PUNE INTERNATIONAL CENTRE

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Working Paper

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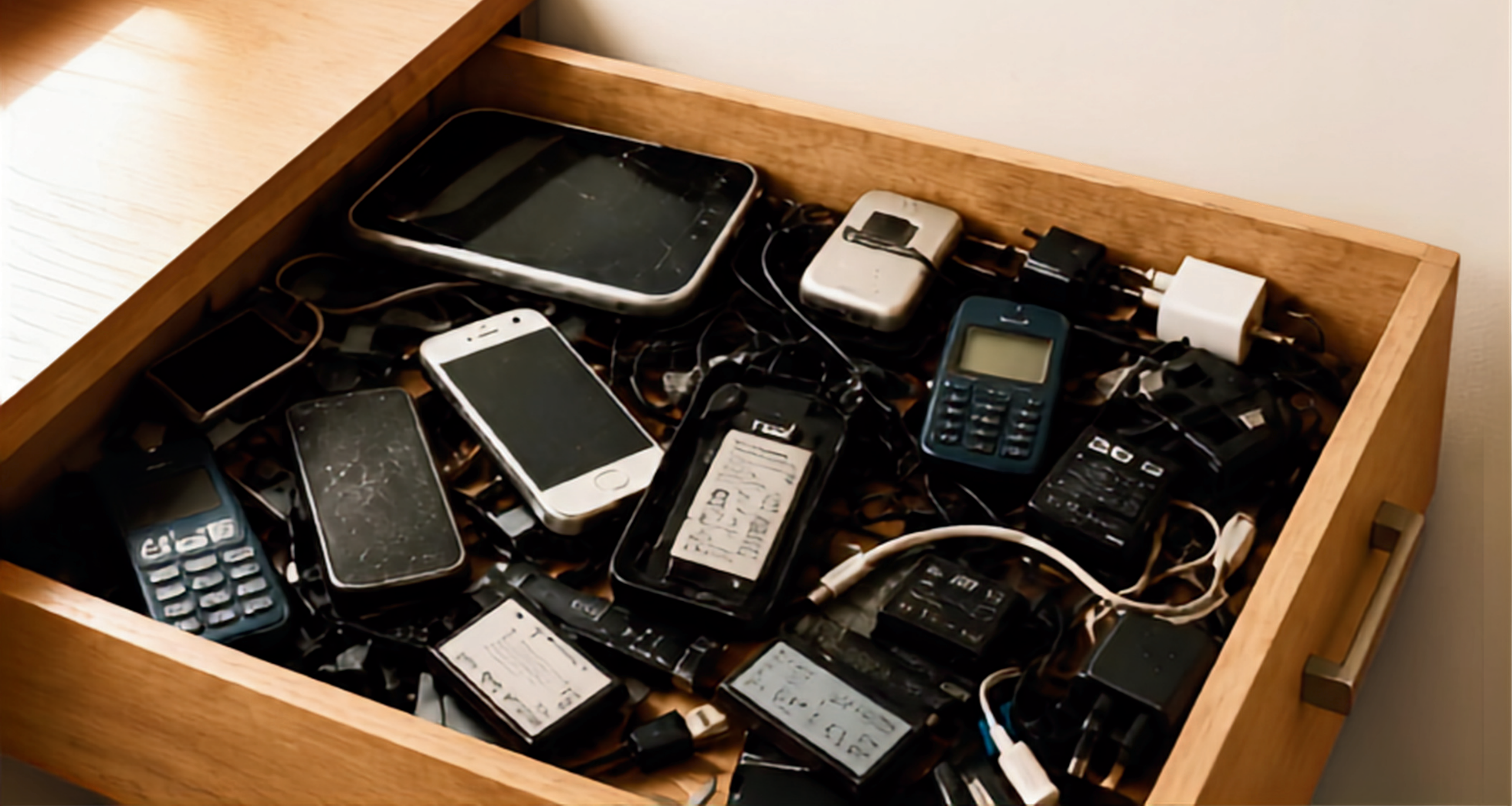

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A qualitative study of policy and governance gaps in Pune.

Co-operative Federalism
& Multilevel Governance.

