Journal of Artificial Intelligence, Virtual Reality, and Human-Centered Computing
ISSN: 3069-2318

PRIME OPEN ACCESS

Volume 2, Issue 2

Review Article

Date of Submission: 28 Apr, 2026
Date of Acceptance: 25 May, 2026
Date of Publication: 02 Jun, 2026

AI & IoT for Smart E-Waste Tracking in India: A Policy-Practical Perspective

Divyansh Chaurasia*

Independent Researcher, India

***Corresponding Author:** Divyansh Chaurasia, Independent Researcher, India.

Citation: Chaurasia, D. (2026). AI & IoT for Smart E-Waste Tracking in India: A Policy-Practical Perspective. *J AI VR Hum Comput, 2*(2), 01-05.

Abstract:
India, the world's third-largest WEEE generator (~1.6 million tonnes/year), faces rising sustainability and governance challenges as electronic consumption accelerates. This paper examines how Artificial Intelligence (AI) and Internet of Things (IoT) interventions can strengthen traceability, enforce Extended Producer Responsibility (EPR), and enable a technology-driven circular economy aligned with Vision Viksit Bharat @2047. Drawing primarily on secondary data (policy documents, government and international reports, industry publications), four Indian case studies (Karo Sambhav, Attero Recycling, Ecoreco, Hulladek) and two semi-structured expert interviews, the paper maps technological roles across the e-waste value chain and proposes an actionable, phased roadmap for adoption. Indicative evidence suggests that IoT-enabled collection can reduce collection trips by ~50–60% and related costs by ~30%; AI-assisted sorting can raise recovery efficiency to the 90–95% range for targeted material streams. The paper concludes with short-term (2024–2027) and long-term (2028–2047) policy, institutional, and technical steps to realize scalable, equitable, and evidence-based e-waste management in India.

Keywords: E-Waste, AI, IoT, Extended Producer Responsibility, Circular Economy, India, Vision 2047

Introduction

Global e-waste generation is projected to reach roughly 74 million tonnes by 2030 [1]. India's accelerating digital consumption, urbanization and relatively short device lifetimes have made it one of the world's largest generators of electronic waste, placing significant pressure on formal recycling capacities and regulatory systems [2]. The current system in India is fragmented: collection networks are incomplete, enforcement of Extended Producer Responsibility (EPR) is uneven, and the informal sector handles a large share of discarded electronics under rudimentary conditions with attendant health and environmental risks [2,3].

Digital technologies specifically AI and IoT offer practical pathways to address traceability, inefficiencies and compliance gaps in WEEE management. AI, through computer vision and anomaly detection, can enable high throughput automated sorting and predictive analytics for routing and demand forecasting. IoT devices RFID tags, sensorized bins, and GPS telematics can enable real time tracking from collection to recycling and feed regulatory dashboards [4,5]. Trials and industrial pilots indicate meaningful gains: IoT enabled smart bins and routing can reduce unnecessary collection trips by approximately 50–60% and cut certain collection costs by around 30% (industry pilots and syntheses), while advanced AI sorting lines can attain recovery efficiencies in the 90–95% range for targeted fractions under controlled conditions [6,7].

This paper adopts a policy practical approach. It asks: (1) Where are the operational and regulatory gaps in India's e-waste tracking and EPR framework? (2) How can AI and IoT address these gaps in practice? (3) What phased policy, institutional and technical actions will enable scalable, equitable adoption in line with Vision Viksit Bharat @2047? It answers these questions through synthesis of secondary sources, four illustrative Indian case studies, and insights from two semi structured interviews with sector experts.

Literature Review

Several countries have pioneered digital e-waste tracking. Sweden implemented IoT-enabled municipal bins reporting fill levels for optimized pickups [8]. Japan's Home Appliance Recycling Law mandates barcoding of products [9]. South Korea similarly leverages smart waste collection and recycling infrastructure. The European Commission (2020) highlights that circular economy action plans are essential to embed resource efficiency, while UNEP (2022) emphasizes digital interventions as critical for mainstreaming circularity [4,5].

In India, the CPCB introduced E-Waste Rules (2016, amended 2022), mandating EPR compliance, but enforcement remains weak [2]. The informal sector continues to handle most e-waste under rudimentary conditions [3]. Some startups are piloting AI disassembly and IoT bins, but these remain isolated [10]. Barriers include consumer awareness, high technology costs, and inadequate rural digital infrastructure. The NITI Aayog (2022) report stresses that circular economy strategies in electronics must be scaled nationally [11]. Globally, the latest UNU data confirms that India risks becoming one of the top two e-waste generators by 2030 [12]. However, few studies explicitly examine how AI and IoT can be systematically integrated into India's EPR framework, creating a gap this paper seeks to address.

Methodology

Approach and Data Sources

This is a qualitative policy analysis combining documentary review, purposive case studies and semi-structured expert interviews. The study relies primarily on secondary sources including government policy documents (CPCB, NITI Aayog), international reports (UNU, UNEP, World Bank), industry and NGO publications (Balde et al.; ASSOCHAM), and technical compilations (IEA Bioenergy) to map the problem, technology capabilities, and policy options.

