Informal Waste Collectors and the Circular Economy in Hue City: Practical Contributions and Policy Gaps

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Abstract

The volume of solid waste is increasing rapidly in urban areas of Viet Nam, while the capacity of the formal system for waste separation, collection, and recycling remains limited and insufficiently coordinated. In this context, informal recyclable waste collectors, commonly referred to locally as "ve chai", "đồng nát", or "chai bao", operate as a form of "soft infrastructure" within the circular economy. This paper examines the role of informal recyclable waste collectors in the circular flow of solid waste in Hue City. Using a qualitative approach, combined with legal document analysis and secondary data review, the study demonstrates that this workforce functions as a critical form of "soft infrastructure" within the urban waste management system. In 2025, informal recyclable waste collectors recovered 7,679 tons of recyclable materials, contributing to an estimated reduction of approximately 21,924 tons of CO_2e emissions. Despite their substantial environmental, economic, and social contributions, they continue to face major policy and institutional gaps, including exclusion from extended producer responsibility (EPR) mechanisms, limited access to social protection and occupational safety measures, and the absence of integration into official waste management data systems. The study highlights the importance of an inclusive circular economy framework and proposes policy mechanisms to formally recognize and integrate this workforce into the official waste management system.

Keywords: *circular economy; EPR; informal recyclable waste collectors; Hue City; solid waste.*

1. INTRODUCTION

The volume of solid waste generated in urban areas across Viet Nam has been increasing rapidly while the capacity of the formal waste management system for waste segregation, collection, and recycling remains limited and fragmented. In Hue City, solid waste generation is estimated at more

than 163,000 tons per year, equivalent to approximately 0.83 kg per person per day. Household plastic waste exceeds 60 tons per day, of which approximately 86% is potentially recyclable; however, only about 13% is recovered for recycling (WWF-Viet Nam, 2021). These figures highlight a substantial gap between circularity potential and actual material recovery, emphasizing the need to re-evaluate both the operational performance of the recovery-recycling value chain and the institutional conditions that support it.

In this context, informal waste collectors and recyclable-material traders (commonly known in Viet Nam as *ve chai/đồng nát/chai bao* and in English as informal scrap collectors) function as a form of *"soft infrastructure"* within the circular economy. They collect recyclable materials from households and public spaces in the streets, undertake primary sorting, aggregate valuable materials, and transport them to scrap dealers, junk shops, and recycling facilities. UNDP reports (2024) have emphasized the important contribution of this informal workforce to material recovery, the volume of waste requiring final disposal, and livelihood creation for vulnerable groups, particularly women. However, their role is often insufficiently recognized in policy frameworks, resulting in precarious working conditions, limited access to occupational protection and social protection, and *"almost no voice"* in decision-making processes.

The case of Hue City illustrates the recycling system's practical dependence on the informal sector. The final evaluation report of the project *"Hue – A Plastic Smart City in Central Viet Nam"* (hereinafter referred to as the TVA Project) indicates that the overall recovery and recycling rate remains low (at approximately 5%), with most recyclable materials being recovered through the informal sector. At the same time, the report also highlights the limited capacity of the formal recycling system. The report revealed that several pilot initiatives aimed at integrating or semi-formalizing informal waste collectors (including forming scrap collector groups/cooperatives and digital platforms for recording collection outcomes) have emerged. Nevertheless, these initiatives have yet to evolve into stable and long-term policy mechanisms.

In the context of advancing the circular economy and implementing Extended Producer Responsibility (EPR), the challenge extends beyond simply increasing recycling rates. It also concerns who performs collection activities, through what mechanisms, how recovery outcomes are verified and documented, and how benefits are distributed among stakeholders. Existing reviews of EPR implementation in Viet Nam emphasize the importance of multi-stakeholder approaches, transparent implementation procedures, effective monitoring and compliance mechanisms, and reporting and data systems. Without mechanisms to integrate the informal sector, compliance costs may increase, and recovery and recycling targets may prove difficult to achieve in practice. Accordingly, this study seeks to: *(i)* examine the role of informal waste collectors in the solid waste circular value chain in Hue City; *(ii)* assess their environmental, economic, and social contributions; and *(iii)* identify policy gaps from the perspective of an inclusive circular economy framework, such as EPR mechanisms, data integration into formal systems, and issues related to social protection and occupational safety.

2. RESEARCH METHODOLOGY

2.1. Research approach

This study adopts a qualitative research approach. Information and data were collected and analyzed to examine the role of the informal collection sector (commonly represented by informal scrap collectors) in the overall solid waste management system and circular economy value chain of Hue City.

The research draws upon secondary data collected from published studies, project reports, and research outputs relevant to the study area and subject matter. In addition, legal and policy documents related to the objectives of this study were reviewed and analyzed.

