A Mixed-Methods Field Investigation of Formal and Informal Systems in Rewa, Madhya Pradesh (A Case of E-Waste Management in Mid-Sized Indian Cities)

Dr Aprana Singh[1] and Ms Jaya Singh[2]

[1]Assistant Professor, Department of Environmental Biology, APS University, Rewa (MP)
[2]JRF, Department of Environmental Biology, APS University, Rewa (MP)

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***Abstract*:** The rapid growth of electronic waste (e-waste) has become a serious challenge for environmental governance and sustainable waste management, especially in low- and middle-income countries where formal recycling infrastructure remains underdeveloped. This research paper is based on a three-day field study conducted in July 2025 in Rewa, a medium-sized city in Madhya Pradesh, India, to understand the on-ground realities of e-waste management. The study used direct observation, semi-structured interviews, and photographic documentation. Twelve different sites were studied, including the municipal waste transfer hub, scrap dealer godowns, electronic repair shops, computer vendors, and brand-authorized showrooms; the entire flow of e-waste from generation to final destination was mapped. The findings reveal a dual system. On one hand, a formal public-private partnership operating under a twenty-year contract manages about ninety metric tons of municipal solid waste daily through source-level segregation and waste-to-energy conversion. On the other hand, a strong informal sector consisting of wandering waste collectors, repair technicians, and scrap dealers handles most of the e-waste but works without safety standards, environmental compliance, or proper documentation. The study found that at the local repair level, useful components from televisions, computers, and mobile phones are systematically extracted and reused. The remaining e-waste is sent in bulk to unregulated markets in Delhi and Indore, where prices range from approximately ten to five hundred fifty rupees per unit. Additionally, no special recycling arrangement was found for the plastic casings of electronic devices; they eventually end up in the city's general waste stream. This research shows that the coexistence of formal and informal systems is not a problem in itself. What is needed is effective policy-based integration between them so that health risks can be reduced, material value can be better recovered, and compliance with national e-waste rules can be ensured. The paper offers the following policy suggestions, establishing a dedicated e-waste collection centre at the city level, training informal workers in safe dismantling techniques, and creating an economic incentive system to channel e-waste to authorised recyclers.

Keywords: Electronic waste, Informal recycling, Public-private partnership, Waste-to-energy, Circular economy, E-Waste in Rewa (India)

I. INTRODUCTION

1.1 The Global E-Waste Challenge

Electronic waste (e-waste) has become one of the fastest-growing solid waste streams globally, driven by shortening product lifecycles, rapid technological obsolescence, and surging consumer demand for

electronics (Baldé et al., 2024). According to the Global E-waste Monitor 2024, approximately 62 million metric tonnes (Mt) of e-waste were generated worldwide in 2022 – equivalent to 1.55 million 40-tonne trucks (Baldé et al., 2024). Global e-waste generation has increased by 82% since 2010 and is projected to reach 82 Mt by 2030 (Forti et al., 2020; Baldé et al., 2024). Importantly, e-waste is growing five times faster than documented recycling, and the formal collection and recycling rate is expected to drop from 22.3% in 2022 to only 20% by 2030 (Baldé et al., 2024). This widening gap results in the loss of an estimated US$62 billion worth of recoverable natural resources annually (Baldé et al., 2024).

Beyond resource loss, e-waste contains hazardous substances – including lead, mercury, cadmium, and brominated flame retardants – that pose severe risks to human health and the environment (World Health Organization [WHO], 2024). Children and pregnant women are particularly vulnerable. The WHO (2021) reported that approximately 12.9 million women work in the informal e-waste sector globally, while an estimated 18 million children are engaged in waste-related industries, many in e-waste recycling (WHO, 2021; International Labour Organization [ILO], 2021). Toxic exposures have been linked to developmental disorders, genomic instability, neurodevelopmental damage, respiratory diseases, and endocrine disruption (Shoukat et al., 2025). In sub-Saharan Africa, for example, blood lead levels near informal recycling sites have reached as high as 309 µg/dL – far exceeding the U.S. Centers for Disease Control and Prevention's reference level of 5 µg/dL (Takyi et al., 2025). A disproportionate burden of the e-waste crisis falls on developing economies, particularly in South Asia and sub-Saharan Africa. These regions serve as both destinations for illegally traded e-waste from developed nations and as rapidly growing domestic generators of e-waste (Baldé et al., 2024; Asante et al., 2019).