Interviews and Case Selection

To ground the secondary synthesis in practice, two semi-structured interviews were conducted in June–July 2025 with sector experts: (1) a senior operations manager at a formal e-waste recycling firm (formal recycler with automation experience), and (2) a policy advisor with direct experience on EPR implementation and municipal-level e-waste projects. Interviews lasted 40–60 minutes, followed an interview guide covering technology adoption, operational bottlenecks, EPR compliance challenges, and scalability issues, and were recorded with consent; notes and transcripts were thematically coded for recurrent barriers and enablers.

Identifying details are anonymized in this paper to preserve interviewee confidentiality.

Four case studies were purposively selected to represent complementary innovations across the value chain: Karo Sambhav (PRO / traceability platform), Attero Recycling (AI-assisted sorting and recovery), Ecoreco (consumer-facing IoT kiosks), and Hulladek Recycling (GPS-enabled collection fleets). Cases were chosen for representativeness: they cover producer compliance, industrial automation, consumer collection channels, and logistics transparency. Case information was compiled from company reports, published articles, and interview insights.

Analysis Method

Findings from secondary sources, cases and interviews were synthesized using a thematic coding framework aligned to policy levers (regulatory, fiscal, institutional), technological functions (sorting, tracking, routing), and stakeholder groups (producers, recyclers, municipalities, informal sector). Indicative quantitative claims were cross-checked against available reports to avoid overstating impacts. Limitations include the small number of interviews and the reliance on secondary reports for many impact metrics; therefore conclusions are framed as evidence-informed recommendations rather than statistically generalizable results.

Case Studies and Applications

Karo Sambhav — Digital Compliance and Traceability (PRO Model)

Karo Sambhav operates as a Producer Responsibility Organisation (PRO) providing compliance services to electronics brands. Its platform aggregates producer reporting and uses digital ledgers to record material flows from collection partners to recyclers. As of 2024–25 the PRO network reported onboarding 30+ brand partners and enabling digital documentation to support EPR filings. Karo Sambhav's model shows how centralized digital reporting reduces administrative friction for producers and provides regulators with consolidated compliance dashboards. Interview insights highlighted that such platforms are essential to prevent double-counting and to trace whether collected e-waste passes through formal recyclers rather than informal channels.

Policy lesson: PRO-level digital platforms, combined with minimum data standards, can materially raise the fidelity of EPR reporting and reduce compliance costs for small producers when implemented with shared protocols.

Attero Recycling — AI-Assisted Sorting and Facility Automation

Attero operates automated and semi-automated material recovery lines. Company reports and industry summaries indicate automated computer-vision and sensor arrays enable high-grade material separation, with Attero reports recovery rates of over 90% for certain high-value fractions under its optimized processing [6]. IoT sensors on plant equipment provide real-time throughput and equipment health metrics, reducing downtime and improving yield. Interviews confirmed that automation substantially reduces manual exposure risks while increasing recovery value, though capital and energy intensity remain significant constraints.

Indicative metric: AI-assisted sorting can raise material recovery for targeted streams into the 90–95% range under optimized conditions, substantially increasing the economic viability of formal recycling [6].

Ecoreco — IoT Kiosks and Consumer Engagement

Ecoreco has deployed IoT-enabled e-waste kiosks (sometimes called e-waste ATMs) in urban centers where consumers deposit small electronics in exchange for vouchers or incentives. Kiosks are sensorized for fill level reporting and queue management and integrate QR codes for consumer traceability. Early deployment data show increased collection volumes at kiosk sites and improved user convenience relative to municipal drop-off centers. Interviewees noted that incentives and digital ease of use are critical to shifting urban consumer behavior toward formal collection channels.

Indicative metric: Pilot kiosk networks reported higher participation rates in urban wards where incentives and app integration were available, and operational metrics (fill-level alerts) enabled timelier pickups, reducing kiosk overflows.

Hulladek Recycling — GPS Logistics and Informal Integration

Hulladek's operations in eastern India integrate GPS tracking on collection vehicles and digital logging of pickups, creating an auditable link from collection to plant. Hulladek also works with informal collectors through aggregation contracts, offering digital onboarding and graded payments for quality-sorted material. This hybrid approach shows how digital tools can formalize informal routes without displacing livelihoods abruptly.

Policy Lesson: GPS telematics combined with incentives for informal collectors can reduce leakage to informal dismantlers and improve traceability while supporting livelihood continuity.

AI & IoT Applications in E-Waste Management

Application Area	AI Role	IoT Role	Example in India
Sorting & Disassembly	Computer vision for material identification	Sensor-triggered conveyor belts	Attero
Collection Logistics	Predictive analytics for route optimisation	GPS bin monitoring	Karo Sambhav pilot
Compliance Monitoring	Pattern detection for fraud	RFID-based product tagging	CPCB digital EPR portal
Compliance Monitoring	AI chatbots for awareness	QR-code-enabled take-back	Ecoreco kiosks

Table 1: Below Summarizes the Practical Roles of AI and IoT Across Different Stages of India's E-Waste Chain, Linking Global Best Practices with Emerging Indian Case Examples

Policy Innovations Needed

- **Digital Product Passports (DPP):** QR codes or RFID tags mandated at manufacturing stage [4].
- **Blockchain EPR Registry:** National blockchain ledger for transparent compliance.
- **PPP Innovation Funds:** Co-investment models, recommended by World Bank (2020), to mitigate capital intensity [13].
- **Smart City Integration:** Embed e-waste IoT into municipal platforms [4].

