6	Madhya Pradesh	03	8985
7	Odisha	01	N.A.
8	Punjab	01	150
9	Rajasthan	10	68,670
10	Tamil Nadu	14	52,427
11	Telangana	04	11,800
12	Uttar Pradesh	22	86,130
13	Uttarakhand	3	28,000
14	West Bengal	1	600
15	**Total**	**178**	**438,085.62 (approximately 438,086)**

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

of the formal recyclers are operating at underutilized capacity of their plants (Agarwal and Nair, 2015).

This has become a major challenge for the formal recycling organizations as it is difficult for them to get adequate volume of E-waste. As a result most of the existing plants are working underutilization of their capacity. In this study we attempted to explore the challenges involved in formalization of E-waste recycling in India. While analyzing the recycling process and techniques adopted by the registered recyclers, we made a comparative analysis with informal sectors/actors to explicate the challenges. We found that there are not only legal challenges, but also social, economic, and political challenges that need to be addressed in making of any policy or programs for formalization of E-waste recycling in India.

The study also discusses the major formal recyclers which are registered under CPCB to understand their functioning, the technologies they use and challenges faced by them during operation. To get in depth understanding to their functioning case study has been done on two formal recyclers in Delhi-NCR: Attero Recyclers Pvt. Ltd and SIMS Recycling Solutions. This study would also try to explore the issues and major problems in the process of formalization of the E-waste recyclers in the country.

11.2 Review of literature: recycling of E-waste in India

In India 95% of E-waste is recycled by the informal sector and only 5% is processed through the formal channel (Rochat et al., 2008). The workers in the informal sector use very crude and dangerous methods for treatment of E-waste. They dismantle old electronic equipment with electric drill, cutter, hammer, and screw driver into components parts such as monitor, hard drive, CD drives, wires, cables circuit boards, transformers, charger, battery, and plastic and metal frame. They sell these items for reuse or to workshops for further recycling. The circuit board of computers and other large appliances are heated over coal fires to melt the solder to release valuable electronic components, such as diodes, resistor, and microchips. The microchips and other parts are soaked into concentrated acid to reclaim the precious gold and palladium and the residue waste acids are discharge into nearby field or waterbodies. Wires and cables are stripped or simply burnt to extract metals. Printer cartridges are ripped apart for their tonner and recyclable aluminum, steel, and plastic parts. The different category of plastics are sorted manually by workers on the basis of rigidity, color, and luster and the plastic which could not be sorted visually are burnt and classified by the burning odor. These primitive methods of E-waste processing exposes not only the workers but the nearby residents also to the toxic pollutants emanating from the E-waste processing. The processing of E-waste in the informal sector is not only health and environmental hazards but also give a very low recovery of precious materials from E-waste (Yu et al., 2010).

Some scholars have suggested that customers need to be given incentives to return their end of life (EOL) e-products back to the collection center by enforcing

a buy-back policy. Once a product reaches the end of its useful life, the producers would buy it back from the consumers at a price higher than that of the informal sector, thereby cutting off the supply to this sector and ensuring that E-waste goes to the right channel. This additional cost to the manufacturer could be offset by increasing the selling price of new products (Dwivedy et al., 2015:13). It has been found that consumers in developing countries look for economic benefits for discarding their E-waste (Wang et al., 2010; Dwivedi and Mittal, 2013) and hence imposing any recycling fee would be strongly resisted by them. Dwivedy et al. (2015) in their study found that EPR model practiced in developed countries is likely to fail in India because it imposes cost to consumers. Therefore individual take back scheme based on payment to consumers seem workable in Indian context.

Because of these problems it is necessary to increase the public awareness about the effects of exposure from the deadly chemicals emanating from the processing of E-waste. It is more important to adopt responsible management strategies to minimize the E-waste production and making the E-waste components more easily recyclable and reusable.

According to a study by *Toxics Link*, these operations are very well connected to the supply chain processes of sourcing the raw materials to finding markets for the recovered materials (Sinha and Mahesh, 2007). This study states that the actual processing of E-waste is done in small clusters usually on the periphery of the city. Another study by Srivastava et al. (2011) also states that the operations carried out by the informal workers include collection of E-waste, sorting, transportation, and dismantling and finally recovery of materials. The material recovery processes include open burning, acid bath, and heating of lead solders (Sinha and Mahesh, 2007).

The formal sector in India uses both manual and automated technologies for dismantling, segregation and recycling of E-waste. The workers employed are trained for this job. These methods are safe for both the environment and the workers involved.

The general steps followed by the formal sector for recycling of E-waste are collection, disassembly or segregation, and recycling.

