



## BRIDGING THE GAPS BETWEEN FORMAL AND INFORMAL E WASTE MANAGEMENT IN INDIA WITH EPR

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### ABSTRACT

The aim of this paper is to present a viable and realistic approach for management of E waste in India by integrating the formal and informal sector involved in its handling and processing. Along with that, pragmatic ways to implement EPR (extended producers responsibility) using the concept of joint collection system and partial recovery facility, making it far reaching are suggested with a view to make it a driving factor in formalizing the informal sector. This paper proposes the continuation of the involvement of informal sector in collection by the producers and the formal sector in recycling thereby strengthening the takeback and EPR.

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### INTRODUCTION

E waste comprises of wastes generated from used electronic devices and house hold appliances which are not fit for their original intended use and are destined for recovery, recycling or disposal. Such wastes encompasses wide range of electrical and electronic devices such as computers, hand held cellular phones, personal stereos, including large household appliances such as refrigerators, air conditioners etc.(MoEF, 2008)In India, in spite of the E waste rules coming into force and an existing E waste policy, majority of the collection from household and corporate is being carried out by the informal sector and only a little portion of that is recycled by the formal sector. Along with that, the lack of awareness among manufacturers and the limitations of 'take back' and EPR limited only to IT (Information and technology) companies is not helping effective implementation and enforcement of E waste rules, and vice versa. The informal sector although still illegitimate, has some definite advantages over the formal sector in terms of door-to-door collection and the experience in dismantling.

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Therefore, there is a need to club the competence and advantages of both the sectors in an optimized way so as to take E waste management in India to greater heights. E waste collection by the formal sector in India has been unable to develop deep penetration and reach among households and corporate. Only the companies which are bound by E waste policies are contributing to provide E waste a safe haven through formal collectors. EPR is bound to take time to get into full flow as the only environmental legislation which has a component of EPR is the Batteries (management and handling) rules, 2001. Out of the total potential E waste generated in India, less than 50% was available to be recycled. In many big cities of India, uncontrolled recycling of E waste by the informal sector is being carried out extravagantly. Nearly 95% of the actual recycling is done in the informal sector using unsafe and polluting processes without any awareness of health and environment hazards(GTZ Bird, 2007).There are only 9 small to medium scale dismantling facilities among 138 registered recycling units in India(Ministry of Environment and Forests (MoEF), 2014)(CAG, 2007) . This point to the fact that the informal sector contributes majorly in E waste dismantling which is yielding a depressingly low percentage of precious metals extraction even after employing harmful and dangerous methods for dismantling.

Delhi is the hub of informal recycling activities which include open burning and wet end processes. Illegal, unsafe and dangerous dismantling of E waste can be seen in ghettos like Seelampur and Mandoli in Delhi. Nearly 70 % of electronic waste collected at recycling units in New Delhi was actually exported or dumped by the developed nations (Jayapradha, 2015). Concentrations of heavy metals like As, Cd, Zn, Pb etc. are found alarmingly higher in the soil and water samples collected from Mandoli industrial area (Pradhan and Kumar, 2014). Sangrampur, a village in West Bengal around 50 families are involved in the E waste business. This fact clearly suggests the extent of uncontrolled recycling activities and their threat to the environment surrounding these areas. Among the top ten cities generating E waste, Mumbai ranks first, followed by Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur. There are a number of E waste dismantling facilities that are operating in almost all of these cities (Raghupathy, Krüger, Chaturvedi, Arora and Henzler, 2010). Apart from the unhealthy and unsafe environment of working; there is also a challenge of child labor that the informal recycling poses which is a serious social issue of concern. After the E waste rules came into force, the E waste recycling has become an industry and has begun to register its presence weighted with expectations of sound E waste management and handling.

