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RESEARCH ARTICLE

Participatory Action Research and the Circularity of Plastic: Supporting the Itinerant Waste Buyers in Banyuwangi, Indonesia

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Abstract

This paper explores the interaction between Participatory Action Research (PAR) and the Circular Economy (CE) through a study of itinerant waste buyers (IWBs) in Banyuwangi, Indonesia. Using PAR, which was operationalised through appreciative inquiry and cooperative inquiry, IWBs were engaged as co-researchers to co-create knowledge and strengthen plastic circularity practices. The findings show that PAR embeds recognition within CE at multiple levels: validating informal expertise in everyday recycling (micro), strengthening trust-based market relations (meso), and exposing structural gaps in policy and product design (macro). Empirically, co-designed interventions, such as improved weighing, storage, and communication, enhanced plastic collection, and modestly improved livelihoods. However, circularity remains constrained by the low value and material complexity of plastics, as well as unequal market and policy conditions. The study argues that CE is not purely technical but socially embedded and that PAR provides a critical pathway to align circular economy transitions with the knowledge, agency, and realities of informal waste workers.

Keywords Circular Economy · Plastic Recycling · Recognition · Itinerant Waste Buyers · Participatory Action Research

1. Introduction

The project examined in this paper brought together an interdisciplinary team of researchers from sociology, environmental engineering, and development studies, alongside participants from the informal waste sector identified as Itinerant Waste Buyers (IWBs[5]). The Incubation Network of SecondMuse funded the study as part of the Leakage and Livelihoods Project (2021). It uses a participatory approach to investigate the role of informal actors in plastic circularity. Specifically, this study addresses two main objectives. First, it investigates how a group of IWBs across multiple villages in Banyuwangi Regency engaged in Participatory Action Research (PAR) to enhance the collection and circulation of plastic waste. Second, it examines how PAR, as a methodological approach, interacts with and contributes to conceptualising the circular economy through the everyday practices of informal waste workers.

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[5] Itinerant Waste Buyers (IWBs) are multi-material family recycling businesses active in the plastics, paper/cardboard, metal, and glass recycling value chains (Simpson et al., 2025). They buy materials door-to-door from households and businesses. The IWB purchases recyclables of higher quality along with greater market value than those gathered by waste pickers (Khanal, 2021).

Informal recycling is increasingly acknowledged as one of the most immediate and effective responses to plastic pollution (C. A. Velis et al., 2022; Wilson et al., 2006). Current estimates suggest that the global informal waste and recycling workforce includes around 11.4 million individuals (Lau et al., 2020), while earlier assessments placed this number between 12.5 and 56 million (Stuchtey et al., 2016). Despite operating outside formal systems, these actors play a central role in recovering recyclable materials, particularly plastics, through practices that are both economically viable and operationally efficient within constrained environments. Their contribution is especially significant in low- and middle-income countries, where formal waste management infrastructure is often insufficient, resulting in a high risk of waste leakage into the environment (C. A. Velis et al., 2022). The Indonesian context clearly reflects the importance of these dynamics. Estimates indicate that between 2015 and 2019, Indonesia accounted for approximately 10.1% of global marine plastic leakage (Sari et al., 2021). As the largest archipelagic country in the world, Indonesia faces distinct logistical and infrastructural challenges in managing waste flows across dispersed islands (Vitasari et al., 2024), increasing the likelihood of plastics entering waterways and ultimately the ocean. These conditions emphasise the need to better understand and strengthen the contributions of informal recycling systems within national efforts to reduce plastic pollution.

Despite growing recognition of the informal recycling sector in addressing plastic pollution (Cook et al., 2024), existing research has largely focused on waste pickers working in the dumpsite (Dias, 2016; Koroma et al., 2025), often overlooking other key actors such as itinerant waste buyers (IWBs), whose roles are more embedded in market-based transactions and material aggregation. This bias reflects a broader tendency to prioritise visibly marginalised groups (Wilson et al., 2006), while underexamining enterprise-oriented actors within informal systems who operate across dispersed networks and contribute significantly to material circulation. At the same time, while the circular economy literature increasingly acknowledges the importance of inclusivity (Nurrohman et al., 2025; Pál, 2022), it remains predominantly conceptual and policy-driven, with limited empirical attention to how participatory methodologies can actively enable more just and context-sensitive transitions. In this context, the potential of Participatory Action Research (PAR), operationalised through Appreciative Inquiry (AI) and Cooperative Inquiry (CI), remains underexplored. This study points to a critical gap: despite the recognised importance of informal recycling, circular economy frameworks remain insufficiently grounded in the lived practices of under-researched actors such as IWBs and lack participatory approaches to meaningfully integrate their knowledge, agency, and contributions into plastic circularity systems. By focusing on strengths, existing practices, and future possibilities, AI shifts attention from problem-solving to capacity-building, while CI facilitates iterative cycles of collective action and reflection among participants. Addressing these gaps, this study centres IWBs as an under-researched yet critical group and examines how PAR, through AI and CI, can function not only as a research methodology but also as an enabling approach to advance circular economy practices grounded in the lived experiences, knowledge, and agency of informal waste workers.

The structure of this paper consists of seven main sections. Section 1 is the introduction of the paper, where this part is elaborated to introduce the reader to the issues of study to be presented in this paper. Section 2 describes participatory action research (PAR) and how it engages with the literature of the circular economy. Section 3 is the background of the project, which covers details on waste management conditions in Banyuwangi Regency, project funding, stakeholders involved, and the timeline of the projects. Section 4 reveals the positionality of both researchers and participants. Section 5 explains the research methods used in this study within the context of PAR. Section 6 explores the findings of the research, while Section 7 discusses the researchers' reflection on the findings and the process in which PAR interacts with the co-creation of knowledge around the informal sector of plastic waste management and the broader circular economy concept across different levels. Finally, Section 8 includes a conclusion and recommendations for future research.