Working Paper

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Abstract

This paper examines the state of battery circularity in India through the lens of portable batteries embedded in consumer electronics, a key source of critical mineral-rich "black mass" for recycling. Within this category, the study focuses on smartphone batteries, given the rapid growth of India's smartphone user base. The research is situated in Pune, Maharashtra's second-largest e-waste-generating city, and examines the policy and governance gaps between the Battery Waste Management Rules, 2022 and the E-Waste (Management) Rules, 2022, alongside the possible role of local self-government in building a reverse logistics supply chain. Given the significant presence of the informal sector in this supply chain, which creates persistent data gaps in battery circularity, the study adopts a qualitative approach, drawing on eight semi-structured interviews with policy experts, formal recyclers, public officials, and waste-picker representatives, supplemented by field observations at Pune's SWaCH V-Collect Centre and a local e-waste recycling facility. Four key findings emerge. First, there is widespread public confusion between e-waste and hazardous battery waste, rooted in regulatory ambiguity. Second, dismantling, the manual, labour-intensive extraction of batteries from devices, is an essential but currently unrecognised and unregulated stage of the recycling value chain. Third, despite their constitutional mandate for solid waste management, Urban and Rural Local Self-Governments have no comparable operational mandate for e-waste and battery collection, leaving the sector reliant on producer-led Extended Producer Responsibility mechanisms alone. Fourth, data privacy concerns, rather than lack of awareness, are a major behavioural barrier to smartphone recycling, as consumers fear irreversible loss of personal data. Based on these findings, the study recommends: integrating the two regulatory frameworks to formally recognise e-waste as a source of end-of-life batteries; formally regulating battery extraction as a distinct, labour-protected activity; mandating local governments to establish permanent e-waste collection infrastructure, potentially in partnership with educational institutions; and introducing mandatory, indigenously developed data-wiping certification to address consumer privacy concerns and reduce device hoarding. Most importantly, the study argues that battery circularity policy in India must shift its underlying orientation from end-of-life waste management toward design-for-reuse and lifecycle optimisation.

Keywords: Portable Batteries, End-of-Life (EOL), Battery Circularity, Recycling, Circular Economy, Smartphones, E-waste, Hazardous Waste, Pune.

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Award Recognition

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List of Abbreviations

CE	Circular Economy
EOL	End-of-Life
LIBs	Lithium-Ion Batteries
LABs	Lead Acid Batteries
OEMs	Original Equipment Manufacturers
EPR	Extended Producer Responsibility
EV	Electric Vehicle
BWMR	Battery Waste Management Rules, 2022
MoEFCC	Ministry of Environment, Forest and Climate Change
ULGs	Urban Local Governments
RLGs	Rural Local Governments
LSG	Local Self Governments
PSA	Principal Scientific Adviser (Office of the)
GoI	Government of India
PMC	Pune Municipal Corporation
SWaCH	Solid Waste Collection and Handling (Cooperative)
GST	Goods and Services Tax
IEA	International Energy Agency
UAE	United Arab Emirates
WRI	World Resources Institute
S.O.	Statutory Order (used in Gazette notification numbering)
G.S.R.	General Statutory Rules (used in Gazette notification numbering)

1. Introduction

Concept of Circular Economy (CE), resting on the foundational principle of 3 R's - *Reduce, Reuse, and Recycle* - has gained increasing relevance in the context of the resource-intensive manufacturing sector. Of the 3 R's, two, namely, reuse and recycle, hold critical importance in the context of circularity of batteries (Kumar et al., 2023). This is because the *end-of-life (EOL)* management of batteries poses significant environmental challenges (Office of the PSA, GoI 2024). The linear economy approach towards EOL batteries, based on take-make-dispose ideology, needs to be replaced by the CE approach which will help manage the demand and supply of available resources (Goel, 2021).

As of 2020, data indicate that 70 percent of retired batteries in India were collected by informal aggregators, 20 percent by original equipment manufacturers (OEMs), and only 10 percent directly by formal waste management entities (Gattu et al. 2022). In the case of lead acid batteries (LABs), the informal sector plays a critical role in the collection and recycling process, which compromises the safety of both workers and the environment (Kumar and Mulukutla 2023). The central objective of battery circularity is the efficient recovery of **"black mass"** the powdered residue containing critical active materials like lithium, cobalt, and nickel which serves as the essential feedstock for reintegrating high-value secondary minerals back into the domestic manufacturing value chain (Abramczyk et al. 2025). The black mass generated during battery recycling is frequently exported to countries with established refining infrastructure for the recovery of critical, because India currently has limited capacity of black mass refining. Battery Circularity faces various challenges: lack of circularity-friendly battery design, implementation issues in the EPR (Extended Producer Responsibility) provisions, lack of efficient reverse logistics for retired batteries, challenges in battery data collection and management, absence of standards for battery reuse and recycling, lack of public awareness, market gap for recycled battery material (Kumar et al., 2024) as well as the deterrent of the 18 percent GST levied on retired batteries in the formal sector (ClearTax n.d.). Creating policy solutions and well-planned execution will allow India to tap battery circularity market which presents a **₹75,500 crore (US$9 billion)** opportunity and a chance to shape a self-reliant and efficient battery supply chain (Abramczyk et al., 2025).

