



Generation Patterns and Management of E-Waste in Urban Households in Rewa (Madhya Pradesh)

Dr Aprana Singh¹ and Ms Jaya Singh²

¹Assistant Professor, Department of Environmental Biology, APS University, Rewa (MP)

²JRF, Department of Environmental Biology, APS University, Rewa (MP)

ABSTRACT

The 21st century's widespread use of electronic devices has made waste management more difficult than ever. Significant health and environmental risks are posed by e-waste, particularly in India's rapidly urbanizing areas. This study examines the management of e-waste in Rewa, Madhya Pradesh, where formal systems run by Public-Private Partnership (PPP) models, such as the Pahadia MSW Plant, coexist with informal networks (kabadiwalas, repair shops, and scrap traders). This study investigates the production, management methods, and related health and environmental risks of electronic waste (e-waste) in Rewa, Madhya Pradesh, based on in-depth fieldwork conducted from July to August 2025. The results show a strong but dispersed ecosystem with little capacity for formal processing and high rates of informal recovery. Policy inclusion, training, protective infrastructure, decentralized and EPR mechanisms, and public support are all necessary to close this gap. Key challenges identified include low public awareness, weak enforcement of regulations, inadequate infrastructure and difficulties in integrating the informal sector into a formal e-waste management system. This paper concludes by offering recommendations to address these challenges and promote sustainable e-waste management in Rewa.

Keywords: E-waste in Rewa, E-waste and Informal sector, E-waste recycling, Extended Producer Eesponsibility (EPR), E-waste environmental hazards

1. Introduction

The 21st century's widespread use of electronic devices has made waste management more difficult than ever. Significant health and environmental risks are posed by e-waste, particularly in India's rapidly urbanizing areas. This study examines the management of e-waste in Rewa, Madhya Pradesh, where formal systems run by Public-Private Partnership (PPP) models, such as the Pahadia MSW Plant, coexist with informal networks (kabadiwalas, repair shops, and scrap traders). This study investigates the production, management methods, and related health and environmental risks of electronic waste (e-waste) in Rewa, Madhya Pradesh, based on in-depth fieldwork conducted from July to August 2025. The results show a strong but dispersed ecosystem with little capacity for formal processing and high rates of informal recovery. Policy inclusion, training, protective infrastructure, decentralized and EPR mechanisms, and public support are all necessary to close this gap. E-waste, including discarded televisions, mobile phones, computers, and batteries, often contains toxic heavy metals such as lead (Pb), cadmium (Cd) and mercury (Hg), which pose significant health and environmental hazards if improperly managed (WHO, 2023).

Rewa, a major urban center in the mid-sized city of Madhya Pradesh, makes a strong case for understanding how formal and informal systems coexist in the management of e-waste. A complex interaction between official municipal systems and informal sector operations is reflected in the city's approach to managing e-waste. This study investigated waste flows, stakeholder roles, and policy challenges in Rewa's changing waste management ecosystem through a series of field research visits conducted in July and August of 2025.

1.1 Sources and Generation of E-Waste in Rewa

The main sources of e-waste in Rewa are homes, repair shops, scrap dealers, and brand showrooms. While repair shops produce waste when they replace or repair components, households get rid of outdated computers, televisions, and cell phones. E-waste is collected from homes and small vendors by informal scrap dealers like Nannu Kabadi, who

frequently accumulate 70–80 kg per month before selling in bulk to Delhi or Indore (Singh, 2025). In order to avoid local disposal procedures, brand showrooms like Croma, Sony, and Lenovo usually send faulty products to approved service centers in Jabalpur or Lucknow (Dwivedi & Verma, 2019). The informal sector collects, disassembles, and resells a lot of e-waste, frequently without following safety regulations.

Objectives of the Study: The primary objectives of this study are

- To identify and quantify the major sources of e-waste generation in Rewa.
- To analyze the formal and informal mechanisms of e-waste collection, segregation, and disposal.
- To assess the environmental and health hazards associated with current e-waste handling practices.
- To recommend strategies for the integration of informal workers and the development of a sustainable e-waste management system.