2. Circular Economy and PAR

Kirchherr et al. (2017) define the circular economy (CE) as an economic system that replaces the "end-of-life" concept with strategies of reducing, reusing, recycling, and recovering materials across production, distribution, and consumption processes. CE operates across multiple scales: at the microlevel of firms and consumers, the mesolevel of eco-industrial parks and inter-organisational networks, and the macrolevel of cities, regions, and nations. Its overarching objective is sustainable development, integrating environmental

integrity, economic prosperity, and social equity for present and future generations. According to Ritter et al. (2024), CE is increasingly framed not merely as supportive of sustainability but as a prerequisite for it, as it represents an economic system most closely aligned with sustainability principles, particularly through resource efficiency, waste minimisation, and stakeholder engagement (Garcia-Saravia Ortiz-de-Montellano et al., 2023; Geissdoerfer et al., 2017). The Ellen MacArthur Foundation (2013) further advances this perspective by describing CE as restorative and regenerative by design, promoting renewable energy transitions, eliminating hazardous substances that obstruct reuse cycles, and minimising waste through improved materials, products, systems, and business models. While these conceptualisations emphasise environmental and economic transformation, they also implicitly require social transformation, particularly regarding who participates in and benefits from circular transitions.

Kirchherr (2021) further argues that recognition is the first step toward achieving a socially sustainable and just transition within the circular economy. However, recognition must extend beyond the formal inclusion of stakeholders in policy rhetoric; it must be embedded in the relational and institutional structures that shape transition processes, such as fostering collaborative partnerships and ensuring equitable access to resources and decision-making power. Based on Honneth's theory of recognition, this process entails more than cognitively acknowledging individuals' presence (Honneth, 2014). Recognition also involves emotionally affirming individuals as possessing intrinsic worth and as contributing value to social institutions (Billund & Nørgård Dahl, 2021). In this sense, recognition is both affective and normative, forming a precondition for justice and self-realisation. Schibbye (1993) contends that recognition necessitates encountering the other as a subject, meaning engaging with them as a complete individual whose experiences and viewpoints warrant serious consideration. Such recognition can only occur within a subject–subject relationship rather than a traditional subject–object dynamic. This relational reorientation is central to Participatory Action Research (PAR). As Heron and Reason (1997) emphasise, action research is conducted *with* practitioners rather than *on* them, challenging hierarchical distinctions between the researcher and the researched. It is development-oriented and grounded in the normative commitment that knowledge production should contribute to freer and more democratic forms of social organisation. Reason and Bradbury (2013) similarly conceptualise action research as a participatory and democratic process that integrates action and reflection, theory and practice, in pursuit of worthwhile human purposes and community flourishing.

Accordingly, PAR operationalises recognition within circular economy transitions by institutionalising subject–subject relations, shared knowledge creation, and collective agency. For IWBs, informal waste workers who already enact circular practices through material recovery but often remain socially and economically marginalised, this combined framework foregrounds their role not as peripheral beneficiaries of CE policy but as knowledgeable actors whose recognition and participation are essential to a just circular transition. Section 5 elaborates on how PAR is operationalised in this study in more details.

3. Context: Banyuwangi Regency waste management and background to project

Banyuwangi Regency, located in East Java, Indonesia, generates approximately 852 tonnes of waste per day according to its Waste Management Master Plan. Of this total, only about 22% is formally collected and transported to landfill, while the remaining 78% remains unmanaged and contributes to environmental pollution (CLOCC, 2023). Within the managed fraction, 19% is handled through government-supported facilities, including 21 TPS 3R (3R Waste Management Site) units and one landfill, while an estimated 3% is managed by the informal sector. Institutionally, the Environmental Agency is responsible for waste services in urban areas and designated zones, whereas waste management in rural villages is largely delegated to village authorities, private actors, and informal systems. This fragmented arrangement underscores the significant, nonetheless often underrecognised, role of informal actors in local waste management.

Picture 1. Banyuwangi landfill operation (2021). *Source: Authors*

Picture 2. TPS 3R (3R Waste Management Site) operation in Tembokrejo village, Banyuwangi (2021). *Source: Authors*

Against this backdrop, the project presented in this study was developed as an extension of the Clean Oceans through Clean Communities (CLOCC) initiative, financed by the Norwegian Solid Waste Association (Sirk Norge, formerly Avfall Norge) and implemented by the Indonesian Solid Waste Association (InSWA) in collaboration with the International Solid Waste Association (ISWA) (*CLOCC*, n.d.). Building on CLOCC's emphasis on participatory and locally grounded approaches, the project received additional support in 2021 from the Leakage and Livelihoods (L&L) initiative under The Incubation Network (TIN) by SecondMuse, which promotes circularity in the plastics value chain. Within this framework, the IWBs as under-researched actors were engaged through PAR, which was operationalised through Appreciative Inquiry (AI) and Cooperative Inquiry (CI). The approach focuses on strengthening existing practices through iterative cycles of action and reflection, enabling a more profound understanding of IWBs' business models, market relations, and operational constraints while identifying context-specific pathways to enhance plastic circularity and livelihoods. The research was conducted from November 2021 to November 2022, with further methodological details provided in Section 5.

4. The researchers and co-researchers

The research team comprised an international specialist, an Indonesian non-Banyuwangi project officer, an administrator and manager, and five Banyuwangi-based field researchers. While the international specialist and non-Banyuwangi researchers brought methodological expertise, institutional authority, and access to project resources, the Banyuwangi researchers contributed contextual knowledge, local networks, and linguistic fluency in Osing, the primary language used in interactions with the local informal waste workers. This distinction shaped the dynamics of the study: non-Banyuwangi researchers held greater influence over research design and resource allocation, whereas local Banyuwangi researchers played a crucial role in building trust and facilitating communication. Power within the research process was therefore distributed and relational, shifting across roles and phases rather than residing with a single group.

The co-researchers consisted of ten IWBs from seven villages, selected based on their experience and engagement within the CLOCC project area. Unlike waste pickers, IWBs operate through purchasing and aggregating recyclables across dispersed locations, positioning them as market-oriented actors within the informal sector. Their activities extend beyond village boundaries, reflecting flexible and networked collection practices shaped by access to materials, capital, and buyers.