In the context of the Fourth Industrial Revolution where energy counts among the basic needs of society (the others being food, water, and shelter) (PSA, 2024), batteries lie at the foundation of energy storage. This is particularly true of **lithium-ion batteries (LIBs)** which are characterised by lightweight, efficient, and reliable power. Globally, as digitisation and electrification are evolving, demand for rare earth minerals as essential raw material is expected to double by 2030 (IEA 2023) and will further increase significantly by 2040.

1.1 Research Question

We are concerned with examining the state of portable battery recycling in India, bearing in mind the nature of the sector in which this activity is located and the rules that govern it. Based on estimates that nearly 80 per cent of India's 600 million internet users access the internet via **smartphones**, the country's smartphone user base can be estimated at approximately **480 million** (Aishvarya et al., 2023). Further, India recorded shipments of around 2.7 million laptops in a single quarter in 2025 (Kumar, 2025), show a rapidly expanding stock of consumer electronics having embedded portable batteries.

Given the vast size of the Indian economy, the expanding smartphone market, and, consequently, the scale of battery recycling involved, this study focuses attention on the city of Pune. Maharashtra is India's largest e-waste generating state, contributing 19.8 percent of national e-waste generation, and within the state, Pune ranks second only to Mumbai (Deccan Herald News Service, 2016). Beyond the scale of waste generated, the presence of organisations such as SWaCH makes Pune a particularly instructive case, since e-waste and batteries are voluntarily segregated at source through its V-Collect initiative. The SWaCH V-Collect initiative is a community-based waste-reduction programme that collects pre-loved clothing, books, and e-waste to promote reuse, support the urban poor, and divert material from landfills. Run in partnership with the Pune Municipal Corporation (PMC), the initiative is managed directly by waste pickers (SWaCH Cooperative, n.d.). This form of source-level segregation, integrated with a formally recognised and municipally partnered informal workforce, has not been observed at comparable scale in other Maharashtra districts, making Pune a valuable site for examining how battery circularity functions where collection infrastructure already exists, even as the specific handling of embedded portable batteries remains unregulated.

1.2 Aims and Objectives of the Paper

This paper aims to examine the state of portable battery recycling in Pune, with particular focus on Consumer Electronics containing embedded portable batteries, from which critical mineral–rich black mass can be recovered for recycling. Our objectives for the paper are as follows:

1. To examine policy and governance gaps in the recycling of portable batteries embedded in consumer electronics in Pune, with particular attention to the interaction between the Battery Waste Management Rules, 2022 and the E-Waste (Management) Rules, 2022.
2. To analyse on-ground practices and institutional roles across the portable battery recycling value chain, including collection, dismantling, and segregation, with a focus on the roles of informal actors, waste picker organisations, and Urban Local Governments (ULGs).
3. To identify structural and behavioural barriers limiting effective portable battery circularity, including regulatory fragmentation, lack of local-level collection infrastructure, and consumer concerns related to data privacy in smartphones and tablets.

1.3 Plan of the Paper

In section 2, we carry out a review of the relevant literature; section 3 discusses our methodology; section 4 reports our analysis of data; section 5 provides major findings; section 6 concludes the paper.