1.2 Current Management Practices

Since formal municipal systems only partially integrate e-waste processing, Rewa's e-waste management system mainly depends on unofficial networks. The study highlights significant shortcomings in existing procedures and offers thorough suggestions for managing e-waste sustainably.

1.2.1 Formal E-Waste and Municipal Solid Waste Management Infrastructure in Rewa

Using a public-private partnership (PPP) model, Rewa's municipal solid waste (MSW) management system combines contemporary processing technologies with conventional waste handling techniques. With a fleet of 63 waste collection vehicles divided into sections for dry, wet, sanitary, and hazardous waste, including electronic waste (e-waste), the system covers 45 urban wards (Rewa Municipal Corporation, 2025).

▪ Segregated Waste Collection

The city encourages source-level waste segregation into the four categories by using a door-to-door segregated collection system. However, because of a lack of public awareness and uneven household practices, the infrastructure's ability to facilitate e-waste segregation is limited. Because of this, e-waste frequently ends up mixed with regular municipal waste, which compromises the possibility of safe recovery and recycling (Singh, 2025).

▪ Pahadia Waste-to-Energy (WTE) Plant

The Pahadia MSW Plant, a Waste-to-Energy (WTE) facility that uses Refuse-Derived Fuel (RDF) technology to generate roughly 6 MW of electricity from non-recyclable dry waste, is a major feature of Rewa's formal waste infrastructure. The city's sustainable energy goals are supported by this plant. Additionally, biodegradable organic waste fractions are processed in composting units. However, the city's ability to safely manage and recycle electronic waste is severely limited because the plant lacks a dedicated e-waste treatment unit.

▪ Biomedical Waste Management

Rewa has made great strides in managing biomedical waste in addition to solid and electronic waste. To keep dangerous medical materials from contaminating general or municipal waste streams, the Government Upgraded District Hospital (GUDH), Rewa, operates distinct biomedical waste treatment systems in accordance with Central Pollution Control Board (CPCB) regulations.

1.2.2 Informal Sector Dynamics in E-Waste Management in Rewa

The collection, recovery, reuse, and redistribution of electronic waste, or "e-waste," in Rewa are largely handled by the unorganized sector. This ecosystem, which consists of neighborhood scrap dealers, unofficial traders, and electronic repair shops, functions with little regulatory oversight but is essential to the efficient flow of resources and the economical handling of e-waste.

▪ Component Recovery and Reuse

By actively recovering and reusing valuable components like integrated circuits (ICs), capacitors, RAM modules, batteries, and copper wiring, electronic repair shops and unpaid technicians help reduce waste. By extending the useful life of electronic devices and lowering the volumes of immediate e-waste, these recovered parts are frequently used for repairs or resold. For example, a micro-economy of used electronics is supported in Techno Park, where damaged circuit boards are usually sold for ₹300–550 and mobile phone components are sold by weight.

▪ Price-Based Collection and Trade Networks

Price-based incentives are used by informal scrap dealers like Phalak Traders and Kalim Traders to collect e-waste from homes and small businesses. They offer ₹10 for low-value items and up to ₹550 for high-value boards. The efficiency of collection is increased by this pricing structure. However, there is no official training or protective gear involved, and these transactions take place outside of environmental or occupational safety standards. Due to the lack of approved local recycling or dismantling infrastructure, the e-waste is frequently compressed and transported to larger urban

recycling hubs in Delhi (such as Lajpat Nagar, PVC Market) and Indore after it has been collected (Dwivedi & Verma, 2019).

▪ **Manual Dismantling and Hazardous Practices**

In order to recover valuable components like copper and RAM, scrap dealers frequently disassemble electronics by hand. Nevertheless, this is carried out in hazardous circumstances and without personal protective equipment (PPE). Frequent open burning of non-reusable or low-value residuals, particularly plastics and mixed materials, releases harmful pollutants like dioxins, heavy metals, and persistent organic compounds, contaminating the air, soil, and water.

