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EPR policy instruments for E-Waste in Udaipur smart city.

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Abstract: The rapid advancement of technology and the rising consumption of electronic goods have significantly increased the generation of electronic waste (e-waste) across India. Udaipur, as an emerging smart city, faces growing challenges in managing e-waste in a sustainable and environmentally responsible manner. This research paper investigates the implementation and effectiveness of the Extended Producer Responsibility (EPR) policy in the context of e-waste management in Udaipur. The study outlines the legislative frameworks governing e-waste in India, including the E-waste (Management and Handling) Rules, 2011, and its amendments in 2016, which mandate producers to meet e-waste collection targets and implement deposit-refund systems.EPR is a globally recognized approach where producers are made responsible for the end-of-life management of electronic products. In India, however, e-waste management is still dominated by informal sectors, limiting the success of EPR. This study emphasizes the need for better enforcement mechanisms, active stakeholder involvement, and awareness campaigns to integrate informal sectors into formal recycling systems. The paper also proposes city-specific guidelines tailored to Udaipur, aiming to improve collection, recycling, and reduction practices through registered e-waste collectors, reuse, repair, and green computing strategies.Comparative analysis with international policies such as the WEEE directives highlights innovative practices and tools. If implemented effectively, EPR policies can transform Udaipur into a model green smart city with sustainable and efficient e-waste management practices.

I. INTRODUCTION

1.1 Extended Producer Responsibility (EPR)

Before they can sell new equipment, the producers must take back old equipment for proper disposal. The cost of such "end-of- life" processing must be a part of the sale price, not listed as a separate fee. This gives manufacturers an economic incentive to devise the most efficient methods of coping with the problems of old equipment. Implementation of such measures would require the employment of large number of people, and could potentially mean the expansion of a new economic sector in developing countries. Extended producer responsibility (EPR) where the manufacturer's responsibility for its ICT equipment extends throughout the various stages of that equipment's life cycle with internalizing the cost of managing the equipment at end of life Extended producer responsibility (EPR) is a policy framework in which the responsibility of the end-of-life management of consumer products is assigned to producers.

1.2 What is e-waste?

Electronic waste, also known as e-waste, includes all types of old, non-functional and unused electronic and electrical equipment. This includes all large and small equipment, cables, wires and any consumer electronic and electrical equipment operated by electricity or battery such as mobile, TV, fridge etc. Unscientific disposal/processing of such equipment can be harmful to the environment and human health. Therefore, contribute to environmental protection by giving e-waste to an authorized agency/institution and disposing it using environmentally friendly methods.EPR incentivizes eco-design and facilitates the efficient recovery of valuable materials, contributing to a circular economy for electronics (Cyclos et al., 2018). The Asian continent presents an exceptional case, with its rapidly growing E-waste, recognizing this as one of the several regional directives, the national regulations have emerged across the continent.

II. E-WASTE SCENARIO

2.1 Global E-waste production scenario-

As the world is technologically everchanging, technology itself has become a very integral part of Human lives. Wherever there is consumption, there is waste and with increased consumption of technology, there has been a significant growth in generation of electronic waste (e-waste) as well. To introduce new tech, there is a constant disposal of obsolete tech. The global electronic waste (e-waste) scenario has reached alarming proportions, posing severe risks to both health and the environment. The world generated 62 billion Kgs of E-waste in 2022, an average of 7.8 kg per capita compared to 53.6 billion Kgs in 2019, average 7.3 kg per capita. This amounts to an average increase of 2.8 billion Kg every year, which would mean the world will generate about 84.4 billion Kg of e-waste by 2030. And only 22.3 per cent (13.8 billion

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kg) of the e-waste generated in 2022 was documented as properly collected and recycled (Forti et al., 2020; United Nations, 2020, 2024).Despite growing awareness and initiatives to improve e-waste management, such as extended producer responsibility (EPR) policies and international agreements like the Basel Convention, substantial gaps remain in implementation and enforcement, particularly in low- and middle-income countries (Baldé et al., 2022).

2.2 E-waste scenario in India

India's electronic waste (e-waste) scenario has become increasingly critical, India is not only among the top 5 generators of E waste in the world but also among the top 5 importers of e-waste from the world. In 2023, India produced approximately 3.5 million metric tonnes (Mt) of e-waste, a significant increase from the 2.0 Mt generated in 2014 (Central Pollution Control Board, 2023). By 2030, it is estimated that India's e-waste generation could exceed 5.5 Mt, highlighting the urgent need for effective waste management solutions (Parajuly et al., 2019).