All co-researchers were male and worked within family-based enterprises, where labour was gendered but interdependent. Men were primarily responsible for collection, transport, and transactions, reinforcing their recognition as primary earners. Women, usually wives or daughters, did sorting, cleaning, and storage, which

were important for the quality and saleability of the materials, but were often seen as supportive rather than economic contributions. During the study, the majority of the IWBs were senior individuals aged between 40 and 60 years, with only one participant aged 37 years. In 2023, one year after the research concluded, one of the IWBs passed away due to chronic illness.

5. Methodology and methods of inquiry

This research adheres to Participatory Action Research (PAR) as its grounding methodology. According to PAR, the objective of social research is straightforward: to improve social practice (Brydon-Miller et al., 2003). PAR, as an ongoing process, acknowledges that theory is only beneficial when applied to practices that aim to achieve positive social change. This action research aimed to achieve positive social changes by reducing plastic pollution leakage and improving the livelihoods of the people, which aligns with the values and personal commitments of all individuals involved. As such, this study based its research on the experiences of the researchers and participants in a process called appreciative inquiry (AI). Within the AI process, it is more important to articulate and amplify the positive qualities of a situation rather than identify problems and try to solve them (Reason & Bradbury, 2001). It seeks to understand the current situation; it uses hopeful and affirmative language to emphasise the "not yet" and build capacity and momentum to innovate accordingly (Graham, 2013). This study uses AI to learn how IWBs work, what they have done to reduce plastic leaks into the ocean, and how to enhance their livelihoods.

Additionally, this study combines AI with co-operative inquiry (CI) to engage participants in repeated cycles of action and reflection to address concerns of immediate and substantial importance to their lives, thereby facilitating positive social transformation (Wicks & Reason, 2009). Through the CI process, the researchers attempt to co-create knowledge and do research *with* the co-researchers (Howard et al., 2022). As such, the IWBs in this study are acknowledged as co-researchers, as subjects rather than objects of study. Furthermore, the repetitive cycles resemble the concept of Circular Economy (CE), which operates on multiple scales. As explained in Section 2, CE should commence with recognition that transcends the formal and encompasses relational and institutional dimensions. Consequently, before initiating iterative cycles, it is imperative to establish a communicative space between researchers and participants, either by gaining access to the relevant communities or by fostering legitimacy and the capacity to convene. In essence, this study adopts PAR as its overarching methodology, operationalised through iterative CI cycles and guided by an AI lens to co-create strength-based solutions with IWBs. Figure 1 below illustrates how the PAR, AI, and CI are used in this study.

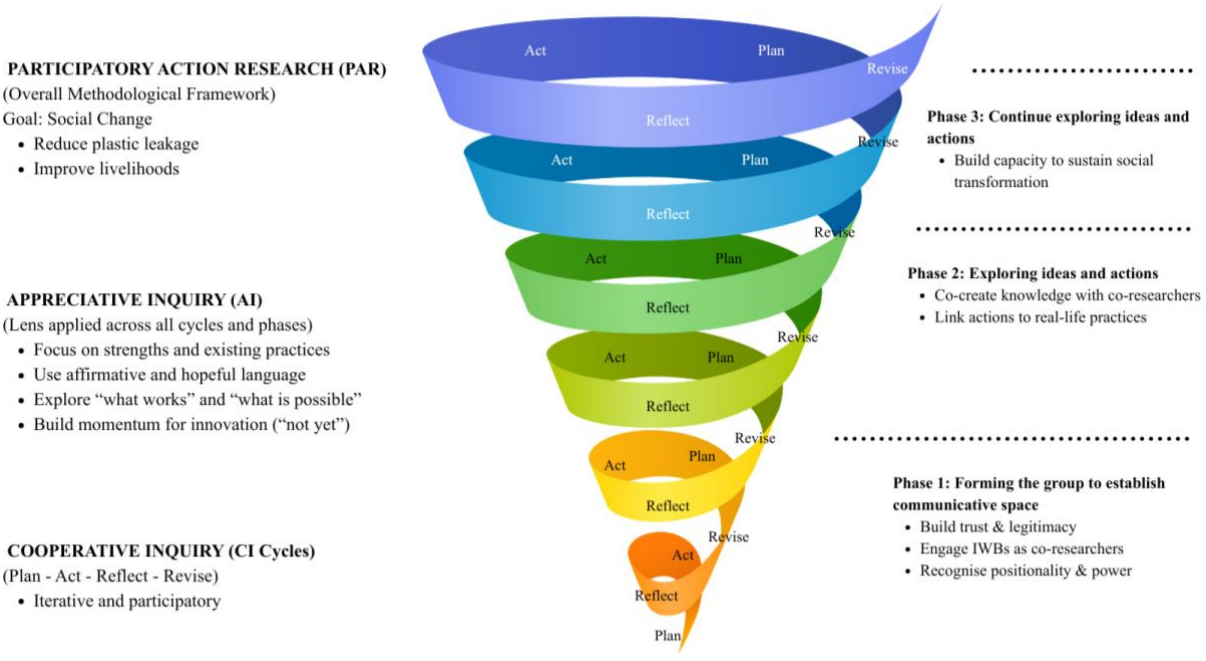

Figure 1. The relationship between PAR, AI, and CI in the study. Source: Authors

Across these phases, data collection was conducted through sustained and iterative engagement with co-researchers. In total, approximately 20 in-depth interviews were carried out, with each IWB participating in at least two rounds and additional interviews conducted when further clarification or follow-up was required. These were complemented by a minimum of six focus group discussions and two large group meetings involving all co-researchers and, in some cases, their family members. To strengthen the analytical rigour of this study, the data generated through interviews, focus group discussions, and field observations were analysed using a combination of narrative and thematic analysis. The analysis followed an iterative process aligned with the cycles of PAR. First, detailed field notes and meeting records were reviewed and arranged chronologically to capture the evolution of practices and reflections across phases. Second, recurring patterns were identified inductively, concentrating on principal themes such as material constraints, market relationships, operational changes, and livelihood impacts. These themes were not pre-defined but emerged through repeated engagement with the data and were continuously refined through discussions among the research team. Third, these empirically derived themes were interpreted in relation to the existing literature on the circular economy, informal recycling, and labour-material relations, enabling a shift from descriptive reporting to an analytical explanation. Particular attention was given to identifying not only reported improvements but also constraints, tensions, and variations across participants. While the study does not aim to establish causal relationships due to the absence of a control group and the context-specific nature of PAR, the analysis seeks to provide theoretically informed insights into the mechanisms through which changes occurred.