The processes used in the informal sector are considered harmful for both human health as well as the environment. Hence, formalization of this sector has been recommended in many studies (Khattar et al., 2007; Rochat et al., 2008; Raghupaty et al., 2010; Chaturvedi et al., 2010; Williams et al., 2013) in order to prevent the hazardous impact of improper E-waste recycling. Besides the health and environmental consequences of informal E-waste processing, the industry is also often affected with the negative employment, spatial, and economic correlates of informality. While earning can be good, especially for the poor and illiterate, less educated, the work place typically have poor health and safety condition, job stability, and social security benefits, and child labor is prevalent (Umair et al., 2015; Pandey and Govind, 2014). It has been also noted that the regions that host informal recycling hubs often have uncontrolled dismantling and disposal sites, with noise, emissions, and rubbish marring the landscape and causing tensions within communities.

The industry is often predicted on criminal and corrupt activities to assure the supply, transport, and sale of materials, and the operation of dubious facilities, while tax evasion means that revenues are not fed into systems intended to provide broader infrastructure, services, and investment. The negative sides of informal sectors have been widely studied and emphasized but the positive sides and the pathways for transitioning from informal to formal recycling has not been explored adequately particularly in developing countries, particularly when informal sector is dominating.

E-waste recycling has been able to provide a much needed source of income to population unable to find formal employment. For instance, Duan and Eugster (2007) estimated that in 2005, five million people were employed in the E-waste reuse industry in China, and in 2007 an additional 0.7 million in the E-waste recycling industry.

To understand the problems in formalizing this sector, it is important to have the knowledge about the functioning of the formal sector. Some of the major recycling companies and the technologies and approaches used by them in India have been discussed in Sections 11.2.1–11.2.2.

11.2.1 Predominance of informal sector

Many studies have noted the existence of informal, hazardous recycling practices of E-waste in the developing countries (Puckett et al., 2002; Osibanjo and Nnorom, 2007; Gullett et al., 2007; Sepulveda et al., 2010) and have highlighted the associated problems of crude recycling process on the health and environment. While recognizing the problems of informal recycling of E-waste, many scholars have underlined the importance of formalization of E-waste recycling in India. Jha et al. (2011) in their study underlined the importance of the use of environmentally safe technologies for recycling of E-waste and extraction of precious metal from E-waste. They estimated the scope and prospective of E-waste recycling in the formal sector in Chaterjee and Kumar (2009) analyzed the informal as well as formal E-waste recycling practices in India and suggested linking of the two sectors to make recycling sustainable in Indian context.

Reddy (2013) in his study pointed out how the upcoming regulation in E-waste recycling has disconnected the informal workers from their livelihood. While studying the plight of informal E-waste recyclers in Bangalore, he found that there were many informal recyclers who wanted to get themselves registered. He noted that the informal recyclers are required to undergo lengthy and complex process/"tough struggle" in order to complete the registration process and in this process they also lose their territorial claim over the collection of E-waste. The process of formalization have given the "big players" a monopoly in E-waste recycling business. Despite formalization there is no audit for the authorized recyclers and hence they adopt "self-regulatory standards" (Reddy, 2013). Reddy (2013) noted that the informal recyclers have not benefited from formalization rather they become vulnerable to losing their livelihood. However, Reddy (2013) did not point out what types of

recycling technology formal recyclers are using and how that helped them to maximize their profits and offer competitive price to consumers/disposers for selling their E-wastes to them.

Thus, one can see it that most of the studies have emphasized on the need for formalization of informal E-waste sector, but very few studies that have analyzed the problems faced by E-waste recyclers in the formal sector. In Indian context, although scholars have suggested the importance of linking informal sector with formal sector, there is very little understanding about the challenges of formalizing the informal sector or linking it with the formal sector. Wang and Huisman (2010) in their study of two pilot projects in China tried to understand the issues related to formalization of E-waste recyclers. Based on the experience of developed countries these two pilot projects were started in 2009 in China to formalize the collection of E-waste and to adopt environmentally safe technologies for E-waste recycling. This study suggested to make the provision of subsidy for the "formal recyclers" to collect E-waste from the consumers as it may help them to have some profitable business and encourage them for more collection. The authors also recommend adoption of a locally viable recycling strategy that can involve the local informal recyclers and provide them training to work under environment as well as health safety norms. The study also counts public education regarding E-waste awareness as an important tool to solve this issue.

Lundgren (2012) conducted a study for ILO to understand the problems associated with the E-waste recycling and argued for formalization of E-waste recycling in developing countries like China.

The process of integrating the informal sector with the formal sector is a challenging task at multiple level. On one hand, there is scarce information about the diversity of networking amongst the informal recyclers and their distribution of task and finances among various stakeholders.