## METHODOLOGY

We systematically studied the existing E waste management in informal and formal sectors in India. Strengths and issues related to both the systems were identified. Extended producers responsibility is suggested as a tool to bridge the gap between informal and formal recycling sectors. An integrated approach is suggested for utilizing the strengths of both the systems. India is classified as having a significant potential for the introduction of pre- and end-processing technologies with a strong support in capacity building in the informal sector (Ahmed, Panwar and Sharma, 2016)

### Hazards of Informal recycling

The entire E waste treatment is carried out in an unregulated environment in informal recycling scenario. Producers prefer the informal recovery ways because of the profit involved in the system ignoring harmful processes such as burning and leaching are employed in order to extract metals from the E waste particularly the PCB (Printed Circuit Board) (Anwasha Borthakur and Singh, 2012). The methods of salvaging material from circuit boards drawn from monitors, CPU disc, floppy drives, printers, etc. are highly destructive as they involve heating and open burning for extraction of metals. Toxic chemicals are used to recover valuable metals such as gold, silver and copper from the PCBs. Working in poorly ventilated areas and without proper personal protective equipment, lead to exposure to dangerous and slow poisoning chemicals. Other than the dangerous activities carried out by the informal sector, its irresponsible disposal leads to several hazards. Presence of heavy metals like lead, mercury, zinc, chromium, arsenic etc. beyond the threshold limits make E waste hazardous. Along with the heavy metals, inorganic acid, polycyclic aromatic hydrocarbons, etc. can potentially cause serious health hazard (Huo et al., 2007) Apart from the health, the contamination of soil and groundwater can cause serious damage to the environment. The irresponsible disposal of components having lead, cadmium, mercury etc. affects soil

fertility due to leaching, and makes drinking water as toxic and unfit for usage. Lead levels in the blood samples of children living in the areas of E waste recycling is found to be higher than the stipulated limit in China (Guo et al., 2014). Significant amounts of lead ion are dissolved in water from broken lead containing glass, such as the cone glass of cathode ray tubes, which causes acid waters in landfills. The most dangerous form of burning E waste is the open-air burning of plastics in order to recover copper and other metals (Ahmed and Makkar Panwar, 2015)

### Advantages of Informal sector

The informal sector, in spite of having association with several health and environment hazards, has some advantages in collection. It has a widespread, sophisticated and well established network of door-to-door collection of domestic and corporate E waste. Waste has certainly not been an asset for Indian consumers but a liability which is best to be discarded to the traditional scrap collectors, or *kabadiwalas*. These scrap collectors, apart from having a penetrating network, also pay well to the consumers whereas formal recyclers find it hard to meet the consumers' demands. But the real issue starts when these scrap dealers sell the E waste to informal dismantling ghettos from where the problem of unsafe practices of recovery and disposal begin. With the advent of formal recycling, the local authorities and recycling industry has found the E waste in much overwhelming quantities to handle (Raghupathy et al., 2010). Requirement of high investments and overheads to follow environmental compliance is a major concern. The existing informal sector contributes to lessen this burden of the E waste management agencies (Chaturvedi, Arora and Ahmed, 2010). The major problem in banning the informal sector completely from the E waste management chain is in turn sacrificing its highly effective collection system which is a major cost involving factor in making it economically feasible. A number of people involved in this business are earning their daily bread from this and hence it is the biggest challenge to employ them in formal E waste management. Over 25,000 people handle 50,000 tons of E waste in various scrap yards in Delhi every year. (Sinha, Mittal, Rajankar and Sharma, 2014)

### Current status of EPR in India

EPR is an environmental policy approach in which a producer's responsibility for a product is extended to the postconsumer stage of the product's life cycle, including its final disposal. EPR is one of the key highlighting features of E waste rules, 2011, but due to lack of strict penalties in E waste rules, the law has not been taken seriously by many stake holders who have a mandate to file forms indicating their actions in line with the rules (Agarwal and Mullick, 2014). EPR implementation could not take place in India because of various reasons. Since most manufacturers in India are unaware of the E waste laws' conviction of implementing EPR with the vision of making the producers responsible for the safe recycling and disposal of their products when they reach end of life and discarded by the consumers. EPR adheres to either the direct take back of the used and discarded appliances through exchange offers or voluntary donation by consumers, or through forming PROs (Producers Responsibility Organizations) and recycling, disposing and using raw material elsewhere through registered formal recyclers. Another is the 'take back' system which forms the spine and

structure of EPR, is limited to the IT industry and others show no responsibility or accountability otherwise. Majority of brands operating in India do not have a tangible responsibility to handle E waste that is generated by their goods at end of life stage. Despite having a take back system in place, most companies have that only for namesake. A few of them have set up collection centers but they are not adequately enough to handle tremendous amount of E waste being generated in India. The major problems faced in implementation of EPR are the proper record of electronics goods entering the market and financial crisis for management of E waste.