India is currently the world's third-largest producer of e-waste, after China and the United States, generating an estimated 3.2 million metric tonnes annually (Astute Analytica, 2024). Official government data report that India generated approximately 1.78 million tonnes of e-waste in the financial year 2023-24, up from 1.61 million tonnes in 2022-23 (Ministry of Environment, Forest and Climate Change [MoEFCC], 2025). However, despite having 322 registered recyclers with a combined processing capacity of 2.21 million tonnes per year (MoEFCC, 2025), the country's formal recycling channels manage only about 15% of its e-waste (CPCB, 2026). The remainder – approximately 85% of India's e-waste – is managed by the informal sector, comprising itinerant waste collectors (kabadiwalas), scrap dealers, repair technicians, and household-level recyclers (Sengupta et al., 2023; Dutta & Goel, 2021). These workers recover valuable materials such as copper, gold, silver, and palladium using hazardous methods including open burning, acid leaching, and manual dismantling without protective equipment (Borthakur & Govind, 2019). The consequences are severe. Workers suffer from respiratory illnesses, neurological damage, skin diseases, and elevated blood levels of lead and cadmium (Shoukat et al., 2025; WHO, 2021).

India's E-Waste (Management) Rules, 2022 (MoEFCC, 2022) introduced an Extended Producer Responsibility (EPR) regime, requiring producers to register on the CPCB portal and ensure environmentally sound recycling. However, the rules lack provisions for funding recycling infrastructure (MoEFCC, 2025), and enforcement remains weak. The CPCB (2026) reported that 17 states and union territories lack adequate e-recycling facilities, 21 states do not maintain proper records of inter-state e-waste transport, and 27 states reported no informal e-waste activities during inspections – a likely undercount given the sector's prevalence. There is an urgent need to integrate informal workers into formal, safe, and socially inclusive recycling systems (Borthakur & Govind, 2019; CPCB, 2026).

1.2 The Urban Governance Gap

India's medium-sized cities occupy a complex and often overlooked position in the e-waste management landscape. Unlike major metropolitan centres such as Delhi, Mumbai, Bengaluru, and Chennai – which have attracted some formal recycling investments and policy attention – second- and third-tier cities generally lack dedicated e-waste management facilities (Garlapati, 2016; Dutta & Goel, 2021). Instead, municipal solid waste (MSW) systems remain the primary focus, with hazardous waste streams like e-waste treated as an additional problem to be accommodated within existing collection frameworks (Borthakur & Govind, 2017; CPCB, 2020). Nevertheless, the consumption of electronic devices in these cities is rising rapidly. Nationwide, over 65% of India's e-waste is generated by tier-2 and tier-3 cities, a share that is projected to increase as digital access expands beyond metropolitan areas (ASSOCHAM-EY, 2018; Economic Times, 2019). Consequently, these cities are producing substantial volumes of e-waste, almost all of which flows into informal channels (Sengupta et al., 2023).

Rewa, located in northeastern Madhya Pradesh, is a city of approximately 250,000 people (Census of India, 2011), a population that has since grown, placing it firmly within India's category of medium-sized urban centres. Rewa presents an important case for examining how formal solid waste infrastructure intersects with the informal e-waste economy. Recently, the city implemented a comprehensive MSW management system under a twenty-year public-private partnership (PPP) with Re Sustainability Limited (formerly Ramky Enviro Engineers), one of Asia's leading integrated waste management companies (Re Sustainability, 2024; Times of India, 2024a). This system includes source-level waste segregation, three transfer hubs, and a 6 MW waste-to-energy (WtE) plant at Pahadia (Re Sustainability, 2024; CPCB, 2025). The Pahadia facility is designed to process 400 tonnes per day of mixed solid waste and generate approximately 6 MW of electricity (Re Sustainability, 2024; Times of India, 2024b).

Critically, however, it has not yet been systematically studied how this formal arrangement handles e-waste specifically, nor how it connects with the already-existing informal sector. This gap is significant because the informal sector handles over 90% of India's e-waste nationally (Sengupta et al., 2023; CPCB, 2020). Without deliberate integration, formal-sector interventions risk bypassing – or even undermining – the livelihoods of millions of informal waste workers, many of whom depend on e-waste for their income (Wilson et al., 2012; Nair & Kaushik, 2021). Understanding these dynamics in Rewa could offer scalable lessons for other medium-sized Indian cities facing similar challenges.