11.2.2 Formal and informal interaction

In the literature, one may find a continuum of the degree of integration of informal E-waste recyclers with the formal recyclers. This ranges from those advocating a prohibition of informal recycling, through those ignoring their existence, to those where the sector is recognized but pressed to conform to and compete with the formal sector and to those who argue to integrate the strengths of the informal sector with the formal. In the other words, the approach could be seen as hostile, disconnected, interacting, and synergetic (Davis and Garb, 2015).

Hence, the present study tries to explore the possible hurdles in the process of organizing the informal E-waste recyclers in India, challenges and concerns of the formal E-waste recyclers specifically in the Delhi-NCR. Previous studies available in this area and insights from the interviews conducted helped this study to focus on the challenges associated with recycling of E-waste in the formal sector in India.

11.3 Methodology

In order to understand the challenges involved in the formalization of E-waste recycling, we conducted interviews (in formal as well as informal settings) with the formal recyclers, policy makers, and officials involved in the implementation of the regulatory provisions and the individual and bulk consumers. Consumers were asked about their disposal process of E-waste and to conduct this research data have been collected from both primary as well as secondary sources. For primary data the formal recyclers in the Delhi-NCR were interviewed and a semistructured questionnaire was also used to gather the required information. Along with this notifications and guidelines issued by Government of India were also analyzed. The prevalent methods and techniques of E-waste recycling in India were explored based on previous studies and reports. In order to explore the problems of formal recyclers we studied two-registered formal recyclers in NCR.

11.4 Formal recycling technologies used in India

As discussed earlier, there are at present total 178 registered formal E-waste recyclers/dismantlers in India. These recyclers have adopted environmentally safe methods for treating the E-waste. For collection of E-waste, the formal recyclers are either contacted by the bulk consumers, household consumers or government or private offices or they bid for procuring the E-waste from government and private organizations. Many of these recyclers either have their own collection vehicles or hire it from the logistics company. Some of the recyclers also provide door to door collection as a part of their collection drives or awareness programs. For disassembly, either manual or semiautomated methods are employed. The workers who are involved in dismantling of E-waste are provided with safety gadgets like eye shields, safety jackets, gloves, and ear plugs.

A general flow chart of E-waste recycling process adopted in formal recycling facilities in India has been depicted in Fig. 11.1.

According to this process, initially the collected E-waste is segregated according to the parent product and then it is sent for dismantling. The components like solder, battery, and cables are obtained after dismantling the electronic gadgets. The components like PCBs and plastics are put through mechanical shredding to separate the ferrous, nonferrous, and plastic materials. The shredded materials are further crushed and then sent for segregation where the precious metals like gold, silver, and palladium are recovered. In India most of the recyclers do not have the capacity for the extraction of pure metals from the crushed E-waste and they export the material to recycling companies in the developed countries like Umicore, Xtrata, and TESSAM for further processing (Sinha et al). These components are further sent for recycling to obtain metals like tin, lead, nickel, and lithium. The hazardous substances present which cannot be recycled are sent to the hazardous waste treatment facilities.

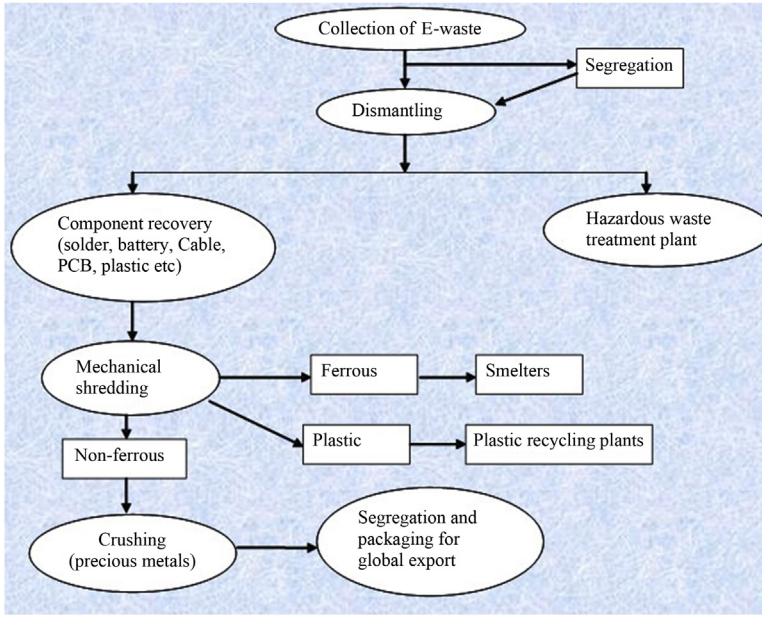

Figure 11.1 E-waste recycling process in formal sector in India.
Source: Compiled from various sources.