2. Literature Review

2.1 Industry 4.0 and Circular Economy Transition

As the world witnesses the full digitization of the production process a revolution labelled Industry 4.O has taken the world by storm (MoRTH, 2025), Hamad and Jawad (2024) believe that this revolution extends beyond mere technological novelty to a fundamental change in knowledge and production, involving the integration of machines, infrastructure, and people into fast, interconnected networks. The Ministry of Road Transport and Highways (2025) observes that, as the world moves toward digitalization and electrification, energy storage cells serve as the foundation for consistent, flexible, and efficient power delivery. These interconnected networks allow the establishment of *"aftermarket supply chain"*, a point emphasised by De Mattos et al. (2018) who argue that one of the most important components of the circular business models is the reverse logistics of the supply chain. The supply chain is a critical unit of action for the implementation of a circular economy model because of the need for a joint effort "beyond organizational boundaries" and involves coordinating upstream partners to obtain environmentally friendly inputs and downstream partners to cooperate with the adoption of environmental management practices, such as return, reuse, and recycle. Apurva Goel (2021) notes that the industry has thus far followed the linear approach of *take-make-dispose*, but which is now considered a failed model because it is now deemed to be unsustainable. Press Information Bureau (2021) specifically mentions that since India possesses only 2% of the world's landmass and just 4% of its freshwater resources, a linear economy would severely constrain its manufacturing sector and the overall economy, making the circular model essential for gaining competitiveness and achieving self-reliance.

2.2 Growing Importance of Batteries in the Energy Transition

As energy storage cells, batteries play a vital role, and lithium-ion batteries in particular are recognized for providing lightweight, efficient, and reliable power. Abramczyk et al.(2025) note that India's battery circularity market is likely to be worth around ₹75,500 crore (US$9 billion) by 2050 and provides an opportunity to shape a self-reliant and efficient battery supply chain. India will face increased demand for batteries due to the rise of Electrical Vehicles (EVs). To match this demand 3R practises are a must for introducing battery circularity. It is estimated that battery circularity could well meet over 40% of India's lithium, nickel, and cobalt needs and has the potential to create more than 106,000 direct green jobs (Abramczyk et al., 2025). IEA (2023) have noted that, as digitisation and battery-dependent technologies have evolved, the demand for rare earth minerals as essential raw materials have exploded rapidly and is expected to double by 2030. Some of the major impediments in current battery circularity are the lack of circularity-friendly battery design, implementation issues in the EPR provisions, lack of efficient reverse logistics for retired batteries, challenges in battery data collection and management, absence of standards for battery reuse and recycling, lack of public awareness, and a market gap for recycled battery material (Kumar et al., 2024). Gattu et al. (2022) points towards a data gap with respect to the absence of a national-level battery registrar for tracking and recycling batteries. .

2.3 Battery Circularity Governance in India

Indian battery circularity is governed by Battery Waste Management Rules, 2022 (BWMR) which aims to create a reverse logistics supply chain through EPR. The rules mandate recovery targets of 70% for portable and electric vehicle batteries in 2024–25, increasing to 80% in 2025–26 and 90% 2026–27 onwards. For automotive and industrial batteries, the recovery targets are fixed at 55% in 2024–25 increasing to 60% from 2025–26 onwards. These targets are designed to promote higher recycling efficiency, reduce environmental risks, and support sustainable battery waste management through formalized recovery systems. Although disconnect between BWMR and E-waste management rules fails to establish reverse logistics supply chain in the recovery of portable batteries more used in consumer electronics.

2.4 Portable Batteries, Smartphones, and Emerging Governance Challenges

The literature examined in this study primarily focuses on electric vehicle (EV) batteries and batteries used for renewable energy storage systems. However, as highlighted by Aishvarya et al. (2023), India has an extensive scale of smartphone usage, with an estimated 480 million smartphone users, indicating a rapidly growing stock of portable batteries embedded in consumer electronics. This suggests that portable battery waste from smartphones and other electronic devices also represents a significant and underexplored component of India's battery waste and circular economy challenge. Recycling of Smartphone devices presents an opportunity from both perspectives of BWMR and E-Waste Management Rules. Patrao and Karnik (2023) investigated the low rates of mobile phone recycling in the United Arab Emirates

(UAE), a country with a smartphone penetration rate of approximately 97%. One of the primary reasons for the low rate of mobile circularity is data privacy.

2.5 Research Gap

Existing literature is more focused on recycling EV and automotive batteries, whereas attention to portable batteries is lagging as it presents the challenge of being embedded in a device, notably in a smartphone. Given that the current battery circularity discourse has a blind spot as far as smartphone batteries are concerned, it is crucially important that batteries used by smartphones are studied systematically.