▪ **Lack of Regulation and Environmental Risks**

The informal e-waste industry in Rewa functions completely outside of official waste management frameworks, despite its effectiveness, affordability, and high material recovery rates. There are major risks to the environment and public health when hazardous materials like leaded glass, lithium-ion batteries, and mercury-containing products are handled and disposed of improperly. These dangerous substances are frequently dumped in open areas without any environmental protections, mixed with municipal waste streams.

The informal e-waste ecosystem in Rewa is ingenious and driven by profit, but it lacks legal accountability, environmental protections, and adequate infrastructure for secure recycling. Establishing localized authorized e-waste dismantling and recycling facilities, capacity-building initiatives, and the strategic integration of informal workers into formal systems are all necessary to close this gap.

2. Literature Review

Rapid technological advancements and a lack of formal recycling infrastructure make managing electronic waste, or "e-waste," a serious environmental and public health concern in developing nations. Numerous academic studies highlight the prevalence of informal sectors, systemic inefficiencies, growing health risks, and changing regulatory initiatives (Ongondo et al., 2021; Baldé et al., 2024). Informal networks play a crucial role in the collection and processing of e-waste, according to a recurring finding in the literature. Ongondo et al. (2021) point out that the main drivers of e-waste recovery in India are informal operators, who frequently operate without regulatory oversight. Despite their economic viability, these systems usually function in dangerous environments and disregard environmental or occupational safety regulations. According to Kumar et al. (2023), the majority of Indian cities rely significantly on decentralized informal actors, such as scrap dealers, repair technicians, and street-level collectors. Similar research by Dwivedy & Mittal (2020) and Toxics Link (2021) demonstrates that while these networks improve material recovery and reuse, they do not have organized procedures for the secure disposal of hazardous byproducts, which can cause significant environmental contamination.

Informal e-waste management has significant and well-established health effects. During procedures like manual dismantling, open-air burning, and acid-based metal extraction, informal workers—who are usually untrained and lack personal protective equipment—are frequently exposed to hazardous materials, according to Sharma and Patel (2022). Numerous serious health consequences, such as respiratory infections, neurotoxicity, kidney damage, and chronic illnesses, have been linked to this exposure (WHO, 2021; Heacock et al., 2016). Furthermore, informal recycling clusters are frequently located in or close to residential areas with high population densities, posing health risks to the local community in addition to the workers. Pregnant women and children are particularly vulnerable to heavy metal toxicity, which can have long-term effects on maternal health and cognitive development (Grant et al., 2013; UNEP, 2019).

India has gradually updated its policy framework to address the growing issue of e-waste. A significant step forward in this direction has been made with the Ministry of Environment, Forests, and Climate Change's introduction of the most recent E-Waste Management Rules, 2022. By requiring manufacturers to handle the end-of-life phase of their products through collection, recycling, and safe disposal, these regulations formalize the Extended Producer Responsibility (EPR) principle (MoEFCC, 2022). The 2022 regulations also suggest using authorized dismantling facilities and certified collection centers to integrate informal waste workers into the formal economy. The goal of this inclusive model is to protect the environment while maintaining livelihoods. However, there are still disparities in implementation. Local government entities frequently lack the administrative ability, funding, and technical know-how to successfully operationalize these mandates, particularly in Tier-II and Tier-III cities (Chaturvedi et al., 2021; Ghosh et al., 2020). The discrepancy between national regulations and their actual implementation at the local level is a common criticism in scholarly and policy discourse. Due to a lack of infrastructure and lax enforcement, smaller urban centers lag behind larger cities like Delhi and Bengaluru, which have implemented organized e-waste management systems and public awareness campaigns (CSTEP, 2022). Building local government capacity, implementing context-sensitive strategies, and raising public awareness are all necessary to address this urban-rural divide. Moreover, conflict still arises from the coexistence of formal and informal e-waste systems. Due to their adaptability, social trust, and economic necessity, informal actors continue to play a significant role (Manomaivibool, 2009; Wilson et al., 2012). Effective transition

requires not only stricter policy enforcement but also the design of hybrid models that incorporate informal workers into the formal sector without eroding their income sources. Bridging this systemic divide is essential for creating sustainable and inclusive e-waste management frameworks in India and other developing nations.