Recycling of PCBs is an important process in the E-waste recycling industry as it contains precious metals like gold and silver. The first step in this process includes grinding of segregated PCB into desired particle size by mechanical process which includes physical impaction,[1] shredding,[2] and granulation. Further concentration of the precious metals is done by various separation techniques. Magnetic separation technique is used to separate the ferrous elements from the crushed PCBs while the aluminum particles are separated by using eddy current process (Chaterjee and Kumar, 2009). This metal rich powder then passes through electrostatic separation technique to remove the plastic parts. After this step the metal rich powder is sent for metal recovery. This is done either by hydrometallurgical or pyro-metallurgical methods. In hydrometallurgy chemical processing is done while in pyro-metallurgical process, metals are extracted using thermal treatment. In thermal treatment, the problem of disposing liquid effluents is avoided. Hence, thermal incineration combined with pyro-metallurgical treatments is used commercially for extraction of metals from PCBs. The hydrometallurgical methods are also used for metal recovery. In this process, thermal processing is followed by

[1] Physical impaction comprises methods which break down products to enable the recovery of reusable and recyclable parts, components, and materials.
[2] Shredding is the breakdown of the product into pieces via fragmentation, ripping, or tearing which may then be sorted into differing material streams with dissimilar subsequent processing demands.

electrolytic refining for purification of copper. For the recovery of gold from PCB, cyanide solution is generally used.

Generally the above mentioned methods are used in formal E-waste recycling in India. However, research is going on to develop better techniques which are more environmentally safe. Various biological and hybrid techniques have been suggested different studies (Bhatt et al., 2012; Pant et al., 2012) that need to be tested on field to confirm its commercial use. Therefore to explore the problems in the process of recycling E-waste in the formal sector case study of two registered recyclers in Delhi NCR was conducted. The following paragraphs discuss the challenges faced by these recyclers during recycling and management of E-waste in the country.

11.5 Formalization of E-waste recycling in India

In the recent years Government of India has taken several steps for formalization of E-waste recycling, in India. The first serious step to formalize the process was the enactment of E-waste (Management and Handling) Rules 2011 which came into effect from May 1, 2012. The rule made the registration of E-waste recyclers a mandatory process without which they may not be allowed to process the E-waste. The recyclers were made to ensure that their facility and the recycling process complied with the standards or guidelines as prescribed by the Central Pollution Control Board from time to time. In the case of state recyclers ware required to obtain registration from the SPCBs. The rule also enjoined upon all registered recyclers to make all the records available to the Central or State Pollution Control Boards or Pollution Control Committees of Union territories for their inspection. They also need to ensure that the residue generated should be disposed of only at authorized common hazardous waste Treatment Storage Disposal Facility (TSDF). In addition to these responsibilities, the recyclers were also required to file annual returns in Form 3 to the SPCB or Pollution Control Committee as the case may be on or before 29 June following the financial year to which those returns relate. However, various issues like social and economic implications, positive and negative drivers of current E-waste scenario in India have not been addressed properly. Since most of the recycling activities are taking place in the informal sector the rule does not mention steps for formalization of these informal activities. There is also no clarity in the mode of collecting E-waste from the consumers, which may create problem. Furthermore no role for the informal sector which process a large segment of E-waste has been mentioned in the new rule.

Considering some of the shortcomings of the E-waste (Management and Handling) Rules, 2011 some modifications were made in 2015 and the new rules were published as “E-waste (Management) Rules 2016” which came into effect from October 1, 2016. The new rules have added some more responsibilities for the E-waste recyclers. As per the new rules the recyclers will be responsible to ensure that no environmental damage is caused during the storage and transportation of

E-waste and the recycling process do not cause any adverse effect on health and environment. They have also to make sure that the fractions or materials which are not recycled in their facility are transferred to respective authorized recyclers. More stringent provision were made for the recyclers to maintain the record of the total E-waste collected, dismantled, recycled, and sent to authorized recyclers in Form 2 and copying the same to the CPCB or SPCB as the case may be.

As a consequence of the new regulation many E-waste recyclers have applied for registration either with the State Pollution Control Boards or the Central Pollution Control Board. As a consequence, the number of registered formal recyclers/dismantler with Central Pollution Control Board (CPCB) has increased to 178 in the country. The State-wise distribution of the registered recyclers/dismantlers has been given in Fig. 11.2.