3. Methodology

Before we begin our discussion of the methodology used, it is important to understand nature of batteries that we are studying

Portable Batteries are defined as sealed batteries weighing less than five kilograms and not intended for industrial use, electric vehicle traction, or automotive starter, lighting or ignition purposes. Schedule II of the Rules (MoEFCC, 2022) recognises portable batteries used in consumer electronics, thereby covering batteries used in devices such as mobile phones, laptops, tablets, wearables, and similar personal electronic equipment. Table 1 provides a taxonomy of different types of batteries. The attention of this paper is focused on the first item in the list.

Type of Battery	Definition (as per Rules)
Portable Battery	A sealed battery weighing less than five kilograms, not designed for industrial purposes, electric vehicles, or automotive use. Typically used in consumer electronics such as mobile phones, laptops, toys, and remote controls.
Automotive Battery	Any battery used exclusively for automotive starter, lighting, or ignition (SLI) power in motor vehicles.
Electric Vehicle (EV) Battery	A battery specifically designed to provide traction power to hybrid and electric vehicles for road transport, including two-wheelers, three-wheelers, and four-wheelers.
Industrial Battery	Any battery designed for industrial uses, excluding portable, electric vehicle, and automotive batteries. This includes sealed batteries (excluding portable batteries), unsealed batteries, and energy storage system batteries.

Table 1: Different types of batteries

Source: (Ministry of Environment, Forest and Climate Change [MoEFCC], 2022)

The study adopts a Qualitative triangulation using primary field evidence and secondary policy analysis appropriate for examining portable battery recycling practices that are largely embedded within the informal sector and remain insufficiently captured in formal datasets.

Given the limited availability of quantitative information and the fragmented nature of battery recycling activities, an exploratory case study approach was employed to analyse policy design, institutional arrangements, and on-ground practices.

The study is situated in Pune, a major metropolitan city in Maharashtra, selected for its relevance as a significant centre of consumer electronics usage and waste generation, as well as for the researcher's institutional location and field access within the city.

Primary data were collected through semi-structured interviews and field observation. The interview process began with a telephonic discussion with a researcher working on battery circularity in the context of electric vehicles, which provided contextual grounding and facilitated access to additional stakeholders. Snowball sampling was subsequently employed to identify formal dismantlers and other actors involved in battery and e-waste handling, recognising the trust-based and hard-to-reach nature of the sector. Field observations and informal discussions were conducted at the SWaCH V-Collect initiative centre in Aundh, Pune, which serves as a central node for city-level e-waste collection and preliminary segregation. Interviews were conducted with SWaCH personnel engaged in e-waste handling, along with a telephonic interview with a waste picker associated with the organisation. One more important field visit was made to E – waste recycling firm based in Pune which started in September 2012 and currently recycles E – waste supplied from other parts of Maharashtra and from other states of the country. Participants who were interviewed for this research, including people from field studies requested anonymity and hence, their names have not been disclosed out of respect for their privacy concern. In parallel, the study undertook secondary analysis of policy documents, rules, and guidelines related to battery and e-waste management. Experience and observation from the field were used to critically interpret gaps between regulatory intent and on-ground implementation. In total, the study draws on eight qualitative interviews conducted across policy experts, academic researchers, public officials, formal recyclers, and waste-picker representatives, supplemented by site observations. Interview transcripts, field notes, and policy documents were analysed using thematic analysis, focusing on regulatory awareness, battery extraction practices, labour conditions, data management, and institutional coordination across the battery recycling value chain. As an exploratory qualitative study, the research is subject to limitations including a small sample size, the informal and non-standardised nature of activities, and the absence of comprehensive quantitative transaction data.

4. Data Analysis

Our analysis of battery recycling in the city of Pune primarily relies on the interviews that we conducted. This is supplemented by our observations and analysis of secondary data from policy documents, rules, and guidelines. As stated above, we have structured our analysis around specific themes, which, we believe, will allow us to present our findings in a cogent manner.

4.1 Regulatory Ambiguity between E-Waste and Hazardous Battery Waste

Discussions with stakeholders at a used battery collection centre in Pune revealed a lack of public understanding regarding the distinction between e-waste and hazardous battery waste, particularly in the case of consumer electronics where portable batteries are embedded within devices. The E-Waste (Management) Rules, 2022 defines e-waste as electrical and electronic equipment, including solar photo-voltaic modules or panels or cells, whole or in part discarded as waste, as well as rejects from manufacturing, refurbishment and repair processes (Ministry of Environment, Forest and Climate Change [MoEFCC], 2022). However, the Battery Waste Management Rules 2022 clearly state that battery should be considered as hazardous waste and not E-waste. In the current government framework, battery extraction prior to the recycling process is the legal boundary which separates e-waste and battery waste. One of the implications of this framework is that it does not recognise or regulate the process and labour involved in extracting batteries from e-waste (such as phones, laptops, tablets). The questions of *how the battery will be extracted*, *by whom*, or *under what labour conditions* are ignored thereby creating a regulatory blind spot around a critical and hazardous stage in the recycling value chain.