### Formal recycling sector in India

The formal sector comprises of government authorized agencies or companies which are supposed to collect, recycle and dispose the E waste in an environment friendly way. The registered recycling units use proper equipment and provide a safe and healthy environment for workers, ensuring a safe and sound recycling and disposal. But the real issue with the formal sector is that these units are unable to access the materials due to the informal collectors or scrap dealers selling the E waste to informal recyclers. Out of India's total E waste only 5 percent is recycled by the formal sector. The plausible reason for this is the 80% share of household waste (Yoheeswaran, 2013).

As most of the E waste is channelized to non-formal sector, the formal sector is facing the problem of not having sufficient input material (A Borthakur and Sinha, 2013).

### Formalizing the informal sector

The informal E waste recycling sector provides jobs to thousands of people in urban and semi-urban areas, and supports the formal waste management agencies like municipalities. Thus, the informal recycling hubs have taken a form of a small or medium scale industry which involves semi or unskilled workers engaged mainly in mechanical separation and recovery from E waste. While implementing the E waste rules and its regulations, the social aspect cannot be ignored. The E waste rules call for the registration of all of those dealing with collection, dismantling, refurbishing and recycling (Raghupathy et al., 2010) of E waste of the formal and informal sector. But this sort of formalization would lead to severe unemployment in the informal sector, which itself would be a major and serious issue of concern for government to contemplate and worry. Promoting international trade, state of art technology and applying alternative business model by separating low grade and high grade boards and preconditioning of boards allows financial incentives and minimizes environmental risks. (Rochat, Rodrigues and Gantenbein, 2008).

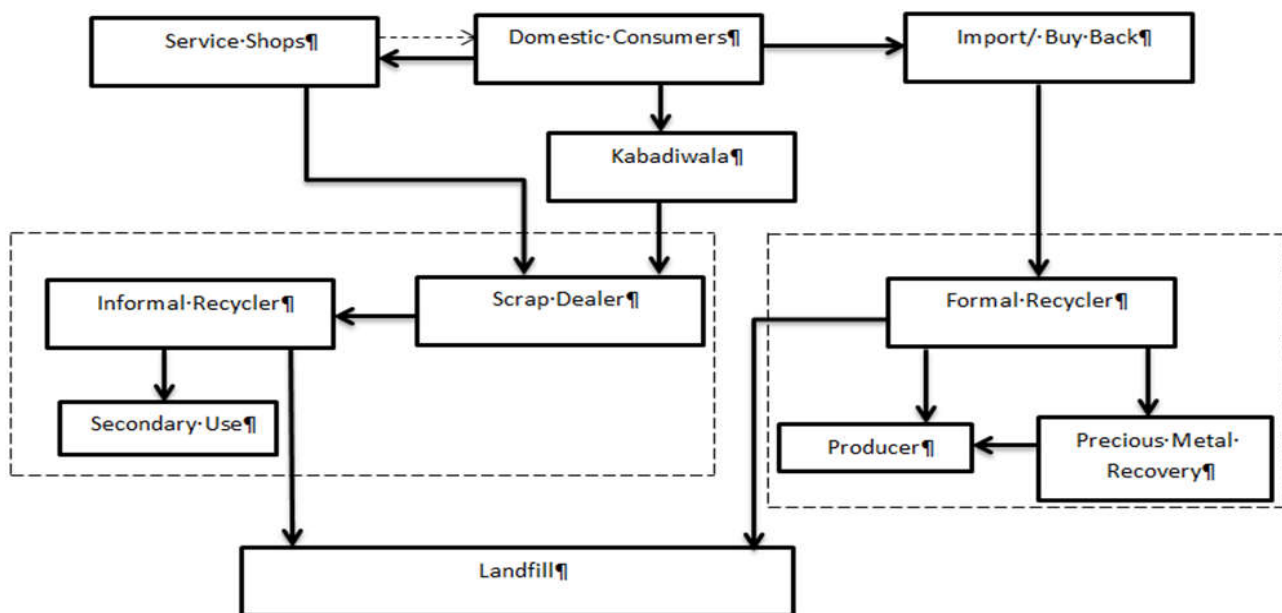


Fig 1. E waste flow process diagram in current scenario

Out of the total waste produced nearly 40% decays in homes (GTZ Bird, 2007). To add to this, the formal sector is neither having the penetration in domestic sector nor it pay that well to the consumers for their used goods as the informal collectors do. But, if the informal collection channelized and organized by means of PROs establishing common collection site, it would help the E waste flow to the formal recycling sector, either directly or after requisite examination in the testing facility and primary dismantling. This will help boost the formal recycling sector which is facing scarcity due to informal collectors selling E waste to the informal dismantlers. The formal recycling sector can be made accessible to India's E waste through PROs forming a dedicated collection network utilizing the informal sector in a holistic way.