It can be observed from the list that Karnataka has the largest number of registered recyclers/dismantlers in the country followed by Maharashtra and Uttar Pradesh. Each formally registered recycler has been permitted by the Ministry of Environment and Forest to process a certain quantity of E-waste annually. The permissible volume has been given in Table 11.1.

From Table 11.1 it can be observed that the total annual volume of E-waste permitted to be recycled at the available registered E-waste recycling facilities is approximately 438,086 metric tons. On the other hand the E-waste generation in India in the year 2013 was estimated to be 589,893 metric tons and for the year 2015 the projected figure was 713,770 metric tons (Silva, 2012). This shows that there is a huge gap between the capacity of registered recyclers and the amount of E-waste generated annually. This problem is further aggravated when the registered recyclers face the problem of underutilization of their installed or permitted

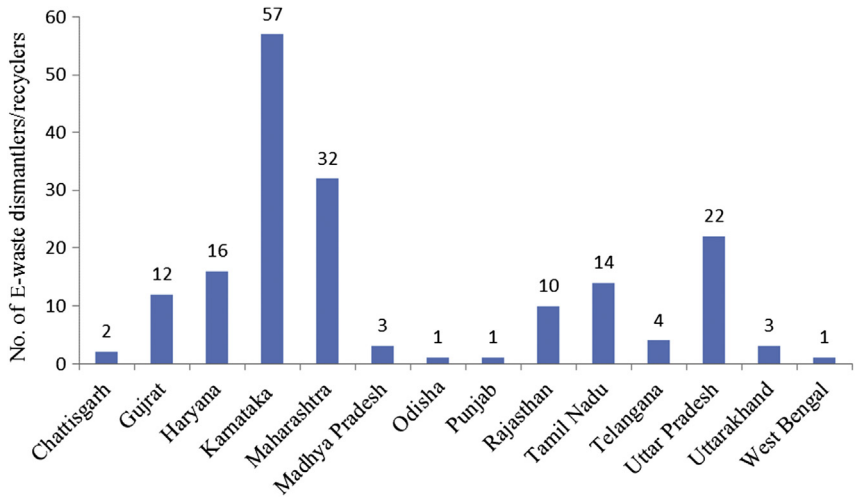

Figure 11.2 State-wise distribution of registered recyclers/dismantlers in India.
Source: CPCB Data as on 29.12.2016 (Available at: cpcb.nic.in).

capacity. The previous studies (Arora, 2008), (Christian, 2012) have pointed out that due to the flexible regulatory mechanisms and lack of awareness among the consumers, a large chunk of E-waste is diverted toward informal sector. The formal recyclers need finances to maintain the infrastructure of the recycling plants due to which they cannot compete with the value for E-waste provided by the scrap dealers.

There are many reasons why the local scrap dealers are able to pay more for the E-waste than the registered dealers. The local scrap dealers sell their E-waste to informal recyclers who use very crude and hazardous recycling techniques like open incineration and acid stripping for extracting metals from E-waste. In this process they use concentrated acids (sulfuric and nitric acid) and other poisonous chemicals which over the time end up polluting the environment. Such primitive methods for metal extraction result in incomplete processing of E-waste which lead to pollution, health hazards. As they lack funds and technical expertise these informal recyclers end up performing inefficient metal extraction. Since transporting the residue and effluents safely to the registered TSDFs is not feasible for the informal recyclers, they dispose them in nearby waterbodies or dump in landfills. The toxins thus leach into the soil and groundwater and pollute the ecosystem.

Another reason for informal sector paying more for the E-waste is that they do not require to make any investment in infrastructure or safety measure. Recycling establishment in the informal recycling sector typically have a scrap yard setup, where workers handle toxic E-waste components under hazardous working conditions, sometimes even without proper ventilation or lighting (Pandey and Govind, 2014). Workers keep their hands dipped for long hours in poisonous chemicals and are exposed to fumes of concentrated acids while processing E-waste. Safety gear like gloves, ventilations fans, and face masks are unheard of as these setups do not invest in the required protective gear for handling toxic materials. This puts workers at a risk of developing serious health conditions like asthma, bronchitis, and even cancer.

In order to cut down the cost, the informal sector employs large number of women and children for collecting and dismantling E-waste. One can see many young children collecting/breaking integrated circuits, capacitors from PCB with their bare hand, without taking any form of protection from the hazardous toxins in E-waste. Since these children are still in a developing stage they are at a higher risk of absorbing high proportion of hazardous chemicals developing severe medical conditions.

On the other hand, the registered recyclers are subjected to a highly regulated operation as it involves disposal and recycling of toxic and hazardous electronic components. Government and environmental bodies regularly conduct audits to ensure that E-waste recycling facilities deploy environmentally responsible and safe recycling processes. However, E-waste recycling operations in the informal sector are not regulated by any environmental or government bodies, as it would require them to invest in adopting green and eco-friendly E-waste recycling processes.