4.2 Dismantling vs. Recycling: An Unrecognised and Unregulated Stage

Discussions with a battery dismantler revealed that consumers generally do not recognise the distinction between dismantling and recycling. Dismantling consumer electronics containing embedded portable batteries is a necessary prerequisite to the battery recycling process. This dismantling process is unavoidable when hazardous or valuable components are embedded inside products, and this process is largely manual and labour-dependent. The Battery Waste

Management Rules 2022, do not formally recognise this labour-intensive task and, hence, remains unregulated (De Ron & Penev, 1995). Recognising and formalising the dismantling process is therefore essential for developing policy solutions that clearly allocate responsibility, define labour and safety standards, and address the costs associated with labour and machinery involved in battery extraction.

4.3 Limited Awareness of Battery Material Value and the Recycling Economy

The huge size of the battery circularity market in India has been pointed out above. Recycling alone could supply 40–48% of India's lithium, nickel, and cobalt demand and is capable to create over 106,000 direct green jobs (Abramczyk et al., 2025). According to the owner of e-waste recycling plant based in Pune, Portable batteries are mineral-dense products whose material value is invisible at the consumer level but significant at scale. Transition from 5G to 6G in the near future will increase the number of smartphones in use which will, inevitably, increase the portable battery wastage. The owner further noted that, while local smartphone repair shops extensively refurbish, repurpose, and reuse other smartphone components, the same does not happen for embedded portable batteries. The owner also informed us that black mass from batteries (that is, lithium, cobalt, nickel, graphite, copper and aluminium) is sent to abroad for refining it for its reuse, because India has only a limited capacity for black mass refining. Much of the black mass is in Japan and Belgium.

4.4 Missing Role of Local Governments in E-Waste and Battery Collection

According to 12th schedule in 74th Constitutional Amendment Act, 1992 (Government of India, 1992) and 11th schedule in 73rd Constitutional Amendment Act, 1992 Public health and Sanitation are mandatory and core functions of Local governments. In urban areas, this constitutional mandate is further reinforced by the Solid Waste Management Rules, 2016, which explicitly assign responsibility for waste collection, segregation, transportation, and disposal to Urban Local Governments (ULGs) (Government of India, 2016). The constitutional provisions and rule clearly establish a constitutional and legal basis for designating waste management as a municipal responsibility. Hence, it is clear that collection, storage, transportation and disposal of waste are constitutionally envisaged functions of Urban Local Government (ULGs) as well as Rural Local Governments (RLGs).

The SWaCH organisation personnel in one of the filed visits expressed the need for the availability of dedicated plot of land for E waste and battery collection. The owner of the e-waste recycling firm based in Pune pointed out that current rules do not account for transport costs, which are currently paid by the recycling firms. Neither the E-Waste Management Rules, 2022 nor the Battery Waste Management Rules, 2022 explicitly mandate Urban Local Governments to allocate land or set up permanent collection centres, relying instead on producer-led Extended Producer Responsibility systems with local governments only playing a facilitative role. If a dedicated plot of land is not available for recycling purposes, it leads to fragmented collection, poor accessibility for citizens and over-reliance on informal networks. Hence, it is important that urban and rural local governments are tasked with the responsibility of E-waste collection. And like in Solid waste management act, 2016 where Urban governments shall arrange door-to-door collection, provide community bins, Transport waste, same needs to be done for e waste also. EPR mechanisms may be effective for large and standardised battery streams, they are less suited to consumer electronics batteries, which are small but generated in very large volumes.

4.5 Data Privacy as a Behavioural Barrier to E-Waste and Disposal

A core finding of the Patrao & Karnik, 2023 study is that data security concerns significantly discourage recycling behaviour. User fears that personal data stays accessible even after device disposal. Users fear irreversible loss or misuse of intimate personal data which may include old photo albums. Hence, consumer awareness alone maybe insufficient to make a success of the recycling programme but winning the trust of consumers may be equally essential.