The analysis is primarily based on the collected secondary data and policy documents. The study also builds upon key findings generated under the TVA Project in Hue City. Data synthesis and legal document analysis helped clarify existing policy gaps objectively.

2.2. Data sources and selection criteria

Secondary data were used to support: *(i)* the assessment of practical contributions made by actors involved in waste recovery and recycling systems, particularly those operating within the informal sector; and *(ii)* the qualitative analysis of policy gaps related to solid waste and plastic waste management.

Data were compiled from four principal sources: (1) Government and operational reports, including data on solid waste collection, transportation, and treatment, information on waste treatment facilities, and assessments of local waste management practices; (2) Project reports and development programs, which provided technical indicators, waste flow diagram, and management practices derived from intervention programs such as the TVA Project, together with thematic reports produced by international organizations on solid waste management; (3) Legal and policy documents at both national and local levels relating to solid waste management, waste segregation at source, the circular economy, and the recycling and treatment responsibilities of producers and importers under the EPR regulation; and (4) Academic research (journal articles and specialized studies) addressing solid waste management, circular economy practices, and the role of the informal sector in material recovery.

The collected materials were screened according to three criteria: *(i)* Relevance to the research objectives (solid waste and plastic waste management, recovery and recycling value chains, informal collection systems, data and monitoring mechanisms, and benefit-sharing arrangements within circular economy and EPR frameworks); *(ii)* Reliability and transparency of sources (with priority given to government publications, project reports employing clearly documented methodologies, peer-reviewed studies, and documents with identifiable references and sources); and *(iii)* Timeliness (focusing on recently issued policies and datasets to accurately reflect the prevailing policy environment and current waste management practices).

2.3. Data analysis

The study employs a qualitative analytical framework based on literature review and document analysis to clarify the role of the informal collection and recycling sector (including scrap collectors) in the plastic waste circular value chain in Hue City. It also seeks to identify the gap between circularity potential and actual material recovery in the context of advancing the circular economy and implementing the EPR.

Data analysis was conducted in three stages: *(i)* Data sources were screened and standardized: secondary materials, reports, and project documents with clear origins were selected, with preference given to official publications and technical reports related to solid waste and plastic waste management. *(ii)* Thematic coding was undertaken: a coding framework was developed, focusing on: (a) The structure of recovery and recycling value chains; (b) Actors and operational mechanisms within the informal sector; (c) Recovery data and supporting evidence; and (d) Institutional and policy bottlenecks. *(iii)* Policy - practice comparison was conducted: Operational realities and field observations documented in reports were compared with governance requirements (including recognition mechanisms, coordination, monitoring, and reporting) to gain arguments on conditions for integrating the informal sector into formal waste management systems and EPR implementation frameworks.

3. RESULTS AND DISCUSSION

3.1. Solid waste management context and circular economy orientation in Hue City

In recent years, solid waste management in Hue City has achieved notable progress, with the solid waste collection rate reaching 100%. On average, approximately 448 tons of waste are generated daily across the city, equivalent to around 163,525 tons per year (WWF-Viet Nam, 2025). Waste collection services are primarily provided by the Hue Urban Environment and Public Works Joint Stock Company (HEPCO), while the remaining areas are served by Hang Trung Co., Ltd. Regarding waste treatment infrastructure, since 2024 the majority of municipal solid waste has been transported to the Phu Son Waste-to-Energy Plant, located approximately 20 km from the city center and designed to process up to 600 tons of waste per day (Environmental Industry Magazine, 2026). In addition to the formal collection system, Hue City also has a well-established informal collection network (scrap collectors), which plays a significant role in material recovery and recycling activities.