1.3 Research Objectives

This study had three main objectives:

1. To document the formal e-waste collection, segregation, processing, and disposal mechanisms are operating under Rewa's municipal solid waste system.
2. To study the informal e-waste management practices adopted by scrap dealers, repair shops, computer vendors, and brand showrooms, including material flows, pricing structures, and final destinations.
3. To identify the gaps and lack of integration between the formal and informal systems, and to present evidence-based policy suggestions that can make these parallel systems more integrated and more sustainable

II. METHODOLOGY

The fieldwork was conducted in Rewa, Madhya Pradesh, across three days in July 2025. Rewa is the administrative headquarters of Rewa District, situated approximately 130 kilometres northeast of Allahabad (now Prayagraj). The city is divided into forty-five municipal wards and has a growing middle-class

population with increasing access to consumer electronics, including televisions, computers, mobile phones, and home appliances. The municipal solid waste management system is operated by Nagar Nigam Rewa in partnership with Asia Resil Resustainability Limited under a contract signed in 2020.

2.1 Site Selection and Sampling

A purposive sampling strategy was employed to capture the full spectrum of e-waste handling actors. Twelve sites were selected based on information from municipal officials and local informants, representing four categories of actors. The first category comprised formal municipal infrastructure, specifically the Municipal Solid Waste Collection and Transport Hub at PTS Chauraha. The second category consisted of informal scrap dealers, including Nannu Kabadi at Dhobiya Tanki (identified as the city's largest scrap dealer), Phalak Traders in Nipaniya, and Kalim Traders in Nipaniya. The third category included electronic repair shops and computer vendors, selected from Shilpi Plaza (Latef Service Center for televisions, New Aditya Infotech for computers, New Sonu Mobile Repairing Center for mobile phones) and the Ramagobind area (Expert Computers, Aditya Computers, Computer Solution), plus Techno Park, a specialised television board trader. The fourth category comprised brand-authorised showrooms, including Croma on APS Road, Sony Showroom, and the Lenovo Service Center on Allahabad Road.

2.2 Data Collection Methods

Data were collected through three complementary methods. Direct observation was employed at each site to document physical infrastructure, waste segregation practices, storage conditions, and worker activities, with photographic documentation captured using a digital camera. Semi-structured interviews were conducted with key informants, including Mr. Mukesh Pratap Singh (Operations In-Charge at the MSW Transport Hub), Mr. Nannu Kabadi (the principal scrap dealer), repair technicians and shop owners at each of the repair and computer shops, and showroom staff at the three brand locations. Interviews explored sources of e-waste, volumes handled, prices received, buyer identities, disposal methods for non-recyclable components, and awareness of regulations. Pricing data were recorded for specific e-waste categories, including motherboards, RAM modules, hard disks, batteries, and complete television sets. Finally, material flow mapping was constructed by triangulating interview data across multiple actors to trace the movement of e-waste from household generation through intermediate handlers to final destinations.

2.3 Data Analysis

Qualitative data from interview transcripts and observation notes were analysed using thematic analysis, with themes derived both deductively from the research objectives and inductively from emergent patterns. Quantitative data on prices and volumes were compiled into comparative tables. Material flow pathways were visualised as network diagrams. Triangulation was achieved by cross-verifying information from multiple sources – for example, comparing repair shop accounts of buyer identity and frequency with scrap dealer accounts of sourcing patterns.

2.4 Ethical Considerations

All informants participated voluntarily after receiving an explanation of the research purpose. Where informants requested anonymity, this has been respected by omitting identifying details. No sensitive personal information was collected. The research received institutional approval from APS University, Rewa, as part of the author's academic fieldwork requirement.