3. Research Methodology

The e-waste generation and management ecosystem in Rewa, Madhya Pradesh, was thoroughly examined using a mixed-methods research design that combined quantitative and qualitative techniques. The study was carried out between July 02 and July 10, 2025, using a mix of document analysis, site visits, structured interviews, and field observations.

3.1 Primary Data Collection

Primary data was obtained through structured and semi-structured interviews with key stakeholders involved in e-waste and municipal solid waste (MSW) management. These included:

- Municipal officials from the Rewa Municipal Corporation
- Scrap dealers and kabadiwalas at informal collection hubs
- Repair shop owners at locations such as Shilpi Plaza and Ramagobind Market
- Brand showroom representatives from major electronics retailers

In addition to interviews, direct field observations were conducted at:

- Pahadia Waste-to-Energy (WTE) and MSW Processing Plant
- Municipal solid waste collection hubs, including PTS Chauraha, Saman Naka, and Manas Bhawan
- Informal e-waste recycling and collection points across various neighborhoods in Rewa

Photographic evidence, observation notes, and informal interviews supplemented the structured data, providing contextual insights into practices, worker behavior, safety conditions, and material flows within the waste management system.

3.2 Secondary Data Collection

Secondary data was collected from multiple reputable sources, including:

- Municipal records and reports from the Rewa Municipal Corporation
- Guidelines and statistical data from the Central Pollution Control Board (CPCB)
- Academic literature related to e-waste management practices, informal sector dynamics, and waste policy in urban India

3.3 Sampling Strategy

To choose representative stakeholders from the formal and informal sectors engaged in the production, collection, recovery, and disposal of e-waste, a purposive sampling technique was used. The selection process made sure that a range of actors were covered, including grassroots recyclers, government representatives, and public-private partners.

4. Health and Environmental Hazards of E-Waste Management in Rewa

The study highlights the significant health and environmental risks associated with Rewa's prevalent e-waste management practices, especially in the unregulated informal sector. Risks to human health and ecological stability are increased by the absence of specialized e-waste systems and regulatory enforcement, even in the presence of formal waste infrastructure.

4.1 Occupational Health Risks

Workers engaged in informal e-waste dismantling and recycling face multiple occupational hazards, primarily due to unsafe handling methods and absence of protective measures:

- **Toxic Chemical Exposure:** Heavy metals like lead, mercury, cadmium, and brominated flame retardants (BFRs), which are present in circuit boards, batteries, and display units, are frequently present in the workplace for informal workers. Long-term exposure to these chemicals is associated with cancer, organ damage, and neurological disorders.
- **Respiratory and Dermal Hazards:** Dioxins, furans, and polycyclic aromatic hydrocarbons (PAHs) are released when wires and plastic components are burned outdoors, posing serious respiratory risks. Chemical burns, infections, and skin lesions can also result from coming into contact with sharp metals, broken glass, and acid solutions used in component extraction.

▪ **Absence of PPE and Occupational Safety:** Safety goggles, masks, gloves, and ventilation systems are not used in the unorganized sector. Workers, including children and adolescents in certain situations, are exposed to unfiltered toxic emissions and bodily harm due to a lack of personal protective equipment (PPE).

4.2 Environmental Contamination

Informal e-waste processing contributes significantly to **long-term environmental degradation**, jeopardizing land, water, and air quality:

- **Contamination of Soil and Groundwater:** When e-waste is disposed of in an open area, hazardous materials seep into the soil. Compounds containing lead, mercury, and nickel from cathode ray tubes and abandoned batteries seep into aquifers, contaminating food chains and sources of drinking water.
- **Air Pollution from Open Burning:** The World Health Organization (WHO) classifies dioxins as a Group 1 carcinogen, one of the persistent organic pollutants (POPs) released when PVC insulation and plastics burn.
- **Disruption of Waste Streams:** When hazardous e-waste is combined with municipal solid waste (MSW), it frequently finds its way into composting facilities or general landfills. Cross-contamination results, harming the infrastructure used in organic processing and decreasing the usefulness of recyclable fractions.