But considering the high number of informal processors it is very impractical and difficult to follow. However, the National Environment Policy (NEP) itself emphasizes strengthening the informal sector and legalizing them so that they can be absorbed in the authorized recycling industry (MoEF, 2008). The experience which these semi and unskilled workers have aggregated for these many years in dismantling, if pragmatically used can turn the tables in favor of smooth and acceptable formalization. The manual and mechanical skills of separation, dismantling and recovery can be exploited by the formal units in primary and less intricate recovery. Apart from the primary recycling, informal sector involved in collection of E waste has no alternative. They simply reduce the burden from formal agencies that don't have that much reach as the

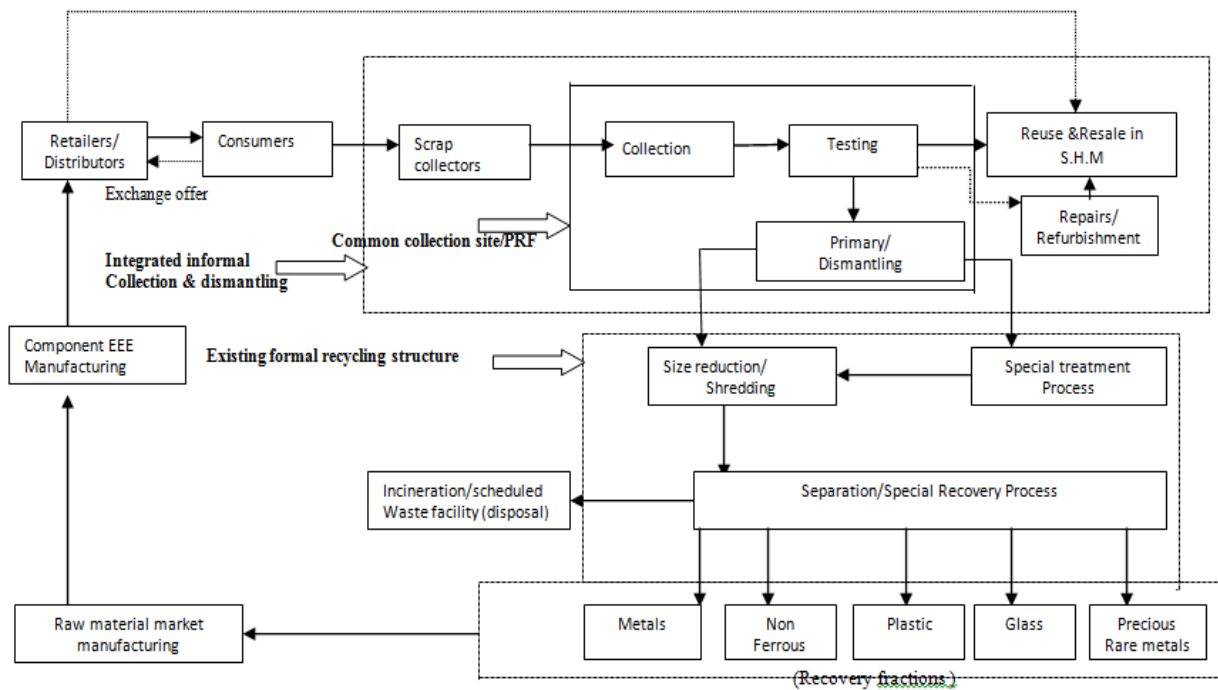


Fig.2 Suggested model for integrating formal and informal sector in India through EPR

scrap collectors have. If this historically established network can be utilized by producers, it can exponentially increase their take back and would help establishing take back system in India. By engaging in recycling activities, the informal sector also creates environmental benefits for the municipal authorities, helping them to reach recycling targets and save precious landfill space (Gupta, 2010).