5.1. Phase 1: Identifying co-researchers (November 2021 – January 2022)

In this phase, researchers played a central and dominant role in defining participation, setting criteria, and determining the direction of engagement. Two main entry points were used to identify potential participants. First, village leaders affiliated with the CLOCC project proposed informal waste workers through existing memoranda of understanding. Second, researchers conducted field visits to dumpsites to introduce the study and identify additional candidates. Researchers then assessed potential participants and established two key selection criteria: a minimum of two years of experience in the recycling sector and a clear understanding of the types and quantities of materials handled. These criteria were intended to ensure participants had stable, pre-COVID19 pandemic engagement in the sector and sufficient operational knowledge. Based on these considerations, and with the intention of involving IWBs from the outset as central actors in the study, waste pickers were excluded, and the focus was placed on itinerant waste buyers (IWBs), who demonstrated stronger market-based experience and material expertise.

Field observations and in-depth interviews were used to further understand candidates' business practices. Researchers were also transparent about participation requirements, including sharing business information and engaging in group discussions, which candidates could accept or decline. This process resulted in the selection of ten IWBs from early December 2021 to early January 2022, who subsequently became co-researchers in the study.

5.2. Phase 2: Exploring ideas and actions (January - February 2022)

Between January and February 2022, researchers and co-researchers engaged in a series of six focus group discussions to explore the guiding question of who are we, what we do, and how each of us can participate in this group. The co-researchers held these discussions in their neighbourhoods to create a familiar setting and gradually prepare participants for larger collective meetings. Each session involved six to eight participants, including researchers, co-researchers and one of their family members, reflecting the household-based nature of their work. The purpose of this phase was to build confidence among co-researchers to engage in dialogue, question one another, and articulate diverse perspectives on their business practices. Researchers facilitated these discussions by encouraging open exchange and supporting participants to express their views more independently.

Through these iterative conversations, the initial focus on reducing plastic leakage evolved into a more grounded inquiry centred on improving livelihoods, which the co-researchers articulated as increasing the collection of recyclable plastics. By early February 2022, data had been generated on business models, gendered divisions of labour, collection areas, and logistical capacities, such as storage, transportation, and buyer relationships. Researchers synthesised these insights into individual action plans, which were presented

and discussed with co-researchers and their families during a collective meeting on 10 February 2022. In this phase, the role of researchers shifted towards facilitation, while co-researchers became increasingly central in shaping the direction of inquiry, generating data, and defining practical actions to be implemented in the subsequent phase.

5.3. Phase 3: Continuing action and reflection (March – November 2022)

The transition between the second and third phases was fluid, as both involved iterative cycles of action and reflection. For analytical clarity, this phase is marked by the collective meeting on 10 February 2022, where individual action plans were presented and further developed. During this meeting, participants were divided into two gender-based subgroups. The husband-and-son group discussed strategies related to cooperative marketing, digital value chain applications, collective sales arrangements, and business formalisation. The wife-and-daughter group focused on identifying tools and support needed to improve sorting, cleaning, and storage practices. These discussions provided insights that informed a subsequent meeting on 30 March 2022, where we delivered tailored support to each co-researcher. Following these discussions, co-researchers were introduced to their respective village leaders to formalise agreements for recording daily quantities of recyclable materials collected and sold between May and November 2022. This monitoring process enabled the tracking of changes in plastic recovery over time. By April 2022, the non-Banyuwangi researcher had transitioned to another project site, while local researchers continued to facilitate communication and follow-up activities. In this phase, researchers primarily acted as facilitators and providers of targeted support, while co-researchers became the main actors in implementing actions, generating data, and advancing everyday practices of plastic circularity within their own operational contexts.

6. Research findings

6.1. Challenges to plastic circularity

Plastics, particularly plastic packaging, present significant inherent barriers to circularity. We (hereafter referred to as ‘researchers and co-researchers’) found that plastic packaging is often dirty, lightweight, and challenging to clean, process, and store, making it unattractive for recycling. Even after preprocessing, small packaging plastics frequently remain unmarketable. The lack of access to piped water for washing further compounds the difficulty, and the low economic value of these plastics discourages co-researchers from investing effort in their collection. Additionally, the scarcity of secure, dry, and adequate storage near their homes reduces motivation to capture and trade more plastics. The complex nature of low-value packaging, such as multi-layer packages, single-serving capsules, and foams, limits the recoverable value and increases processing and marketing costs. Contamination from residues like sugary drinks, oils, or chemicals attracts pests and makes handling unpleasant, while some chemical residues pose health risks to co-researchers and their families. Removing such contamination is time-consuming and often requires resources that are not readily available, reinforcing the material barriers to plastics’ circularity. Some specific issues that were discussed during the study include the inability to meet market specifications, transport/storage constraints, and opportunity cost for plastics that could be spent on more valuable or easier-to-recycle materials.

We acknowledge that the recyclability of plastics is determined not by producer claims but by globally determined specifications, in combination with what local buyers are willing to purchase and how much they are willing to pay. From this standpoint, improved preprocessing and temporary financial incentives from producers are insufficient to change the balance. We understand that it is burdensome for the co-researchers to handle such materials. The co-researchers, whose livelihoods depend on marketability, consistently favour commodities like cardboard, aluminium packaging, and metal, which are easier to process and offer higher returns.