Vision Viksit Bharat @2047 Alignment

Putting artificial intelligence and the Internet of Things to work in e-waste governance promotes Viksit Bharat vision goals: sustainability in terms of lowered leakage and better recovery; economic growth by way of value recovery and green jobs; and technological leadership through scalable domestic solutions for circularity. Through policy action in phases and pilot-to-scale learning, India could put recovered materials back into domestic supply chains, strengthening the resilience and reducing import dependence for critical metals.

Recommendations and Conclusion

Recommendations

Short Term (2024–2027)

• **Pilot Expansion:** Scale smart bin + routing pilots across 5–10 metropolitan wards to validate IoT fill sensors and AI routing models at municipal scale.

• **Regional AI Sorting Hubs:** Establish 2–3 regional co-invested AI sorting demonstrations co-funded by PPP innovation funds to validate cost-benefit and trained workforce models.

• **DPP & Registry Trials:** Launch DPP and blockchain pilots for selected product categories (mobile phones, small appliances) and integrate pilot data with CPCB/EPR portals.

• **Informal Sector Onboarding Pilots:** Create digital aggregator pilots with informal collector training and mobile payment mechanisms.

Medium to Long Term (2028–2047)

• **Scale-up and Standards:** Adopt national DPP standards and scale blockchain registry; mandate DPPs for all new electronics over a phased timeline.

• **Nationwide Network of AI-IoT Recycling Hubs:** Expand regional sorting hubs to achieve national coverage and enable feedstock flow into domestic manufacturing.

• **Adaptive Regulation:** Implement real-time compliance dashboards for regulators; use AI anomaly detection to focus audits and inspections.

• **Circular Value Chain Integration:** Facilitate linkages between recovered materials and manufacturers under procurement policies to close loops.

Conclusion

The paper ultimately called out legislation and the IoT embedded within regulation, standard-setting, and inclusive business models to boost e-waste traceability, ineffective disposal, and EPR compliance in India. The analysis has indicated the potential for enormous efficiency improvements afforded by targeted pilots and large-scale demonstrations such as IoT bins, AI sorting hubs, DPP pilots, and registries: The indicative evidence suggests 50-60% fewer trips, ~30% collection cost reductions with IoT + routing, and 90-95% efficiency recovery for the targeted fractions with AI-assisted sorting. Hence, a phased program must act on these impacts: short-term pilots and capacity building from 2024 to 2027, followed by a scale-up to national standards and registries, and the inclusive formalization of informal collectors from 2028 to 2047. Hence, laid across all types of the initiatives, India would be in a very strong position to achieve the Vision 2047 objectives and offer a replicable case study for technology-enabled circular economy leadership.

Note About the Author

Divyansh Chaurasia is an independent researcher interested in the application of Artificial Intelligence and Internet of- Things for sustainability and policy innovation. His work deals with the emerging technologies that can resolve environmental issues, particularly for the processes of e-waste control and circular economy. He is highly motivated to combine technology with policy to bring about real-world, scalable solutions for the future.

References

1. Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). The global e-waste monitor 2020. United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam, 120.
2. Central Pollution Control Board (CPCB). (2023). Annual report on e-waste management. Government of India.
3. Mathews, A. (2016). ASSOCHAM-KPMG study warns India on rising e-waste levels. A study. The Associated Chambers of Commerce & Industry of India.
4. European Commission. (2020). Circular economy action plan: For a cleaner and more competitive Europe. European Commission.
5. UNEP. (2022). Building circularity into economies: E-waste and the role of digital technology. United Nations Environment Programme.
6. Granström, L., Spelhaug, C., & Potter, C. (2024). Advanced sorting technologies in the waste sector: Case studies compilation.
7. UNU. (2021). AI and robotics for waste management (Policy brief). United Nations University–INWEH.
8. Lindhqvist, T., & Dalhammar, C. (2019). Extended producer responsibility in practice. Lund University.
9. METI. (2022). Home appliance recycling law in Japan. Ministry of Economy, Trade and Industry, Government of Japan.

10. Balde, C. P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2021). The global e-waste monitor 2020. United Nations University.
11. NITI Aayog. (2022). Circular economy in electronics and electrical sector in India. Government of India.
12. Balde, C. P., Kuehr, R., & Blumenthal, K. (2022). E-waste statistics partnership: Global e-waste data report. United Nations University.
13. World Bank. (2020). Managing e-waste in developing countries: Policy and technology options. World Bank.
14. Tran, B. (2025, August 21). Smart waste management stats: How cities are using IoT bins. PatentPC.