Since E-waste recycling establishments in the informal sector are unregulated and unregistered with the respective government bodies, they also evade taxes.

Registered recyclers on the other hand are subject to taxes under law for establishing E-waste recycling facilities. These are the primary reasons for E-waste recyclers in the informal unorganized sector being able to pay consumers more for their E-waste as compared to registered E-waste recyclers. The cost conscious consumers in India required to be sensitized for disposing of their E-waste through registered and authorized dealers.

11.6 Initiatives for formalization of E-waste recycling in India

Despite the enforcement of the E-waste Management and Handling Rules 2011 and 2016, most of the E-waste recyclers in the country are still operating through the informal sector. In the recent years the government in collaboration with some NGOs like GIZ-ASEM has undertaken the responsibility to create awareness about the hazards of E-waste among the informal workers.[3] Some of these organizations are *Toxics Link*, *Chintan* and *WEEE Recycle* (an association of GIZ and MAIT). These NGOs are involved in interacting with the informal recyclers as well as the general public to create awareness about the hazards of informal recycling of E-waste. Chintan, for instance, worked in association with Delhi Pollution Control Committee for formalization of informal E-waste recyclers in Delhi. Similarly, *Toxics Link* is an NGO working on waste and pollution issues. The *Toxic Link* has led several awareness programs in schools and colleges and has initiated training programs for different stakeholders associated with E-waste management throughout the country.

They have organized various workshops on the benefits of formalization as a result of which some members from HRWA and 4 R have formed two formal collection and dismantling companies named *E-waste HRA Pvt. Ltd*. (2010) and *Green E-waste Recyclers Pvt. Ltd*. (2011) in Delhi. These two recyclers collect and segregate the E-waste and then channelize it to authorized formal recyclers.

The *E-waste HRA Pvt. Ltd*. has set up its center in Delhi to collect, segregate, and store the E-waste from about two hundred and fifty informal collectors and dismantlers. The E-waste collected is then auctioned to the formal recyclers (Garide, 2014). The company has also signed letter of intent with *SIMS Recycling Pvt. Ltd*. and *Earth Sense Recyclers*, two formal E-waste recyclers of Delhi-NCR (Resources-Formalization of Informal Sector), for further treatment of E-waste. The other company, that is, *Green E-waste Recyclers Pvt. Ltd*. was formed in 2011 and is also engaged in collection, segregation, and storage of E-waste. The collected material is then transferred to authorized dismantlers and recyclers of E-waste. The

[3] ASEM is a joint program of the MoEF, Govt. of India and German International Cooperation (GIZ) on behalf of the Federal Ministry for Economic Cooperation and Development, Germany. This program focuses on the urban and industrial environmental management in India.

company has also applied to get registered as an E-waste dismantler (Sohail and Vasudev, 2013).

Similarly in Bangalore, *EWarDD* and *Eco BiRRD* have been registered as the formal E-waste recycling companies changing from their informal status. Besides these few cases, the shift from informal to formal has not taken place on a wider scale due to several problems. The informal sector in India is still very large and very few are aware of the harmful impact as well as the benefits of formalization. This may be the reason that these initiatives could not inspire a majority of informal E-waste recyclers to get registered.

11.7 Challenges faced by formal recyclers in Delhi-NCR

In order to understand the challenges faced by the formal recyclers in India we conducted a few case study in NCR. In Section 11.7, we have discussed in details about their challenges. An informal interviews were conducted with the officials at the Noida office to understand their procedure of E-waste handling and the challenges they face.

11.7.1 Attero Recyclers Pvt. Ltd

The Attero Recyclers Pvt. Ltd. was established in the year 2007 and is India's largest integrated end to end electronics assets management company situated in Roorkee (Uttarakhand). It provides services like customized end to end solutions for E-waste management, electronics asset recovery, data security, and electronics reverse logistics along with repair, refurbishment, and retailing of electronics. It is an ISO14001[4] and OHSAS 18001[5] certified company. *Attero* has a 100,000 square feet state-of-the- art facility for E-waste management at Roorkee (Uttarakhand) with having first of its kind of metallurgical process. Along with complete processing of E-waste they also provide facility for picking up E-waste from the premises of the consumers.