6.2. Market relationships

We recognise that maintaining strong relationships with scrap dealers/buyers is central to how circularity operates in the informal waste sector, not merely as a logistical necessity but as a relational mechanism shaping market access and value realisation. During the second phase of the study, researchers, with permission, engaged directly with buyers without the presence of co-researchers to better understand these dynamics. According to Sukron, a scrap dealer, pricing is intentionally differentiated across IWBs based not only on material quality but also on perceived personal attributes, indicating that market valuation is partly socially constructed. Similarly, Mispan noted that he profiled IWBs prior to engaging in transactions, reinforcing that pricing decisions are influenced by subjective assessments rather than standardised criteria. In this context, communication skills function as a form of economic capital, as trust, which is essential for transactions, is built relationally rather than contractually. Given that reliable buyers are limited and unevenly distributed, co-researchers must invest significant effort in preparing materials to meet specifications while simultaneously maintaining relationships that enable continued market access, which is crucial for ensuring that their products are accepted and valued in the marketplace.

6.3. The importance of weighing scales, storage, vehicles, and online group chats

The findings indicate that weighing scales, storage, vehicles, and online group chats function not merely as operational supports but as mechanisms that reshape control, efficiency, and coordination within informal recycling systems. Most co-researchers reported infrequent use of weighing scales, with transactions often relying on buyers' measurements or bulk estimation, reflecting asymmetrical control over pricing. The preference for analogue over digital scales suggests that precision is negotiated within relational contexts, where excessive accuracy may disrupt trust-based exchanges. In this sense, weighing practices are embedded in social relations rather than governed solely by technical standards.

Storage and transport similarly operate as enabling conditions for material circulation. Limited storage constrains the ability to accumulate low-density plastics and meet buyer specifications, linking material properties directly to infrastructural capacity. Small transport improvements, such as carts or shared vehicle access, reduce physical constraints and expand collection networks, thereby increasing potential material flows. The group meeting on 10 February 2022 translated these constraints into action, where co-researchers co-developed individual action plans. The proposed supports such as scales, storage improvements, and transport upgrades reflect attempts to reconfigure everyday practices rather than introduce entirely new systems.

Picture 3. One of our IWBs with support of a platform scale and buckets for sorting and cleaning (2022). *Source: Authors*

Picture 4. Customised cart as part of support for some of the IWBs (2022). *Source: Authors*

In addition, the WhatsApp group facilitated informal coordination by enabling real-time exchange of price information, buyer requirements, and sorting practices. This digital layer strengthens peer-based knowledge sharing without formalising cooperation, illustrating how coordination in informal systems emerges through distributed and adaptive communication rather than institutional structures.

Picture 5. Newly built storage space with an improved shed (2022). *Source: Authors.*

6.4. Performance increase and change

For co-researchers, one of the criteria to be involved is an agreement that the co-researchers will be required to log their collected and sold materials daily. However, during the process we found that it was not an easy task to do so, as some of them were not itinerating nor selling their recyclables daily. Some co-researchers collected materials for a week and then sold them once a month, while others sold their materials daily but were unable to log the sales due to the absence of official receipts. Therefore, this paper can only analyse data on collected recyclables. Below is graphic data on plastics and all other materials (cardboard, metals, etc.) collected from May 2022, just after the disbursement of support packages, to November 2022, the official end date for the project.

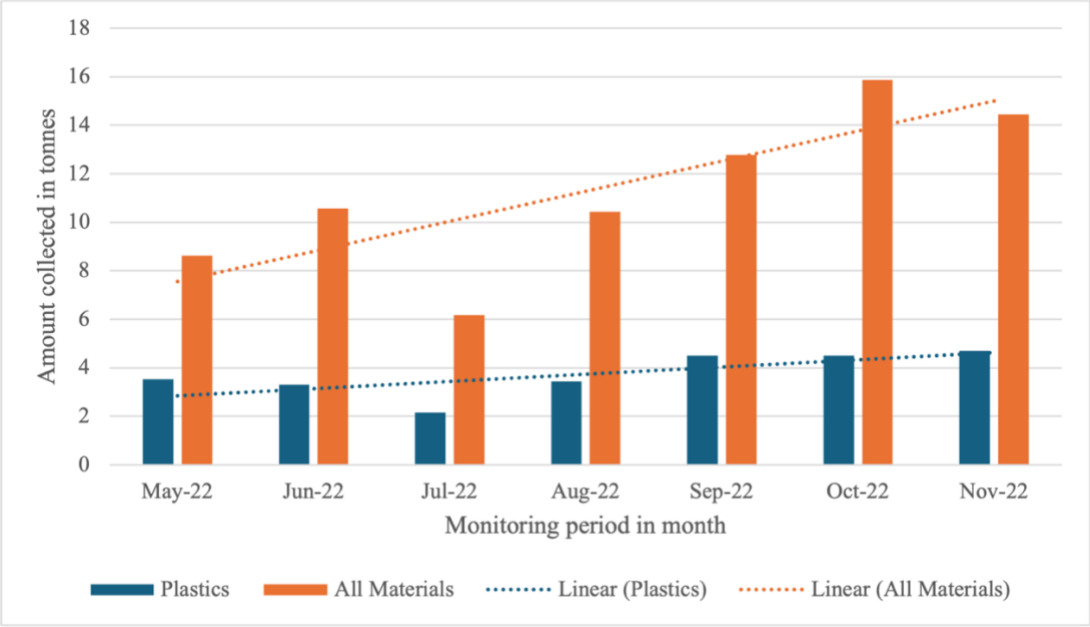

Figure 2. Plastics and all materials reported to have been collected (bought) by 10 IWBs, between November 2021 and November 2022. Source: Authors

One of the key observations from the monitoring process is the apparent increase in the quantity of plastics and total materials collected by co-researchers over the seven-month period following the intervention. However, rather than treating this trend as a direct outcome of the intervention, it is more analytically useful to interpret it as emerging from the interaction between operational adjustments, market dynamics, and relational changes within the recycling system.