III. RESULTS

The formal waste management system operating in Rewa represents a substantial public investment in infrastructure and institutional capacity. The city deploys sixty-three collection vehicles, each divided into four compartments with a total capacity of one metric ton. These compartments are designated for dry waste (paper and plastics), wet waste (biodegradable kitchen waste), hazardous waste (including e-waste and biomedical waste), and sanitary waste (compostable materials). This source-level segregation model, implemented through door-to-door collection across all forty-five wards, is a critical enabler of downstream processing efficiency.\

Collected waste is transported to one of three secondary storage and sorting hubs located at PTS Chauraha, Saman Naka, and Manas Bhawan. Each hub has a designed handling capacity of approximately 150 metric tons daily, though actual throughput varies. The hubs function as transfer stations where waste is consolidated, further sorted, and then forwarded to the central processing facility at Pahadia. According to Mr. Mukesh Pratap Singh, the Operations In-Charge interviewed at the PTS Chauraha hub, the system processes approximately ninety metric tons of waste daily across all fractions.

The Pahadia plant is configured as a waste-to-energy facility, meaning that suitable waste materials – primarily dry, non-recyclable fractions with adequate calorific value – are converted into usable energy rather than being landfilled. For e-waste specifically, the formal system's role is currently limited to identification and separation of hazardous electronic items at the source and hub levels. Once separated, e-waste is stored temporarily and then sent to authorised recyclers; interview data did not specify which recyclers or what proportion of separated e-waste actually reaches them. The plant also handles toxic e-waste components such as wires, motherboards, and medical electronic devices, ensuring that these materials do not enter the general waste stream destined for landfills.

A notable strength of Rewa's formal system is its public awareness infrastructure. An Information, Education, and Communication campaign, delivered through door-to-door outreach, community workshops, and informational leaflets, aims to educate residents about proper segregation practices, the environmental importance of recycling, and safe disposal methods for hazardous materials. This campaign, which also operates in neighbouring Satna, represents a recognition that technical infrastructure alone is insufficient without household-level behavioural change.

The entire system operates under a twenty-year public-private partnership contract between Nagar Nigam Rewa and Asia Resil Resustainability Limited, signed in 2020. This long-term arrangement provides financial predictability and enables strategic planning, including the phased deployment of new technologies and workforce training programmes. According to municipal sources, this model has inspired similar initiatives elsewhere in the region.

3.2 Informal E-Waste Handling by Scrap Dealers

The informal sector in Rewa operates as a tiered network of scrap collectors and dealers. At the base of this network are itinerant collectors, known locally as theliya walas, who travel through residential areas using handcarts or cycle rickshaws to purchase discarded items directly from households. These collectors aggregate small quantities of e-waste along with other recyclables such as paper, plastic bottles, and metal scrap, and then sell to larger dealers. Nannu Kabadi, operating from Dhobiya Tanki on PTS Road, is the largest scrap dealer in Rewa. During the interview, Mr. Nannu explained that his e-waste supply comes primarily from these itinerant collectors, who gather items including old television parts, PC plastic components, wires and cables, motherboards, broken mobile phones, chargers and adapters, laptop

components, keyboards, damaged remote controls, printer cartridges, electronic toys, and compact discs. He estimated collecting approximately seventy to eighty kilograms of e-waste monthly. Every two months, this accumulated stock is sold in bulk to wholesale markets in Delhi's PVC Market, where it is either dismantled for component recovery or shipped to recycling facilities, largely unregulated.

Two additional scrap dealers operating in the Nipaniya area were also surveyed. Phalak Traders, a medium-scale operation, collects waste from roadside vendors and specialises in paper, magazines, plastic bottles, and cardboard boxes from refrigerators and televisions. Plastic bottles fetch ten rupees per kilogram; refrigerator and TV boxes bring twelve rupees per kilogram. The owner reported selling to buyers in Satna (specifically to factories in Sajjanpur) or Delhi, depending on prevailing market rates, and typically waits until accumulating twenty-five to thirty quintals (2.5 to 3 metric tons) of stock before selling. Kalim Traders is a larger operation equipped with a plastic pressing machine that compresses plastic bottles into dense bales for transport. This dealer collects paper, plastic, and iron, and sends consolidated shipments to Delhi and Indore after accumulating approximately sixty metric tons, a process taking three to six months.

Notably, none of these scrap dealers maintained any written records of e-waste transactions, nor could they identify whether the ultimate buyers of their materials hold authorisation under India's E-Waste (Management) Rules. Pricing was determined orally based on current market conditions in Delhi, with no quality grading or environmental compliance costs factored into the price.