Attero claimed that its reverse logistics can move about 10,000,000 pounds of material each month. It also provides an online/offline channel for collection of E-waste from the end use consumers. It has its offices in Noida, Bangalore, Mumbai, and Roorkee in India and one also in Los Angeles, United States. It has been reported that *Attero* collects E-waste from about 500 cities and has its collection centers across 22 states throughout the country (Jacob, 2013). The company collects

[4] ISO 14001 sets out the criteria for environmental management system. It maps out a framework that a company/organization can follow to set up an effective environmental management system. It provides assurance to company management, employees, and external stakeholders that environmental impact is being measures and improved.

[5] OHSAS 18001stands for Occupational Health and Safety Assessment Series. It is an internationally applied British Standard for occupational health and safety management systems. It is intended to help an organization to control occupational health and safety risks.

the E-waste at major collection centers (http://mait.com/ewaste/collection-centers.html) and from there it sends the E-waste to its Central recycling plant located at Roorkee (Uttarakhand). Its each collection center is authorized by the Pollution Control Boards of the respective government of the state. The collected E-waste is stored at these centers, lined up, and then transported to the recycling plant. The total recycling capacity of the plant was told to be 35,000 metric tons but due to the lack of availability of enough waste material, they recycle only 12,000 metric tons. One of its official informed that the main sources of their E-waste collection are the bulk consumers and the manufacturers.

11.7.2 SIMS Recycling Solutions (Noida)

SIMS was founded in the year 1917 in Sydney by a recycled metals dealer and was initially a scrap metal recycling company. Later the company expanded its business in Europe and North America. In 2008, *SIMS* Group merged with an American scrap metal recycling company, Metal Management, to form Sims Metal Management Limited. It was in the year 2002 that it became Sims Recycling Solutions in UK to handle the issue of E-waste. The company was established in India in 2008 when Trishriraya (Chennai) became SIMS Recycling Solutions first center in India. In 2010, Sims acquired TIC Group in India (Delhi). Currently, *SIMS* has over 40 facilities throughout the globe and recycles approximately 735,000 tons of E-waste each year. In India, *SIMS* has its centers in Bangalore, Chennai, and Delhi. For this study, the Delhi center was selected. The official interviewed at *SIMS* informed that they mainly get E-waste from government offices along with some other bulk consumers. *SIMS* has been recognized as a registered recycler by Delhi Pollution Control board and hence, the consumers contact them through the government website. The company is permitted to collect about 500−1000 metric tons of E-waste annually in India but practically they are able to collect only about 200 metric tons. *SIMS* at Noida has permission only for dismantling and segregation of E-waste. At this site, the equipments are dismantled in various components and for this process they use both manual force and machines.

The common problem, that most of the respondents from the companies narrated, was the competition from the informal recyclers in the city. They suggested that most of the households as well as the bulk consumers including the IT companies prefer to sell their E-waste to the scrap dealers as they pay more value for their waste than what we may pay them. “We cannot buy the E-waste at high rates as we have to make a large investment for operating and maintaining the recycling plant as per the norms and standard set by the government,” stated the interviewed official.

Many studies have indicated that due to lack of awareness about the hazardous nature of E-waste among the public, they dispose of their E-waste through informal dealers. For instance, Kwatra et al. (2014) conducted a study in Delhi and observed that though 58% of the respondents, most of which were associated with the field of environmental science, were aware about the term “E-waste” only 4% could describe the exact issue and the problems related to it. The authors also found

Table 11.2 Differences in the rate of procurement by informal and formal E-waste collector.

Items	Price offered by informal market (in Rs.)	Price offered by formal recyclers (in Rs.)	Difference in price (in Rs.)
Hard disk	45 per piece	Rs. 20 per piece	25
CPU	300–400 per unit	100 per unit	200–300
Mobile phone (fully intact without battery)	1000 per kg	600 per kg	400
Mobile phone boards (plates)	1900 per kg	800 per kg	1100
Chargers	100–250 per kg	20 per kg	80–230
Refrigerators	1000	Offered no money due to cost of disposal.	1000
Television	Depends on screen size. Rs. 500–1000	Free of cost due to leaded glass and cost of disposal	500–1000

Source: Field work data collected from the scrap dealers and formal recyclers.

respondents who were using Internet were more familiar with the term E-waste than those to those who were not using the Internet. When they were told about the hazardous nature of E-waste most of the respondents agreed that some action should be taken to solve this problem. A similar study (Saritha et al., 2015) was conducted in Vishakhapatnam to understand the level of awareness on E-waste among the respondent and it was found that 90% were unaware about the issue. The authors also indicated that 75% of the respondents store their E-waste because they don't know the proper mode of disposal.

Similarly, another research (Venkatraman, 2015) conducted on a group of students in Mumbai and it was reported that about 62% of the respondents do not know the details about the electronic waste or E-waste though they were familiar with the term.