First, the introduction of basic infrastructure, particularly weighing scales and improved storage, altered the micro-level conditions under which co-researchers operate. Access to independent weighing enabled co-researchers to exercise greater control over transactions, reducing reliance on buyers' measurements and increasing confidence in pricing negotiations. Improved storage capacity also allowed co-researchers to accumulate materials over time, enabling them to meet buyer specifications and engage in more strategic selling practices. These changes did not directly increase material availability, but they transformed the way we could capture, manage, and market existing material flows. Second, these operational adjustments interacted with meso-level market relationships. As co-researchers gained greater control over weighing and storage, they were better positioned to negotiate with buyers and expand their collection networks. This aligns with observations from interviews, where co-researchers reported increased ability to reach new suppliers and maintain more stable trading relationships. The observed increase in collected volumes may therefore reflect not only improved efficiency, but also a reconfiguration of trust and bargaining dynamics within local recycling markets. Third, it is important to consider alternative explanations and limitations in interpreting these trends. The absence of a control group, combined with incomplete sales data and potential seasonal fluctuations, means that the observed increases cannot be attributed solely to the intervention. External factors such as changes in market prices, availability of recyclable materials, or unrelated livelihood strategies may also have influenced collection volumes. Moreover, variations in reporting practices among co-researchers introduce additional uncertainty in the dataset.

Taken together, the findings suggest that the observed increase in material collection is best understood not as a linear outcome of intervention inputs, but as the result of interacting mechanisms across multiple levels. At the micro level, tools and infrastructure reduced operational frictions; at the meso level, these changes enabled shifts in market relations; and at the macro level, persistent material and economic constraints continued to shape the limits of what could be achieved. This interpretation reinforces the argument that plastic circularity is not driven by technical improvements alone but by the alignment of material properties, market conditions, and socially embedded practices. Section 7 further examines these multi-level dynamics in relation to broader circular economy frameworks.

6.5. Livelihood effects

The findings indicate that livelihood outcomes are shaped not only by increased material capture but also by changes in control, recognition, and household labour organisation within informal recycling systems. As co-researchers operate within family-based enterprises, operational improvements translated into modest but uneven livelihood benefits across household members. Improved access to sellers, expanded storage capacity, and more predictable transactions reduced reliance on waste picking at open dumping sites, suggesting a partial shift toward more stable and less hazardous income strategies. At the household level, these changes reconfigured the visibility and value of labour. As material quality and marketability improved, women's roles in cleaning, sorting, and storage became more explicitly linked to income generation rather than treated as auxiliary tasks. This shift contributed to greater recognition of women's contributions and, in some cases, to changes in decision-making dynamics within the household. However, this recognition remains contingent and embedded within existing gendered divisions of labour, which often limit women's access to resources and decision-making power in economic activities.

The provision of platform scales illustrates how technical interventions can produce broader socio-economic effects. By increasing transparency and reducing dependence on buyers' measurements, scales enhanced confidence in transactions and reduced income uncertainty. This strengthened both bargaining position and relational trust, contributing to a greater sense of control over daily work and earnings. Overall, livelihood improvements are best understood as incremental and relational, emerging from the interaction between operational changes, household dynamics, and market structures, rather than as direct or uniform outcomes of the intervention.

Picture 6. The wife of one of the IWBs is cleaning and sorting plastic recyclables. *Source: Authors*

Picture 7. Women in the family helping with sorting and cleaning recyclables (2022). *Source: Authors*

7. Discussion

This study acknowledges that the research process was not neutral but shaped by the positionality of the researchers and the structure of the project. The research team operated simultaneously as facilitators and knowledge producers and, indirectly, as providers of resources through the intervention. This dual role may have influenced participant responses, particularly by encouraging the articulation of positive outcomes or aligning expectations with perceived project objectives. Pre-existing relationships between local researchers and participants further facilitated trust and access but may also have shaped the openness, selectivity, and framing of shared information.

In addition, the PAR approach, particularly through Appreciative Inquiry, intentionally foregrounds strengths and opportunities rather than problems. While this orientation enabled constructive engagement and capacity-building, it may have limited the visibility of negative cases, failures, or conflicting perspectives. Recognising these limitations, the analysis attempts to critically reflect on both reported improvements and the structural constraints that persisted. Rather than treating the findings as objective measurements of impact, they are understood as co-produced accounts shaped by interaction, context, and the relational dynamics of the research process.

7.1. Enhancing the collection and circularity of plastics

7.1.1. The labour and material limits of plastic circularity This study discovers that plastic recycling within the informal sector is highly labour-intensive and dependent on manual processes. According to Juang and Bateer (2025), in order to increase market value, plastic materials must undergo multiple stages of cleaning and sorting. This finding is reinforced by previous studies by Luthra (2021) in urban India; Hidalgo-Crespo et al. in Ecuador (2023); Gutberlet in Brazil (2012); and C. Velis in the Global South in general (2017). In this study, such activity commonly undertaken by wives and other family members is usually unpaid and rarely recognised as formal work (Jain, 1996), despite its importance to the recycling process. This notion provides twofold reality. On the one hand, the labour-intensive aspect creates jobs for people (Linzner & Lange, 2013), especially in developing countries like Indonesia, where informal labourers outnumber formal workers (Hamid et al., 2022). On the other hand, the same study reveals that the informal nature of the job often leads to several vulnerabilities as a result of labour law neglect, particularly for women, including lack of job security, inadequate wages, and limited access to health benefits. Furthermore, nine out of ten co-researchers are elderly people, who, according to Rahayuwati et al. (2024), dominate the informal sector, as evidenced by our study.

In the context of Indonesia, Law Number 18/2008 recommends that each household be responsible for waste segregation from the source, which is strengthened by Presidential Regulation Number 81/2012.