4.3 Systemic Challenges in Governance and Infrastructure

The hazardous nature of Rewa's current e-waste landscape is compounded by several systemic deficiencies:

- **Absence of Traceability and Documentation:** The production, transportation, and ultimate disposal of e-waste are not formally tracked. Since informal transactions are still not recorded, it is practically impossible to collect data, regulate them, or hold them accountable.
- **Low Public Awareness:** The majority of homes and small repair shops are unaware of the dangers of e-waste and the proper ways to dispose of it. Inappropriate disposal goes unchecked in the absence of educational outreach.
- **Weak Enforcement and Regulatory Gaps:** Local enforcement is still quite low even with national laws like the E-Waste Management Rules, 2022. The MPPCB and Nagar Nigam lack the authority to control informal actors, there are no designated e-waste inspectors, and there are no regular compliance checks.

5. Strategic Recommendations for E-Waste Management in Rewa

To mitigate the health and environmental risks posed by current practices, a multi-dimensional and inclusive strategy is necessary. The following recommendations aim to address policy, infrastructure, education, and enforcement gaps:

5.1. Policy and Infrastructure Development

- **Establishment of Dedicated E-Waste Collection Centers:** Rewa must develop formal e-waste collection facilities across key urban zones. These centers should operate under the supervision of Nagar Nigam and Madhya Pradesh Pollution Control Board (MPPCB) and be integrated with existing MSW transport systems. QR-based tracking and digital documentation should be introduced to ensure traceability.
- **Formalization of the Informal Sector:** Recognizing the reach and efficiency of kabadiwalas, local repair shops, and aggregators, the city should offer certification, training, and micro-finance schemes to bring these actors under the regulatory umbrella. Registered informal workers should be included in official e-waste aggregation and logistics models.

5.2. Awareness and Occupational Safety Initiatives

- **Comprehensive Public Education Campaigns:** Robust Information, Education, and Communication (IEC) initiatives should be launched citywide to promote household-level segregation and safe disposal practices. Use of local languages, community influencers, and digital media can increase outreach.
- **Worker Safety and Training Programs:** Periodic capacity-building workshops should be organized for informal workers, focusing on safe dismantling protocols, chemical hazard recognition, and proper PPE usage. Subsidized distribution of gloves, masks, coveralls, and first-aid kits should be prioritized.

5.3. Technology and Processing Expansion

- **Enhancement of E-Waste Processing at Pahadia Plant:** The existing Waste-to-Energy infrastructure at Pahadia should be upgraded to include dedicated lines for e-waste dismantling, sorting, and component recovery, supported by safe chemical handling systems and emissions control technology.

- **Partnerships with Certified Recyclers:** Rewa must establish strategic collaborations with authorized recycling units in Delhi, Indore, and Bhopal to ensure scientific disposal of high-risk components. These partnerships should also enable reverse logistics for take-back programs managed by electronic producers under EPR norms.

5.4. Regulatory Strengthening and Monitoring

- **Implementation of E-Waste Management Rules, 2022:** Local authorities must ensure on-ground enforcement of national legislation through:
 - Routine compliance audits of commercial electronics sellers and service centers.
 - Registration drives for scrap dealers and aggregators.
 - Penalties for illegal dumping or open burning of e-waste.
 - Use of GIS mapping and RFID tagging to track waste flows and leakage points.
- **Establishment of an E-Waste Monitoring Cell:** A dedicated cell within Nagar Nigam or MPPCB, equipped with trained personnel and digital dashboards, should monitor the city's progress toward safe and sustainable e-waste management.