### Bridging the Gap

Producers can use the already existing informal collection to a good extent to make the take back system more comprehensive, inclusive and consumer friendly. This is till date has been limited to a few IT companies and exchange offers for domestic consumers. Also, by organizing the collection, the scale of business can be quantified and annual E waste generated can be assessed to much more proximity to exact figures. This helps in prediction of E waste generation for the near future, which in turn helps policy planners and decision makers to come out with new management schemes. Bridging the gaps between formal and informal E waste handling is the need of the hour and it can be obtained using following approach in the existing system.

### Joint collection system

Currently the take back system in India, as far as the domestic segment is concerned, is limited to exchange offers or consumers selling their old or distorted appliances to the retailers. The limitation of EPR to the IT companies is mainly attributed to the lack of awareness among other manufacturers. To make EPR more comprehensive and far reaching, producers of same equipment can form PROs (Producers Responsibility Organizations) to set up a common collection site hiring the existing and well established informal scrap collectors. The scrap collectors, who have to pay the consumers for their scrap, will be financed by the PROs and the collection targets will be unanimously decided by the producers or retailers of the same equipment through consultations and discussions with the informal collectors

involved. This would help in taking the take back even to the most lethargic of the consumers, who in Indian scenario are not very enthusiastic to volunteer for returning their end of life appliances. The PRO thus formed will help in effective implementation of EPR involving the informal sector and in turn will help boosting the already existing informal collection system which has a definite edge over formal sector in this regard when it comes to collection from the most interiors of the localities.

### Partial Recovery Facility (PRF)

The common collection site would consist of a testing unit and a partial recovery facility (PRF) carrying out primary dismantling processes involving workers from informal recycling sector experienced in manual and mechanical separation and dismantling. The testing facility will send the ready to use (plug and play) and repairable appliances to the Second Hand Market and repair shops respectively, whereas the equipment consisting hazardous substances like broken LCDs and CRTs will be directly dispatched to the registered formal recycling unit. In this way, the PRF enabled with the testing facility will help boost the finances of the producers as they would get a much better return from the re-sale markets as compared to what they paid in getting the discarded scrap from the household. The workers from informal recycling sector will be employed by the PRO in PRF to tackle the threat of unemployment which they otherwise would have faced in case of unplanned formalization of E waste. Primary dismantling shall involve only those dismantling processes which require simple mechanical separation by hammer and chisel or manual recovery, which the semi and unskilled workers had been carrying out in the informal recycling sector. The warehouse, which is the common collection site consisting of a PRF will also be managed by them. Also, the primary dismantling will be supervised and monitored by the producers themselves. In PRF, after being tested as non-repairable, the equipment is segregated according to their equipment. The hazardous parts like Lithium ion batteries and Lead acid

batteries from computers and mobile phones (Parthasarthy, Bulbule and Murthy, 2008). These fractions should then be transported to registered recycling unit, without exposing the semi and unskilled workers in the PRF to those parts. Only the manual dismantling and separation will be carried out in the PRF, which also includes decontamination of PCB and PWB (Printed wiring boards) from all types of liquids and gases (Aier, Prabhakaran and Kannadasan, 2013). Size reduction only under safe and permissible limits will be done and further processes will be carried out in the registered recycling unit.

### Existing system and Proposed approach

Figure.1 depicts the current existing system of E waste management and handling in India, where consumers discard their end of life electronic appliances to kabadiwala and local scrap dealers for satisfactory prices. Waste generated from local service shops also follows its path to scrap dealers. These scrap dealers in turn sell these devices to the informal recyclers, which employ unskilled workers following uncontrolled and hazardous practices of dismantling, recovery and disposal. While manual and mechanical separation and segregation involves good utility of these activities, but using toxic chemicals for metal extraction can be hazardous for the health of workers. The rudimentary and unsophisticated recovery methods lead to partial recovery of metals and the purity of the metals recovered is substandard so its maximum portion goes to secondary user for low quality purposes rather than completing the recycle chain by reaching the producers. Also, disposal by means of land filling can have adverse effects on water and soil by means of leaching which contaminates them with harmful substances. It also does not provide any testing mechanism for the collected scrap. This in turn leads to a number of refurbishable, reusable and repairable goods going for material recovery. There is no collaboration or link between the processes followed by informal as well as formal handlers.

Figure.2 depicts the flow process diagram for the suggested model for formalization of the informal sector involved in E waste management in India applying the principles of EPR. Salient features of the proposed model are as follows.