However, the situation on the field is rather different, as the definition of "source" is not defined strictly at the household level. According to co-researchers, materials acquired and purchased still need to be sorted by polymer type, such as HDPE (high-density polyethylene), LDPE (low-density polyethylene), PET (polyethylene terephthalate), polyvinyl chloride (PVC), and polypropylene (PP), and colour, to match buyers' demands. This finding is supported by Alassali et al. (2021) and Feil et al. (2017), who suggest that sorting is one of the key procedures in the recycling process for obtaining high-value materials. Furthermore, co-researchers claim that these procedures are not only labour-intensive but also time-consuming, and they require adequate storage to accumulate items before sale. The lightweight and bulky nature of plastics exacerbates these limits, as co-researchers must achieve adequate weight to cover transportation expenses and maintain feasible prices.

These findings challenge dominant circular economy narratives that frame plastics as readily recyclable materials (Oladele et al., 2025). In practice, recyclability is not solely a technical property but is shaped by labour requirements (Llorente-González & Vence, 2020), market conditions (Hu et al., 2022), and infrastructural limitations (Alassali et al., 2021). From the co-researchers, plastic circularity is contingent on economic viability rather than environmental desirability. As such, the burden of making plastics "circular" is disproportionately shifted onto informal actors, whose labour compensates for material inefficiencies embedded in product design and waste systems. This highlights the need to critically reassess circular economy assumptions and to account for the social and material realities of recycling practices in informal contexts.

7.1.2. Plastic circularity across levels The operational improvements observed in this study reveal that plastic circularity is shaped by interactions across multiple levels, from everyday practices to broader market and design systems. At the micro level, the activities of co-researchers are directly constrained by the material properties of plastics, particularly their low weight, high volume, and susceptibility to contamination (Alassali et al., 2021; Oladele et al., 2025). The interventions introduced through the project, including weighing scales, improved storage, and transport support, primarily addressed these constraints by reducing operational frictions. For example, access to platform scales enabled co-researchers to manage the economic sensitivity of lightweight materials, increasing control over transactions and strengthening their bargaining position. Similarly, improved storage allowed for accumulation and delayed sales, which are necessary strategies for handling low-value plastics.

At the meso level, these micro-level practices are embedded within local market systems and relational dynamics (Eringa & Groenveld, 2016). The effectiveness of operational improvements depended not only on tools and infrastructure but also on existing relationships with buyers, pricing mechanisms, and informal norms of exchange. The preference for analogue scales, for instance, reflects the importance of maintaining trust and flexibility in transactions rather than maximising precision. Transport and storage improvements further enabled co-researchers to navigate these market conditions by expanding their collection networks and aligning material quality with buyer requirements. In this sense, circularity is co-produced through interactions between material flows and market relations, rather than determined solely by technical efficiency. This research further highlights that in global consumer goods supply chains, lead corporations generally wield authority, whereas in recyclable supply chains, intermediaries predominantly govern the chain (Colombijn, 2020; Crang et al., 2013; Gregson & Crang, 2015).

At the macro level, the limits of plastic circularity become more apparent when considering product design and policy frameworks such as Extended Producer Responsibility (EPR). In Indonesia, a recent study by Iacovidou et al. reveals that plastic consumption is dominated by small, low-cost, single-use packaging designed for affordability, often in multi-layer formats that are difficult or impossible to recycle (2025). According to the same study, these design decisions drastically diminish the economic value of plastics in informal systems, thereby shifting the cost of managing low-value materials to the informal sector or allowing products to leak into the environment (Cordova et al., 2024). While EPR policies aim to shift responsibility upstream (Victor, 2026), their implementation often emphasises collection targets or downstream interventions without adequately addressing the structural issue of non-recyclable product design.

Collectively, these findings suggest that improvements at the micro level can enhance the efficiency of informal recycling practices, and meso-level adjustments can strengthen market coordination, but neither can fully overcome the constraints imposed at the macro level. The project's interventions enabled co-researchers to better cope with the material and economic limitations of plastics, yet they did not fundamentally change the conditions that render many plastics non-circular. This highlights the need for a more integrated approach

to plastic circularity, one that aligns product design, policy frameworks, and informal practices, so that the responsibility for circularity is not disproportionately borne by actors operating at the margins of the system.

7.2. Contribution of PAR towards the CE concept

7.2.1. Micro level: Recognition in everyday circular practices At the micro level, PAR reveals how circularity is enacted through the everyday practices of co-researchers, whose expertise in material identification, sorting, and logistics sustains material flows. These practices reflect the foundational role of informal actors in material recovery systems (Scheinberg et al., 2010; Wilson et al., 2006). However, from a recognition perspective, such contributions are often misrecognised, as experiential knowledge is undervalued within systems that privilege technical and formal expertise (Gutberlet, 2015), leading to a lack of acknowledgement for the critical role that informal actors play in sustainable material recovery.

Through Appreciative Inquiry (AI) and Cooperative Inquiry (CI), PAR repositions IWBs as co-researchers and co-producers of knowledge, shifting from subject–object to subject–subject relationship (Heron & Reason, 1997). This approach enables recognition at the level of practice by validating informal expertise as central to circularity. However, this recognition was not immediate. Social stigma surrounding waste work (Sapkota et al., 2020), in our case often viewed as low-status or associated with theft, initially constrained trust and interaction with wider communities. To create a space for communication, it was necessary to actively change how people saw IWBs as contributors to the environment. Recognition, in this sense, becomes a necessary condition for participation, enabling dialogue and knowledge co-creation grounded in lived experience. While recognition at the micro level validates everyday practices, it must also be sustained through relationships and interactions across actors within the system, such as through collaborative projects and ongoing communication that reinforce shared understanding and commitment to collective goals.

7.2.2. Meso level: Recognition through relational and market coordination At the meso level, circularity is shaped by the relationships between IWBs, buyers, and institutions. Although IWBs play a central role in material flows, their contributions often go unrecognised by institutions, despite their functional reliance (Dias, 2016). This reflects a gap between contribution and recognition within local circular systems. Through an iterative process of CI, this study creates communicative spaces where co-researchers could articulate their experiences, negotiate perspectives, and reflect collectively on market dynamics together with us. Recognition here operates relationally (Bin, 2022), constructed through trust (Brennan, 2021), negotiation, and ongoing interaction. For instance, the preference for analogue weighing scales reflects the importance of maintaining trust-based exchanges rather than maximising technical precision. PAR facilitates partial alignment among various forms of knowledge and authority, enhancing coordination while not entirely rectifying structural inequalities.