2.3 in Chandigarh

Consumers also have the option of returning their e-waste to the EEE producers under the EPR policy scheme, as mandated in the EWM Rules 2022

2.4 In Udaipur

2.4.1 PCB has developed Plastic Credit App, team will take the equipment from home and then dispose it off,Second initiative for a clean city, deposit e-waste like old laptops, mobiles, fridges and coolers, money will be given as per the weight

2.4.2 News, City Reporter | Udaipur :

To save the environment, after first collecting plastic bottles from homes, offices and institutions, Pollution Control Board (PCB) has started a campaign for proper disposal of electronic waste (e-waste). Under this, the team will collect e-waste like old fridge cooler, mixer laptop, TV-computer from your house. The price for these items will be paid per kilogram or per piece. A receipt will also be given. This garbage will be collected and sent to the authorized recycler for disposal. For this, you can place a request on the mobile app PlasticCredit of the Regional Pollution Control Board. On this app, the general public, Hotel, hospital and industry operators can register for free. Initially the name of this application was Plasticlean which has been changed to PlasticCredit. Actually the state government is running a campaign for proper disposal of e-waste in the state.Under this, e-waste collection campaign will be run in Udaipur from 5 to 7 July 2025. To make it successful and create awareness among people, Udaipur PCB has started it 20 days ago. Apart from the mobile app, the team is also collecting e-waste by setting up camps in hotels and apartments. On Friday, the trial started from RSG Apartment located at Pratapnagar-Balicha bypass. Camps will be set up at other places in the coming days.

2.4.3 More than 50 devices are included in the list, which will weigh those who are heavy :

Under the scheme, the payment rate for each item has been fixed across the state. Computer will be paid Rs 350 per piece, laptop Rs 500, notepad Rs 500, mobile phone Rs 100 to Rs 500. While the rate for TV is Rs 30 per kg and fridge is Rs 40 per kg. More than 50 items are included in the list. If the condition of any equipment is very bad then its price can change.

On World Environment Day, PCB launched PlasticCredit mobile application to make the city plastic free. Along with this, machines were started in the city at Mumbaiya Bazaar of Fatehsagar, outside Sahelion ki Bari Gate, Doodhtalai, Sukhadia Circle Chowpatty, Sajjangarh Ticket Counter. Under this, common people are collecting plastic bottles coming out of their homes, offices or institutions. So far, about 2500 to 3000 bottles have been collected. Participants will be given free health checkup, cloth bags, terracotta bottles etc. as gifts.

III. EPR POLICY INSTRUMENTS ON WASTE -A REVIEW

In recent years, the management of e-waste, defined as electrical and electronic devices that have reached their final time span , has garnered significant attention due to the rapid proliferation of electronic devices and the subsequent environmental and health challenges resulting from improper disposal.

Policy 2021 EPR success dependent on market expansion, economies of scale, reduction in uncertainty .

Policy 2022 Investigation of EPR schemes in India Suggestion of modified EPR model for e-waste India

Policy 2023 Absence of informal sector in Indian e-waste legislation Collaboration of formal and informal sector required

3.1. How can you help In Udaipur ?

Give or donate to an authorized institution/agency.

Return to an authorized store under a buy-bank or exchange program.

Get a fair price by disposing of e-waste through authorized recyclers.

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3.2 Exchange your old appliances and electronics in the e-waste collection drive .

Notes:

1. The rate provided is the starting price on per pound or per kilogram basis.
2. If the material is of better quality, then appropriate and higher price will be paid for it.
3. For material on kilogram basis, the weight will be measured on the weighing scale at the collection facility or collection vehicle.
4.The rate of the goods/material is for the entire item(s) and if any item/material is found missing, then the rate will be fixed on the basis of the physically available product.The rate will be determined after the recyclers inspect the material.

3.3 Extended Producer Responsibility Framework in India

3.3.1 Registration. - (1) The entities shall register on the portal in any of the following category, namely: -

(a) manufacturer;
(b) producer;
(c) refurbisher; or
(d) recycler.

3.3.2 Responsibilities of the manufacturer. – All manufacturer shall have to, -

(1) register on the portal;
(2) collect e-waste generated during the manufacture of any electrical and electronic equipment and ensure its recycling or disposal;
(3) file annual and quarterly returns in the laid down form on the portal on or before end of the month succeeding the quarter or year, as the case may be, to which the return relates.

India adopted EPR framework to regulate e-waste in its E-waste (Management and Handling) Rules, 2011, which became effective in May 2012. The 2011 Rules use mandatory take-back as the policy instrument within the EPR approach. The Indian Ministry of Environment and Forests (MoEF) has amended the 2011 Rules; the new Rules have become effective in October 2016. Among other important changes, the amended Rules set collection targets for the producers and require them to set up a deposit-refund system. In this context, this paper reviews the theoretical research on policy instruments available for EPR and empirical research on the experience of EPR policy instruments in other countries to draw implications for EPR policy design and implementation in India.

EPR is defined as ‘a policy principle in which the upstream actorsmust be made responsible for the waste generated even in the downstream activities with a focus on the take back, recycle and disposal of the product’ (Lindhqvist, 2000). Compared to the PPP where the producers were only responsible for the waste generated in the production process, under the EPR, producers are responsible for waste generated by a product throughout its lifecycle.