4.6 Policy Silos and the Absence of Data-Secure Take-Back Systems

Under the current regulatory framework, consumer devices and their batteries must be sent only to Registered collection centres and Authorised dismantlers/recyclers, but the policies are silent on the obligation/responsibility of handling and removing the batteries from devices. For consumer devices having portable batteries, India’s E-Waste (Management) Rules, 2022 and Battery Waste Management Rules, 2022 provide only partial policy solutions through Extended Producer Responsibility and mandatory authorised recycling. However, the frameworks work in silos and do not address key consumer-level concerns such as data security, secure data deletion, or integrated take-back of devices with embedded batteries. As a result, while chemical and environmental risks are regulated, behavioural barriers, especially privacy fears remain unaddressed thereby limiting effective collection and recycling of smartphones, tablets, and similar devices.

4.7 Major Findings from Analysis

A brief summary of our major findings is listed below:

1. Public confusion between e-waste and battery waste.
2. Dismantling is an unrecognised but essential stage of battery recycling.
3. The analysis reveals that, unlike the institutional framework for solid waste management, the current regulatory framework for e-waste and battery waste does not assign Local Self Governments (LSG) a comprehensive operational mandate for collection and management, relying instead primarily on producer-led Extended Producer Responsibility (EPR) mechanisms.
4. Data privacy, not merely lack of awareness, is a major behavioural barrier to smartphone recycling.

5. Key Recommendations

a. Integrate the Battery Waste Management Rules, 2022 and the E-Waste (Management) Rules, 2022, and explicitly recognise e-waste as a critical source of end-of-life portable batteries that require coordinated regulatory treatment.

b. Formally recognise battery extraction from consumer electronics as a regulated activity by defining who may perform it, under what safety standards, and with what labour protections and accountability mechanisms.

c. Explicitly distinguish dismantling from recycling in policy and public communication, recognising dismantling as a labour-intensive and unavoidable precursor to battery recycling that requires separate regulatory attention. Government also should incentivise producer for adopting eco-friendly designs to make dismantling process easier, efficient and safer. Government framework with regards to battery and E-waste should recognise the cost of labour, transport and cost of equipment which is important for dismantling process.

d. Mandate Urban and Rural Local Governments to establish authorised, permanent e-waste collection centres for consumer electronics with embedded portable batteries, in line with their statutory responsibilities under the Solid Waste Management Rules, 2016. Local governments may partner with schools and colleges as decentralised collection points, with periodic municipal transport to authorised dismantling and recycling facilities.

e. Introduce mandatory secure data-wiping certification for smartphones and tablets at the collection or dismantling stage to address consumer privacy concerns and reduce device hoarding. The development of indigenous, standardised data-erasure technologies should be actively supported.

6. Conclusion

This study examined the recycling of portable batteries embedded in consumer electronics; more focus has been given on smartphones and tablets. The study finds that low recycling of portable batteries in consumer electronics cannot be explained by weak reverse logistics or lack of public awareness alone. Because these two reasons have more nuances as deeper structural and institutional gaps play a decisive role.

Reveres logistics supply chain starts from recognising difference between E-Waste and hazardous waste which is battery in this case. To sperate these two dismantling processes is crucial where Regulatory fragmentation between the E-Waste (Management) Rules, 2022 and Battery Waste Management Rules, 2022 treats battery extraction from consumer electronics through dismantling process as an assumed outcome rather than a regulated activity. The absence of formal recognition of dismantling as a distinct, labour-intensive process creates blind spots around worker safety, labour conditions, and accountability in battery recycling.

Also, Data privacy concerns related to smartphones and tablets appear as a major behavioural barrier to disposal; without trusted data-wiping mechanisms, awareness alone is insufficient to change behaviour. At institutional level, battery circularity needs to be supported by local governments, but Local Bodies play a limited role under current rules despite their constitutional mandate for waste management, resulting in inadequate collection infrastructure and fragmented systems. No dedicated allocation of Land for E-waste and battery collection becomes the important barrier for making mandated and authorised e waste collection centre. Role of education institution needs to be revisited as making them partner in this whole reverse logistics cycle. Most importantly battery circularity in India should shift its perspective form End of Life waste management to Design-for-reuse & lifecycle optimisation.

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