In this way, recognition at the meso level strengthens the functioning of circular systems by facilitating dialogue and cooperation. However, its effects remain contingent on broader institutional conditions. These relational dynamics point to wider structural constraints, where recognition is unevenly embedded within policy and system design, leading to disparities in how different stakeholders can engage with and benefit from circular systems.

7.2.3. Macro level: Recognition and the structural limits of circular economy systems The absence of embedded recognition within policy and product design frameworks constrains circular economy transitions at the macro level. While Extended Producer Responsibility (EPR) has been widely adopted to assign producers responsibility for post-consumer waste, its implementation in Asia still focuses on electronic waste (Johannes et al., 2021). In many cases, EPR systems are adapted from models developed in high-income contexts (Johannes et al., 2021; Kaffine & O'Reilly, 2013; Manomaivibool, 2010), without adequately accounting for the social, economic, and infrastructural conditions in which informal recycling systems operate.

As shown in this study, these limitations are not only technical but also relational. Informal actors such as IWBs remain positioned as implementers rather than contributors to system design (Kirchherr, 2021), despite

their central role in material recovery. This disconnect is particularly evident in the management of low-value and non-recyclable plastics, including multi-layer packaging, where co-researchers bear the practical burden of collection and sorting. Their labour effectively compensates for inefficiencies embedded in product design; yet this contribution remains insufficiently recognised within EPR frameworks.

Existing research by Johannes et al. (2021) highlights several challenges in implementing EPR in developing countries, including the absence of market-based collection systems, high transportation expenses, limited infrastructure, and weak regulatory enforcement. The results of this study indicate that these challenges are not merely operational constraints; they signify a profound misalignment between formal policy mechanisms and informal, practice-based systems of material circulation. In this context, EPR risks reinforcing existing inequalities by relying on informal labour without integrating it into decision-making processes.

Addressing these limitations requires moving beyond the technical expansion of EPR and toward a more context-sensitive approach that recognises informal actors as integral participants in system design, as is evident in this study. This includes differentiating producer responsibilities, strengthening infrastructure in underserved areas, and, critically, embedding participatory mechanisms that align policy frameworks with the lived realities of informal recycling systems. PAR exposes these structural limitations by linking everyday practices and local interactions to broader systemic conditions. It demonstrates that circularity is not only a technical or economic process but also a relational one (Civera et al., 2025; Jaeger-Erben et al., 2025) shaped by whose knowledge is legitimised and whose labour is valued. Without embedding recognition into policy, product design, and institutional arrangements, circular economy initiatives risk reproducing existing inequalities rather than transforming them.

8. Conclusion and recommendations for future study

This study demonstrates that participatory action research (PAR) offers a meaningful pathway to understanding and strengthening the role of informal actors, specifically itinerant waste buyers (IWBs) within plastic circularity systems. By engaging IWBs as subjects rather than objects, the study reveals that circular economy practices are already actively performed within informal systems, albeit under significant structural constraints. The findings show that IWBs possess critical situated knowledge, enabling them to navigate complex material flows, market dynamics, and logistical challenges more effectively than formal systems often recognise. At the same time, the study highlights the limitations of prevailing circular economy narratives, particularly in relation to plastics. While plastics are frequently framed as recyclable, their material characteristics create substantial economic and operational barriers, such as high processing costs and limited market demand for recycled materials. For IWBs, decisions about material recovery are shaped not by environmental ideals but by market viability. This underscores a key insight: circularity in practice is not determined by technical recyclability alone but by the intersection of material properties, infrastructure, and market demand.

The PAR approach also demonstrates that relatively small, context-specific interventions can lead to measurable improvements in operational efficiency, material collection, and livelihood stability. However, these improvements remain incremental and do not address deeper structural inequalities, including unequal market power, limited infrastructure, and lack of formal recognition. Thus, while IWBs contribute significantly to reducing plastic leakage, they continue to operate within systems that undervalue their labour and knowledge.

Based on these findings, several recommendations emerge. First, policy frameworks should formally recognise IWBs as essential actors in waste management systems. This recognition must extend beyond mere symbolic inclusion to encompass supportive policies, access to infrastructure, and participation in decision-making processes. Creating institutionalised *communication spaces* between municipalities and informal actors is critical to bridging existing divides. Second, interventions aimed at improving plastic circularity should prioritise long-term, system-oriented solutions rather than short-term, incentive-based schemes. Buy-back programs and similar initiatives should be carefully evaluated to ensure they align with existing market realities and do not create temporary or unsustainable effects such as increased plastic waste or market distortions that could undermine long-term sustainability efforts. Third, investments in basic infrastructure can significantly enhance the capacity of IWBs to handle plastics more efficiently. These investments should be co-designed with IWBs to ensure relevance and usability. Finally, this study points out the necessity of participatory methodologies in circular economy research. PAR not only generates contextually grounded

knowledge but also fosters more equitable research relationships and outcomes, which can lead to improved stakeholder engagement and better alignment with community needs. Future initiatives should build on this approach to ensure that circular economy transitions are not only environmentally effective but also socially just, by actively involving diverse stakeholders in the decision-making process and addressing the needs of marginalised communities.

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Authors' contributions Prisilia Resolute: Data curation, Formal analysis, Investigation, Project administration, Validation, Visualization, Writing – original draft, reviewing and editing. Anne Scheinberg: Conceptualization, Formal analysis, Funding acquisition, Methodology, Supervision, Validation, Writing – original draft. M.S. Oktamalandi: Funding acquisition, Project administration, Resources, Supervision, Validation, Writing – review & editing. Gifta Oktavia Fajriyanti: Project administration, Resources, Writing – review & editing.

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Declarations

Competing Interests The authors declare no competing interests.

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