6. Discussion

The research carried out across multiple field visits in Rewa (Madhya Pradesh) unveils a city in transition striving to balance a modern, technologically-supported waste management infrastructure with deeply embedded informal recycling practices. The juxtaposition of municipal mechanisms and street-level realities offers a uniquely layered insight into the challenges and opportunities of e-waste governance in medium-sized Indian cities.

6.1 Systemic Dualism: Formal Efficiency vs. Informal Necessity

A structured Public-Private Partnership (PPP) between Nagar Nigam and Asia Resil Resustainability Limited (RESL) and a loosely regulated network of local kabadiwalas, shop owners, and scrap traders are the two opposing but interdependent pillars of Rewa's waste management system. On the one hand, the Pahadia MSW Plant, which has aerobic composting, RDF segregation, and a working waste-to-energy (WTE) system that can produce up to 6 MW of electricity every day, is an example of technological sophistication. However, areas like Techno Park, Shilpi Plaza, and Nipaniya represent unofficial circuits where electronic components are sold through disjointed value chains after being reused and disassembled. This duality is indicative of India's changing urban ecology and is neither coincidental nor dysfunctional. While formal systems guarantee environmental compliance and scalability, the informal sector contributes substantially to resource recovery and circular economy dynamics, albeit with health and environmental risks.

6.2 Localized Reuse as a Circular Economy Strategy

Reusing working electronic components in repair shops is a common observation made during field visits. Technicians methodically remove usable parts from obsolete devices, such as TV power modules, CMOS batteries, and capacitors and RAMs, thereby lowering waste levels and the need for raw materials. The circular economy's tenets of extending the useful life of products are embodied in this practice. But there are serious issues when standard operating procedures (SOPs) and safety measures are lacking in these unofficial settings. Shop owners and kabadiwalas are at risk of exposure to lead, cadmium, and brominated flame retardants, which are frequently found in e-waste, if they do not have the right disassembly equipment or toxicity precautions. Thus, while reuse practices contribute to sustainability, their current format lacks occupational safety and environmental coherence.

6.3 Informal Value Chains: Unregulated yet Essential

Through a network of cycle-walas and regional aggregators, local scrap dealers like Nannu Kabadi and Kalim Traders gather e-waste straight from residences, repair shops, and electronics vendors. These networks exhibit a decentralized yet flexible reverse logistics system by sending e-waste to Delhi, Satna, or Indore every few months. However, this system lacks traceability, record-keeping, and adherence to the E-Waste Management Rules (2016, amended 2022). It is characterized by anonymity. Despite being rich in metals like gold, copper, and palladium, recyclable materials like printed circuit boards (PCBs), lithium-ion batteries, and TV motherboards are frequently disassembled in dangerous ways that expose workers to bioaccumulative toxins and carcinogenic fumes. Integration of this sector into a formal Extended Producer Responsibility (EPR) framework is not merely desirable, it is imperative.

6.4 The Pahadia Plant: Pillar of Formal Waste Management

A prime example of municipal modernization is the Pahadia MSW Plant. It converts both dry and wet waste into useful products like energy and organic manure thanks to its RDF segregation lines and aerobic compost pits. Its cooperation with Rewa's 500 TPD WTE plant highlights the importance of a closed-loop strategy for managing urban waste.

However, this facility hardly ever receives e-waste. Mobile phones, printer cartridges, and household devices are still collected by unofficial collectors, eluding regulatory scrutiny and scientific processing. Furthermore, local shops throw away materials that could feed the RDF supply, such as thermoplastics from computer chassis or TV casings, into municipal garbage despite the ability to process RDF. This disparity indicates a lost chance for revenue generation and integrated processing.

6.5 Public Participation & Source-Level Segregation: A Missing Link

One problem is consistently found in all field reports: inadequate source-level segregation. The majority of household waste arrives at the hubs mixed, even though Rewa's 45 wards are served by a compartmentalized door-to-door collection system. This strains the plant's manual labor force and reduces the effectiveness of downstream processing. Although they have been started, public awareness campaigns (IEC initiatives) are still quite small in scope. It is now necessary to match Rewa's achievements in formal infrastructure with models for behavioral change. If backed by government incentives, color-coded bins, e-waste pickup smartphone apps, and neighborhood citizen science initiatives could revolutionize the field.