- Producers of the same equipment can form joint ventures, called PRO (Producers Responsibility Organization) for collection involving the informal collectors.
- PROs should be formed with set targets of collection.
- A common collection facility incorporated with testing and primary dismantling facilities or partial recovery facility (PRF) should be set up.
- PRF to have semi-skilled dismantlers earlier involved in informal recycling
- Equipment tested as 'reusable' or 'repairable' to be shipped to second hand markets or repair shops
- Precious metal recovery and the trace metal recovery will be done efficiently using the latest technology

The proposed model helps to overcome the issues of following the environmental laws and completing the recycle chain by reaching the high purity standards of recovered material to meet the requirement of producers. The intervention of sophisticated technology will be making the E waste processing environmentally viable and the strength of collection and dismantling can be utilized as pillars of support

for this system. This helps in providing the formal sector with sufficient quantity of E waste to be processed to run the plant.

### DISCUSSION

Continuation of informal sector in E waste collection is a must to reduce the burden of domestic collection of E waste. To achieve this, informal collection has to be involved by the producers to increase the take back. This will not only help implementing the EPR, but also channelize and direct the E waste to formal recycling sector from the common collection site. Along with that, informal collection will be best utilized when EPR comes into play and vice versa, which is mutual win deal for both the informal sector, and the producers, who will gain from the sale of reusable and repairable in the second hand market. This will also help increase the 'reuse'. The potential risk in the success of this approach mainly lies on the financial support required for the setup and distribution of profit between various stake holders. One of the financial support systems could be Advanced Recycling Fee (ARF), which has been implemented in Switzerland (Sinha-Khetriwal, Kraeuchi and Schwaninger, 2005). ARF is a tax which consumers indirectly pay to the producers when they purchase their appliance. It is mentioned in the invoice of the purchased device. It generates revenues for the manufacturers which in turn will contribute towards funding the recycling of the discarded end of life devices. In this way, the consumers, which are otherwise sluggish and reluctant to environmental issues in India, will be made to get involved in contributing financially for management and handling of E waste in India. Thus, ARF can make both producers and consumers participate in safe disposal and recycling of discarded electronic equipment by helping producers achieve EPR and making consumers contribute financially.

### Conclusions and Recommendation

The threat of unemployment in the informal sector can be tackled by establishing common collection site having a primary recovery facility, which would employ semi and unskilled workers from the informal sector. PRF to have semi-skilled dismantlers earlier involved in unauthorized informal sector, for primary dismantling to be done under adequate monitoring and supervision of the producers. Producers prefer to recover using informal ways and it is complicated to manage manpower and financial resources. The experience of existing informal dismantler in manual/mechanical separation and dismantle will also prove handy. Producers of the same equipment can form joint ventures, PROs (Producers Responsibility Organization) for collection through already established informal collectors with set targets of collection. A common collection facility incorporated with testing and primary dismantling facilities or partial recovery facility (PRF) should be set up. PRF should be located at a site with maximum possible proximity to informal recycling clusters to increase the penetration and reach of both the sectors. Producers should ensure that the workers are carrying out the primary dismantling under a proper supervision and monitoring, and hazardous wastes which require special treatment/disposal process must not be entertained at the common collection site, and be dispatched to registered recycling units directly

To ensure safe primary dismantling carrying on inside the PRF, elementary training coupled with protection and safety

measures must be provided to the workers, who being partially skilled are generally prone to accidents and injuries. Apart from that, informal recyclers and the workers involved in informal sector must be educated about the health and environmental hazards associated with unsafe dismantling and disposal respectively, so that they seriously think about putting the economic aspect aside and prioritize their safety and environment. Reorganizing the current informal and formal sector will reduce the potential risk of child labor involvement because the primary recovery facility is suggested to be under the monitoring of producers. Informal recyclers following the health and environment norms can be legalized, as suggested in the National Environment Policy (NEP), to bring them in the mainstream of recycling (Chaturvedi et al., 2010).

PROs must maintain transparency (Widmer, Oswald-Krapf, Khetriwal and Schnellmann, 2005) in employing the informal sector in both collection and primary dismantling. To ensure this, Government should make environmental authorities like CPCB (Central Pollution Control Board) and SPCBs (State Pollution Control Boards) responsible for frequent inspection of the PRFs. The proposed approach is not the one and only solution to the problems of informal sector and EPR, but it is one of the possible solutions for mainstreaming the informal sector with the application of EPR.

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