3.3 Electronic Repair Shops: Reuse as the First Line of E-Waste Management

The three repair shops surveyed at Shilpi Plaza demonstrated that substantial e-waste diversion occurs through component-level reuse before any material is declared waste. This finding challenges the linear narrative of disposal: a significant portion of what might be counted as e-waste is, in practice, reintegrated into working devices.

At Latef Service Center, a television repair shop, the technician reported that when a non-functional television is brought for service, functional components are extracted from the damaged unit and retained as spare parts. Commonly reused components from television motherboards include capacitors, transistors, integrated circuits, diodes, fuses, display connectors, and power modules. These parts are subsequently installed in other televisions brought for repair, effectively extending the useful life of both the donor and recipient devices. The shop repairs approximately fifteen to twenty televisions monthly, with four to six parts reused per device. For components beyond repair, the shop previously sold to a local collector named Javed, but this channel no longer operates. Currently, agents from Delhi visit the shop every three to six months to purchase non-working motherboards and other components at rates of ten to fifteen rupees per motherboard. Plastic television casings, which have no resale value, are disposed of in the municipal garbage vehicle that passes daily.

New Aditya Infotech, a computer repair shop, follows a similar model. Technicians extract reusable components from damaged desktop and laptop motherboards, including RAM modules, complementary metal-oxide-semiconductor (CMOS) batteries, heat sinks, capacitors, resistors, hard disks, and integrated circuit chips such as the BIOS IC and South Bridge. These components are tested and reinstalled in other systems. The shop repairs approximately twenty-five to thirty computers monthly, with five to eight parts reused per device. Non-working motherboards and other defective components are sold to Delhi-based agents at approximately 150 rupees per motherboard – a higher price than television motherboards due to the higher copper content and trace gold plating on some integrated circuit contacts. Buyers visit every three to six months.

New Sonu Mobile Repairing Center handles a larger volume of devices, repairing forty to fifty mobile phones monthly, with six to nine parts reused per device. Reusable components extracted from damaged mobile phones include power integrated circuits, network integrated circuits, light integrated circuits, display screens, batteries, speakers, microphones, and charging ports. If the central processing unit or main controller is completely destroyed, the motherboard is classified as dead and not reused. Remaining usable parts are harvested for other repairs. Damaged batteries and display units are sold to Delhi agents at a rate of two hundred rupees per kilogram, while RAM and other high-value components are sold at varying rates. Across all three repair shops, a consistent pattern emerged: reusable components are systematically extracted and inventoried, residual e-waste is sold to out-of-state buyers, and non-recoverable plastics are discarded into municipal garbage. No shop maintained a register of e-waste transactions, and none had received any training on safe e-waste handling or storage.

3.4 Computer Shops and Specialised Traders

In the Ramagobind area, three computer shops provided additional data on e-waste volumes and pricing. Expert Computers sells its e-waste within three to five days to itinerant scrap collectors who travel by bicycle or motorcycle. Monthly e-waste generation is approximately fifteen to twenty kilograms, with motherboards fetching 120 to 150 rupees each and RAM modules ten to fifteen rupees each. Dead printers or laptops are returned to the customer if requested; otherwise, they are sold to the same collectors. Aditya Computers follows a two-stage process, reusable components are extracted first, and fully dead items are then sold to local scrap dealers at prices ranging from five to one hundred rupees depending on condition. Computer Solution reported selling e-waste weekly to a network of cycle-based collectors originating from the Amahiya, Badi Garga and Darga neighbourhoods. Their reported rates included 150 rupees per battery, sixty rupees per hard disk, ten to fifteen rupees per RAM module, and eighty to one hundred rupees per motherboard. Techno Park represents a specialised niche within the informal ecosystem, a trader dealing exclusively in dead television graphic motherboards. The owner reported selling fifty to sixty large dead television graphic boards every three months.

Pricing varies by brand and specifications: regular graphic boards sell for 300 to 350 rupees each, while Samsung, Sony, and LG boards command 500 to 550 rupees each. Complete dead television sets are also traded – a thirty-two-inch set brings 2,000 to 2,500 rupees, and a forty-three-inch set brings 3,500 rupees. All stock is sold to agents from Lajpat Nagar, Delhi.