6.6 Institutional Bottlenecks and Brand Showrooms

Brand showrooms such as Croma, Lenovo, and Sony follow formal procedures and send faulty products to their service centers in Delhi, Jabalpur, or Lucknow. Although safety and accountability are guaranteed, this results in a blind spot because these closed-loop systems are not connected to the city's local waste ecosystem. Potential job and capacity-building opportunities are eliminated when local aggregators are left out of this loop. Brands' reverse logistics systems would democratize e-waste recovery and encourage local entrepreneurship if they could include authorized collection centers or certified local processors under EPR regulations.

6.7 Policy Imperatives: Bridging the Divide

The insights derived from Rewa suggest that policy must move beyond binary definitions of “formal” and “informal.” A hybrid model recognizing the fluid continuum between street-level recycling and municipal processing, can offer pragmatic solutions. Some actionable imperatives include:

- Certification and training of local kabadiwalas and shop owners under MPPCB or CPCB frameworks.
- Creation of e-waste banks at ward levels, connected digitally to national EPR systems.
- Incentivization schemes for safe disposal by offering discounts on new devices upon verified e-waste return.
- Waste audits for repair shops and traders to quantify generation and streamline collection.
- Urban mining centers co-located with MSW plants, focusing on e-waste metal recovery.

7. Conclusion

This study shows that formal institutions and informal actors have a complex and interdependent relationship that shapes Rewa's e-waste management ecosystem. The Pahadia Waste-to-Energy (WTE) Plant and composting units are examples of the modern waste infrastructure that the Rewa Municipal Corporation has invested in through Public-Private Partnerships (PPP), but it still does not have a specific, working system for handling electronic waste. The collection and initial processing of e-waste is dominated by the informal sector, which includes kabadiwalas, cycle-walas, and neighborhood repair shops, according to fieldwork done in 2025. These players work together to create a decentralized, effective, and profitable network that can recover and resell priceless electronic parts to bigger centers like Delhi and Satna. However, they frequently operate without basic worker protections, regulatory compliance, or environmental safeguards. The informal sector's flexibility and agility come at a high price. In addition to releasing dangerous pollutants into Rewa's air, soil, and water, unsafe dismantling practices, open burning, and chemical exposures seriously endanger the health of workers who frequently lack any kind of personal protective equipment (PPE). Effective governance is further complicated by the lack of traceability, documentation, and oversight, which makes it challenging to estimate the actual amount of e-waste processed or the environmental harm done. More than just technical solutions are needed to address these issues. The foundation of Rewa's future must be inclusive policy frameworks that formalize the unorganized sector, develop local processing facilities, uphold environmental standards, and involve the public through disposal incentives and education. Rewa can only move towards a sustainable, just, and circular model of urban e-waste management by implementing this comprehensive, integrated approach.

References

- Baldé, C. P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2022). The global e-waste monitor 2022. United Nations University/United Nations Institute for Training and Research.
- Baldé, C. P., Forti, V., Kuehr, R., & Bel, G. (2024). The Global E-Waste Monitor 2024: Facts and Figures. United Nations Institute for Training and Research (UNITAR). <https://www.unitar.org>