Most of our respondents also informed that lack of awareness among the public about the E-waste and the benefits of proper recycling were the major problem they face in getting sufficient amount of E-waste for proper recycling and as a result their recycling plants run under the permitted capacity. Some specific problems were also listed by these recyclers which are discussed as follows.

The respondents from *Attero* recycling unit also felt that there is little support from the government side to create awareness among the public. According to them, they can reach a larger mass if the Government runs a nationwide campaign for raising awareness for E-waste, its hazards and benefits of proper recycling. In addition to underutilization of their processing, some Recyclers (like *SIMS*) also face problem in transporting the E-waste as they do not have their own transport services and they are required to hire from the logistics company which made their operation very expensive (Table 11.2).

Although it is mandatory for all recyclers to be registered, most of the informal recyclers are hesitant to get registered as it may require them to install the proper machinery/infrastructure and to follow all the guidelines for processing of E-waste. Being in the informal sector, they are not bound to follow the labor laws that would be applicable to their workers if they get formalized. In that case, they have to pay them a minimum daily wage, social insurance, and to provide other safety measure in case of any injury/accidents. Moreover, the employers in the informal sector neither pay any taxes nor participate in any government run insurance schemes or social welfare for their workers (Wilson et al., 2006). These are the reasons they are continuing with their old practices. The profit margin is very high for these informal employers. Formalization may reduce their profit as they would be placed at the lower value addition chain. This may be the reason that these workers do not go for registration.

The formal recyclers also faced harassment, as one of the official told us during our interview, by the monitoring agency in the name of checking the safety and security of workers and the environmental pollution. In India due to lack of strict implementation of the existing rules has proven a major challenge in the formalization of the process. Providing proper training to the informal workers to induct them in to the formal recycling companies is also a major challenge. First they need to be given a proper education about the harmful effects of E-waste and then a proper training to practice scientific and safe methods during the processing E-waste. In cities like Delhi, a large number of people are involved in informal recycling of E-waste. In such a case, recognizing and organizing these workers may prove to be a difficult task due to the fact that they work in small clusters at different places all over the city.

Due to a large number of people involved in this process, providing safety measures and establishing of proper recycling facility required a huge investment fund, which is a challenge for a developing country like India. The informal workers also cannot afford to establish the facilities themselves due to which they have evolved low cost methods for recycling which is also hazardous for their health as well as the environment.

Apart from management and monitoring issues there may be some problems from the point of view of these informal workers. These issues may be one of the major reasons behind the hesitation of these workers to work as formal entity. It is presumed that during formalization all the workers and employers may not get the job. Hence, their employment and source of livelihood would be affected.

Thus, these factors may result in affecting or slowing down the process of formalization. Instead of complete formalization, linking the informal and formal channels may prove to be a better option. This study suggests that if the awareness regarding the hazards of improper recycling is spread to a large population, it is would be easier to collect E-waste through formal sector.

This study focuses on the formal E-waste recycling sector and indicates that though the E-waste (Management and Handling) Rule 2011 has been implemented there are still many steps that need to be taken in this regard. Lack of awareness among the consumers is a major hurdle in the functioning of these formal recycling

facilities. This study also finds out lack of strict implementation and monitoring, competition from the vast chain of informal recyclers as a major challenge for these recyclers. It has also tried to throw some light on the formalization issue that has been recommended by both Government and Nongovernment bodies since 2011. The study points toward the problems that may come during formalization, that is, locating and recognizing the informal clusters, raising awareness among the large population in India and lack of financial aid. The most important issue is taking the informal recyclers into confidence about making them join the formal sector by making them aware about the benefits.

11.8 Conclusion

E-waste recycling in the formal sector has gained some importance after 2011 when the E-waste Rules 2011 were implemented making it obligatory for all the existing E-waste recyclers in India to get registered with the Pollution Control Boards of the respective states. Earlier may studies were conducted related to the E-waste recycling in the informal sector, the processes involved, its health and environmental impacts. This study has tried to explore the concerns of the formal recyclers in the country and the challenges they face in operating these facilities. Formalization of the informal sector has been suggested by many scholars but there are various problems associated with this process. With the help of interviews conducted with some of the registered E-waste recyclers it was observed that the implementation of the rules is not being done with required seriousness. Lack of monitoring has led to many registrations but there is no check on the processes adopted by these organizations. Hence, this chapter suggests that along with encouraging formal recycling process, the government as well as nongovernmental bodies should also continue to spread awareness among the informal recyclers in order to make them join the formal stream. There is strong requirement of proper monitoring of these recycling plants to ensure environmentally sound methods being practiced.

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Further reading

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http://www.moef.nic.in/