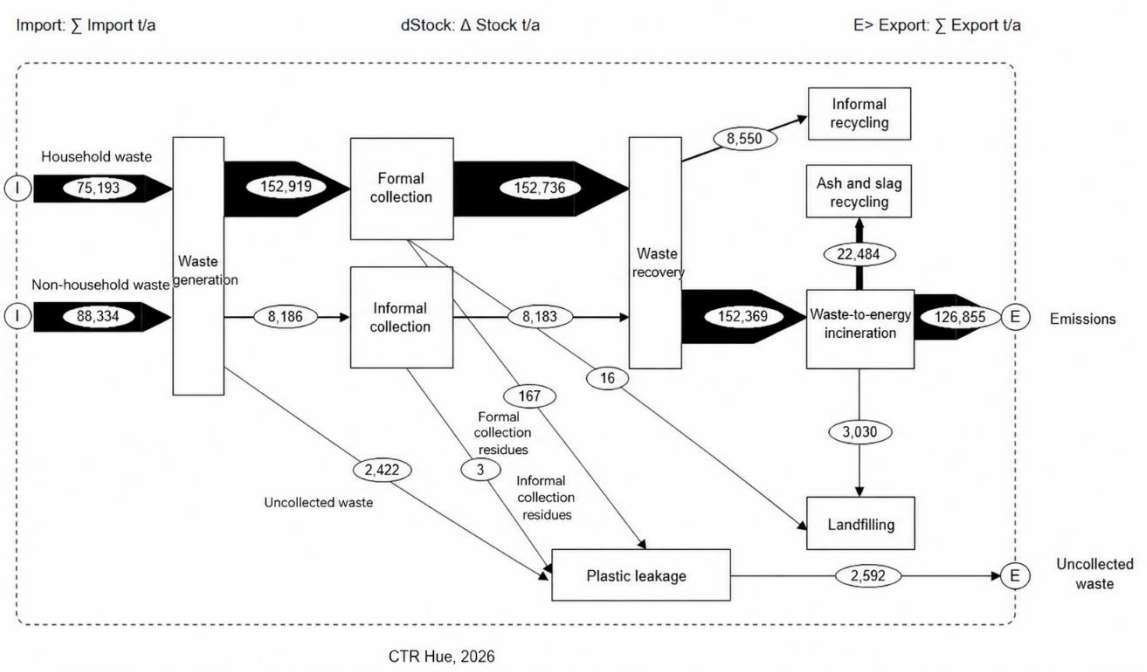

Figure 1. *The solid waste flow in Hue City* (WWF-Viet Nam, 2025)

Apart from these achievements, the city's waste management system continues to face several challenges. Waste segregation at source remains inconsistent, despite strong policy commitments by local authorities and substantial technical and material support provided through the TVA Project. Furthermore, one of the most pressing challenges is financial sustainability. The costs associated with waste collection, transportation, and treatment continue to rely heavily on government budget allocations (WWF-Viet Nam, 2025).

Hue City has identified the circular economy as a key component of its sustainable development strategy. The city issued Plan No. 284/KH-UBND on the implementation of the National Action Plan for the circular economy through 2035. The plan aims to gradually reduce dependence on non-renewable resources, promote the efficient use of renewable energy, and foster the development of circular value chains. Particular emphasis is placed on enhancing economic value creation, stimulating innovation, mobilizing resources, and promoting circular business models, including waste reuse and recycling initiatives (Hue City Portal, 2025).

In the effort of strengthening solid waste management and advancing circular economy objectives, improving the effectiveness of waste segregation, collection, and recycling has become increasingly important. Evidence from Hue City indicates that informal waste collectors, including waste pickers, recyclable-material collectors, and scrap dealers, play a pivotal role in material recovery and recycling activities. Despite their substantial contribution to maintaining recyclable material flows, informal collectors continue to operate outside formal institutional arrangements and remain largely dependent on market-based economic incentives. Consequently, local recovery

and recycling performance could be significantly affected should the activities of this group be disrupted.

Moreover, informal collectors possess extensive practical knowledge and experience in identifying, sorting, and recovering recyclable materials. As such, they represent a valuable resource for improving local recycling performance. Recognizing and progressively integrating the informal waste collectors into the formal waste management system would not only enhance the overall efficiency and resilience of waste management operations but also contribute to improved working conditions, occupational protection, and social inclusion for them.

3.2. The role of scrap collectors as informal actors in the circular material chain

Within the solid waste management system of Hue City in particular and Viet Nam in general, this distinctive informal sector has coexisted with the formal collection system for several decades. It consists of individuals who organize their own work independently, without employment contracts or insurance coverage, and whose activities are driven by the economic value of recyclable materials contained in the daily waste stream.

In terms of demographic and occupational characteristics, informal waste collectors are predominantly women, accounting for up to 90% of the workforce in this sector (Environmental Pollution Control Department, 2025). They typically come from low-income households, have migrated from rural to urban areas, work independently without fixed schedules, and earn incomes that depend entirely on the quantity of recyclable materials collected each day. In Hue City, 99% of these collectors are women, mainly from rural areas, who travel daily from their houses to collect recyclable materials. Their activities extend across households, small alleys, business establishments, and public spaces.

Regarding material types collected, informal waste collectors primarily focus on recyclable materials with market value, including plastics (PET bottles, HDPE bags, and PP containers), cardboard and office paper, used newspapers, metals (iron, aluminum, and copper), and discarded electronic devices. In practice, sorting takes place directly at the point of collection, representing the first stage of the recycling chain without requiring investment in centralized sorting infrastructure (Figure 2).