- Central Pollution Control Board (CPCB). (2023). Annual report on e-waste management in India. Ministry of Environment, Forest and Climate Change, Government of India.
- Chaturvedi, A., Arora, R., & Kumar, S. (2021). Challenges and opportunities in e-waste management in India. *Environmental Science and Pollution Research*, 28(3), 2432–2440. <https://doi.org/10.1007/s11356-020-10692-7>
- CSTEP (Center for Study of Science, Technology and Policy). (2022). Framework for effective e-waste management in Indian cities. <https://www.cstep.in>
- Dwivedy, M., & Mittal, R. K. (2020). Will extended producer responsibility make e-waste management more sustainable in India? *Resources, Conservation and Recycling*, 104, 32–38. <https://doi.org/10.1016/j.resconrec.2015.08.001>
- Dwivedi, M., & Verma, A. (2019). *Informal E-Waste Recycling in Indian Cities: Case Studies and Policy Frameworks*. [Publisher not specified].
- Ghosh, S., Sinha, A., & Mishra, T. (2020). Decentralized approaches in e-waste governance in Indian municipalities: A review. *Waste Management & Research*, 38(4), 407–415. <https://doi.org/10.1177/0734242X19896475>
- Grant, K., Goldizen, F. C., Sly, P. D., Brune, M. N., Neira, M., van den Berg, M., & Norman, R. E. (2013). Health consequences of exposure to e-waste: A systematic review. *The Lancet Global Health*, 1(6), e350–e361. [https://doi.org/10.1016/S2214-109X\(13\)70101-3](https://doi.org/10.1016/S2214-109X(13)70101-3)
- Heacock, M., Kelly, C. B., Asante, K. A., Birnbaum, L. S., Bergman, Å. L., Bruné, M. N., ... & Sly, P. D. (2016). E-waste and harm to vulnerable populations: A growing global problem. *Environmental Health Perspectives*, 124(5), 550–555. <https://doi.org/10.1289/ehp.1509699>
- Kumar, A., Singh, R., & Sharma, M. (2023). Informal sector participation in e-waste management: A case study of Indian cities. *Journal of Cleaner Production*, 385, 135647.
- Kumar, D., Jain, M., Chaudhary, J., Sharma, S., Verma, A. S., & Kumar, S. (2023). Review on E-waste management: Current practices and future perspectives in India. *Environmental Research*, 224, 115411. <https://doi.org/10.1016/j.envres.2023.115411>
- Manomaivibool, P. (2009). Extended producer responsibility in a non-OECD context: The management of waste electrical and electronic equipment in India. *Resources, Conservation and Recycling*, 53(3), 136–144. <https://doi.org/10.1016/j.resconrec.2008.10.003>
- Ministry of Environment, Forest and Climate Change (MoEFCC). (2022). *E-Waste (Management) Rules, 2022*. Government of India. <https://moef.gov.in>
- Ongondo, F. O., Williams, I. D., & Cherrett, T. J. (2021). How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management*, 120, 766–789. <https://doi.org/10.1016/j.wasman.2020.10.003>
- Sharma, P., & Patel, N. (2022). Health implications of informal e-waste processing in developing countries: A systematic review. *Environmental Health Perspectives*, 130(8), 087001.
- Sharma, R., & Patel, P. (2022). Health impacts of informal e-waste recycling on workers and nearby residents in Indian cities. *Journal of Occupational and Environmental Hygiene*, 19(5), 245–256. <https://doi.org/10.1080/15459624.2022.2039712>
- Singh, G. (2025). *Field Observations and Stakeholder Interviews on E-Waste Practices in Rewa*. Unpublished field research documentation, July 2025.
- Toxics Link. (2021). *Time to Reboot: The State of E-Waste Management in India*. <https://toxicslink.org>
- UNEP (United Nations Environment Programme). (2019). *A New Circular Vision for Electronics: Time for a Global Reboot*. <https://www.unep.org>
- WHO (World Health Organization). (2021). *Children and Digital Dumpsites: E-waste exposure and child health*. <https://www.who.int/publications/i/item/9789240023901>
- Wilson, D. C., Velis, C., & Cheeseman, C. (2012). Role of informal sector recycling in waste management in developing countries. *Habitat International*, 30(4), 797–808. <https://doi.org/10.1016/j.habitatint.2005.09.005>

Acknowledgement

The author is thankful to the Madhya Pradesh Council of Science and Technology (MPCST), Bhopal, for funding the research project on e-waste in Rewa. Their financial support not only made the field study feasible but also reinforced the importance of evidence-based environmental research in mid-sized Indian cities. The Council's role in nurturing local scientific inquiry is deeply valued, and the author hopes this work contributes to that mission.