3.3.3 Responsibilities of State Government or Union territories. –

(1) The Department of Industry in the State and Union territory or any other government agency authorised in this regard by the State Government or the Union territory, as the case may be, shall ensure earmarking or allocation of industrial space or shed for e-waste dismantling and recycling in the existing and upcoming industrial park, estate and industrial clusters.
(2) Department of Labor in the State and Union territory or any other government agency authorised in this regard by the State Government or the Union territory, as the case may be,
shall, -

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

3.4 **Procedure for storage of e-waste. -** Every manufacturer, producer, refurbisher and recycler may store the e-waste for a period not exceeding one hundred and eighty days and shall maintain a record of sale, transfer and storage of e-wastes and make these records available for inspection and the storage of the e-waste shall be done as per the applicable rules or guidelines for the time being in force

3.5 Modalities of the extended producer responsibility Regime. – (1) All producers shall fulfil their extended producer responsibility obligation as per Schedule-III and Schedule-IV, in doing so they may also take help of third party organisations such as producer responsibility organisations, collection centres, dealers etc

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3.6 Extended producer responsibility Certificate Generation. –

3.6.1 Recycling. - (i) The Central Pollution Control Board shall generate extended producer responsibility certificate through the portal in favour of a registered recycler in the format laid down by it in this regard.

(ii) (a) The quantity eligible for generation of extended producer responsibility certificate shall be calculated by the following formula namely:

$$*QEPR = Qp \times Cf$$

**the QEPR is the quantity eligible for generation of the certificate, Qp is the quantity of the end product and Cf is the conversion factor (quantity of inputs required for production of one unit of output)*

(iii) The validity of the extended producer responsibility certificate shall be two years from the end of the financial year in which it was generated and the expired certificate automatically extinguished after the period unless extinguished earlier as per the provisions of these rules.

(iv) Each extended producer responsibility certificate shall have a unique number containing year of generation, code of end product, recycler code and a unique code and the extended producer responsibility certificates shall be in the denominations of 100, 200, 500 and 1000 kg or such other denominations as may be laid down by the Central Pollution Control Board with the approval of the Steering Committee.

3.6.2 Refurbishing. – (i) The e-waste shall also be allowed for refurbishing and refurbisher shall have to get registered on the portal and based on the data provided, refurbishing certificate shall be generated in favour of a registered refurbisher in the format laid down by it in this regard.

(ii) On production of the refurbishing certificates purchased from the registered refurbishers, the extended producer responsibility of the producers shall be deferred by the duration as laid down by the Central Pollution Control Board for the corresponding quantity of e-waste and shall be added to the extended producer responsibility of the producer upon expiry of the extended life of the refurbished product. (iii) To incentivise refurbishing, only 75 per cent of the deferred quantity shall be added to the extended producer responsibility of the producer for recycling upon expiry of the extended life of the refurbished product.

3.7 Literature gaps

The enforcement of Extended Producer Responsibility (EPR) is another area with notable research gaps. While EPR is a cornerstone of India's e-waste policy, its implementation has been inconsistent, with many producers failing to meet their collection and recycling targets (Faibil et al., 2023). Studies need to explore the barriers to effective EPR implementation and develop strategies to enhance compliance and accountability among producers.

IV. RESULT OF UDAIPUR'S EPR POLICY ON E-WASTE REGULATIONS

The theoretical exploration of the Extended Producer Responsibility (EPR) policy in the context of e-waste management in Udaipur reveals that while the policy framework exists at the national level under the E-Waste (Management) Rules, 2016 (amended in 2022), its practical implementation at the city level remains limited. Udaipur, being a rapidly growing smart city, generates a significant volume of electronic waste due to increased digitalization, rising urbanization, and growing consumer electronics usage.

V. CONCLUSIONS AND IMPLICATIONS FOR UDAIPUR'S EPR POLICY ON E-WASTE REGULATIONS

The implementation of the Extended Producer Responsibility (EPR) policy in Udaipur, a developing smart city, theoretically provides a sustainable framework for managing electronic waste. By mandating producers to take responsibility for the end-of-life management of electronic products, EPR encourages environmentally sound recycling and disposal practices. However, in Udaipur, the policy's effectiveness is limited by poor enforcement, lack of public awareness, and insufficient infrastructure. Strengthening institutional frameworks, enhancing stakeholder participation, and promoting formal recycling channels are essential to realize the full potential of EPR in achieving sustainable e-waste management in the city.

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Analysis indicates that effective EPR implementation in Udaipur has the potential to:

1. Strengthen accountability among producers and importers by mandating proper collection, recycling, and disposal mechanisms.
2. Promote formalization of the informal e-waste sector, which currently handles a major portion of waste through unscientific and hazardous practices.
3. Encourage local infrastructure development for authorized e-waste collection centers and recycling units.
4. Support environmental sustainability by reducing illegal dumping and unsafe recycling methods.
5. Improve consumer awareness and participation through take-back schemes and deposit-refund incentives.

results also highlight several challenges:

- Limited awareness among producers and consumers about their responsibilities under EPR.
- Inadequate coordination between municipal bodies, producers, and recyclers.
- Insufficient monitoring and enforcement mechanisms at the local level.
- Lack of digital tracking and data transparency on e-waste generation, collection, and recycling.

These findings emphasize the need for stronger city-level governance, better infrastructure, public-private partnerships, and continuous stakeholder engagement to ensure the success of EPR policy in managing e-waste in Udaipur effectively.

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