3.5 Brand Showrooms: Formal Sector Compliance

The three brand-authorised showrooms surveyed operate entirely outside the informal e-waste network. Croma on APS Road does not perform any local repairs; defective items including televisions, air conditioners, laptops, and mobile phones are sent to brand-specific service centres in Lucknow, after which e-waste is returned to the company's central warehouse. The Sony Showroom similarly sends defective products to Sony service centres located either within the city or outstation, with no local disposal or resale. The Lenovo Service Center on Allahabad Road sends all e-waste to the Lenovo service centre in Jabalpur and strictly prohibits sale to local scrap dealers. These showrooms thus represent a parallel formal channel that bypasses Rewa's local e-waste economy entirely. While this ensures compliance with corporate environmental policies and national regulations, it also means that valuable materials are exported from the city without any local value addition or employment generation in recycling activities.

3.6 Material Flow Synthesis

Integrating the data from all sources, a coherent material flow map emerges. Household e-waste enters one of three pathways. In the first pathway, items that are still functional or repairable are sold directly to itinerant collectors or taken to repair shops. Repair shops extract reusable components, reintegrating them into other devices, and sell the residual non-repairable boards and components to Delhi-based agents either directly or through intermediate scrap dealers. In the second pathway, items that are not taken to repair shops are sold by households to itinerant collectors, who aggregate materials and sell upward to larger scrap dealers such as Nannu Kabadi, Phalak Traders or Kalim Traders. These dealers then consolidate and ship to wholesale markets in Delhi, Indore, or Satna. In the third pathway, items purchased from brand showrooms are returned through authorised service centre networks to company warehouses in Lucknow, Jabalpur, or other cities, entirely outside the local informal network.

Plastic components from all informal pathways ultimately enter the municipal solid waste stream, either through direct disposal by households or through repair shops discarding casings into garbage vehicles. No plastic from informal e-waste handling was reported as being sent for recycling..

IV. Discussion : The Dual System as Institutional Reality

The findings confirm that Rewa operates a de facto dual system of e-waste management. The formal system, while impressive in its coverage of municipal solid waste and its waste-to-energy capability, handles e-waste only incidentally as part of the hazardous waste fraction. It lacks dedicated e-waste collection points, specialised dismantling capacity, and public awareness messaging specific to electronics disposal. The informal system, by contrast, is robust, responsive to market signals, and achieves significant material recovery at near-zero public cost, but operates without environmental safeguards, worker protection, or regulatory oversight. This dualism is not unique to Rewa; it characterises e-waste management across most of India. However, Rewa's case is distinctive because the formal system is comparatively well-developed for a city of its size, yet remains disconnected from the informal actors who handle the majority of e-waste. The twenty-year PPP contract, while successful for mixed waste, appears to have no provisions for integrating or formalising the existing scrap dealer and repair shop networks. This represents a missed opportunity for synergy.

4.1 Environmental and Health Implications of Informal Handling

The informal practices documented in this study carry significant environmental and health risks that were not directly observed but can be inferred from the literature on similar informal recycling contexts. When scrap dealers in Delhi's PVC Market or Lajpat Nagar receive motherboards and other e-waste from Rewa, they typically dismantle them using hand tools, often on open ground. Valuable metals are recovered by burning wires to remove insulation a process that releases dioxins, furans, and other persistent organic pollutants. Acid baths are used to strip gold and silver from circuit boards, generating toxic liquid effluents that are often discharged into drains or open land. Workers, including children, perform these tasks without gloves, masks, or ventilation, leading to elevated blood levels of lead, cadmium, and other heavy metals (Shoukat et al., 2025; WHO, 2021). The plastic casings discarded into Rewa's municipal garbage represent a different but equally problematic hazard. When these plastics reach landfills or are burned in open dumps, they release brominated flame retardants and other additives that bioaccumulate in the environment. The fact that repair shops and households perceive no alternative to this disposal pathway indicates a critical infrastructure gap.

4.2 Economic Rationality of Informal Actors

From an economic perspective, the behaviour of informal actors is entirely rational given existing incentives. Repair shop technicians maximise value by extracting reusable components before selling residuals. Scrap dealers' aggregate small volumes to achieve economies of scale in transport to distant markets. The price differentials observed fifteen rupees per television motherboard versus 150 rupees per computer motherboard reflect genuine differences in metal content and component value not arbitrary pricing. Computer motherboards contain more copper layers and more gold-plated contacts than television motherboards, justifying the higher price. The frequency of buyer visits (every three to six months across most shops) suggests that Rewa's e-waste volume, while substantial, does not justify more frequent collection by Delhi-based agents. This creates an opportunity for a local intermediary who could aggregate e-waste continuously and arrange more efficient transport, potentially capturing some of the margin currently lost to transaction costs.

4.3 Disconnect Between Formal and Informal Systems

Several specific disconnections between formal and informal systems were identified. First, no mechanism exists for informal actors to sell e-waste to the formal system. Scrap dealers and repair shops have no relationship with Asia Resil Resustainability Limited or the Pahadia plant. Second, no training or certification programme enables informal workers to transition to formal employment. Third, municipal awareness campaigns do not address e-waste specifically or inform residents about where to take electronics for safe disposal. Fourth, the twenty-year PPP contract lacks any performance indicators related to e-waste collection or informal sector integration. These disconnections are not inevitable; they reflect policy choices that can be revised.

4.4 Comparison with National and International Best Practices

India's E-Waste (Management) Rules, 2022 (MoEFCC, 2022) mandate extended producer responsibility, requiring manufacturers to establish collection systems and finance recycling. In practice, however, producer responsibility organisations have focused on large urban centres, leaving cities like Rewa underserved. International best practices offer models for integration. Germany's dual system combines mandatory producer-funded collection points with public drop-off centres, achieving collection rates above 45% (Sinha-Khetriwal et al., 2020). Japan's Home Appliance Recycling Law requires retailers to take back used appliances (Yoshida et al., 2021), a model that could be adapted for brand showrooms in Rewa. Closer to home, the city of Pune has experimented with registering informal scrap collectors as "eco-workers" and providing them with identity cards, training, and access to formal recyclers (Nair & Kaushik, 2021). Rewa could adapt such models to its specific context.

V. Conclusion

This field investigation, conducted over three days in July 2025 in Rewa, Madhya Pradesh, offers a systematic mapping of e-waste material flows, pricing structures, and institutional arrangements in a mid-sized Indian city that has recently invested in formal waste management. The study reveals that Rewa operates a functionally complete yet institutionally fragmented e-waste system. The formal public-private partnership, though successful in managing municipal solid waste and converting waste to energy, addresses e-waste only as an afterthought. In contrast, the informal sector – comprising itinerant collectors, scrap dealers, repair shop technicians, and specialised traders – handles the vast majority of e-waste. Through component reuse and bulk aggregation, these informal actors achieve significant material recovery, selling to unregulated markets in Delhi, Indore, and Satna. However, this work is done without environmental safeguards, worker protection, regulatory compliance, or any documentation. Plastic components

consistently end up in municipal garbage streams, representing both a lost recycling opportunity and a genuine environmental hazard.

The coexistence of formal and informal systems in Rewa is not the problem. In fact, informal actors perform vital functions that the formal system currently does not. The real problem is the complete absence of integration between the two. With the right policy interventions – a dedicated e-waste collection centre, training programmes for informal workers, economic incentives to channel e-waste to authorised recyclers, and amendments to the existing PPP contract to include e-waste-specific targets – Rewa could transform its dual system into a model for other mid-sized Indian cities. Without these interventions, the current situation will only worsen: growing volumes of e-waste handled dangerously, material value lost to inefficient recycling, and the true costs of public health and environmental damage borne by the most vulnerable people.

VI. RECOMMENDATIONS

Establish a dedicated e-waste collection centre at the city level, operated in partnership with informal sector actors, to serve as a single drop-off point for households and small businesses. Develop a training and certification programme for informal workers (repair technicians, scrap dealers, itinerant collectors) on safe dismantling, storage, data sanitation, and environmental compliance. Create economic incentives such as deposit-refund schemes or voucher systems to encourage households to bring e-waste to authorised collection points rather than selling to unregulated itinerant collectors.

Amend the existing PPP contract with Asia Resil Resustainability Limited to include e-waste-specific performance targets, reporting requirements, and a formal channel for informal actors to sell e-waste to the formal system. Launch an e-waste-specific public awareness campaign (door-to-door, local media, leaflets) complementing the existing IEC campaign, informing residents about the hazards of informal disposal and the locations of collection centres. Pilot a producer responsibility organisation (PRO) model in Rewa, funded by brand showrooms (Croma, Sony, Lenovo), to finance local e-waste collection and recycling, drawing on successful models from Germany and Japan.

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