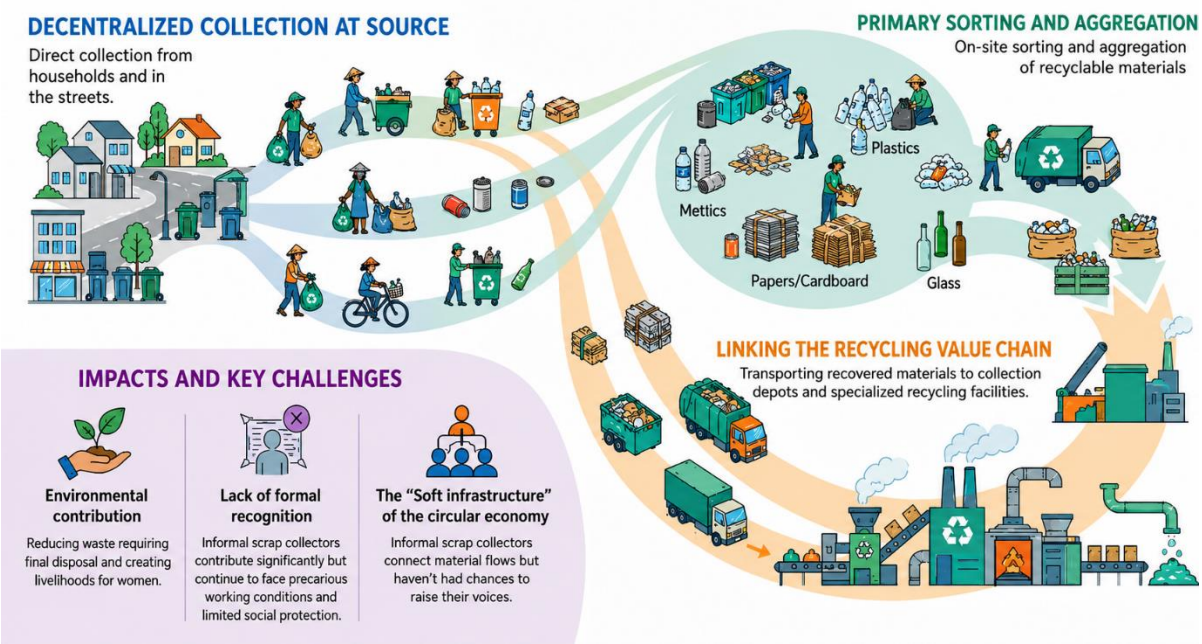

Figure 2. *Informal solid waste collection cycle*

The collection - recycling chain of informal waste collectors is systematic in nature, despite not being formally recognized by law. After collecting recyclables from households and business establishments, the materials are transported to junk shops (first-tier collection facilities), where they undergo further sorting according to material type and quality. From these junk shops, the materials are subsequently transferred to larger intermediary dealers before reaching recycling facilities - either household businesses or enterprises engaged in manual or industrial recycling activities. This chain operates entirely on the basis of trust-based relationships, informal credit arrangements, and scrap material prices that fluctuate daily according to market conditions. It constitutes an informal material circulation chain that operates in parallel with, and effectively complements, the formal system. However, it remains largely unrecognized and inadequately integrated within the institutional framework.

3.3. Practical contributions of scrap collectors to the circular economy in Hue City

3.3.1. Environmental contributions

The informal collection sector plays a leading role in the sorting, collection, and separation of recyclable materials from the city's solid waste stream. In 2025, the informal sector in Hue City recovered a total of 8,550 tons of recyclable waste, including 7,679 tons of scrap materials, with the remainder consisting of organic waste (WWF-Viet Nam, 2025). According to Pham Khac Lieu et al. (2012), several groups contribute inputs to the informal collection system, including waste pickers, HEPCO workers, and scrap collectors (mobile recyclable-material traders). Among these

groups, scrap collectors collected up to 93% of the total volume. This highlights the dominant role of scrap collectors in recyclable material collection in Hue City.

The activities of scrap collectors contribute significantly to reducing the volume of solid waste that must be collected and transported to treatment facilities within the formal waste management system. Before 2024, solid waste in Hue City was primarily disposed of through landfilling at the Thuy Phuong Landfill. Therefore, increased recycling rates directly reduce the volume of waste requiring transportation and landfill disposal, thereby helping to save landfill space and extend the operational lifespan of the landfill site.

At present, as the city transitions to more advanced waste treatment technologies, increased recycling rates will continue to play an important role in reducing the volume of waste requiring treatment at waste processing facilities. In addition, recycling activities help extend the life cycle of materials, conserve natural resources, and mitigate environmental pollution. The volume of recyclable materials recovered in Hue City through informal-sector activities in 2025 is presented in Table 1.

Table 1. *Quantity of recyclable materials collected in Hue City (Source: WWF-Viet Nam, 2025)*

STT	Material type	Quantity (ton/year)
1	Plastics	3,046
2	Paper/Cardboard	2,810
3	Glass	18
4	Metals	1,822

Using emission factors from the Waste Reduction Model (WARM) developed by the United States Environmental Protection Agency (US EPA), estimates based on the quantities of recyclable materials recovered in Table 1 indicate that greenhouse gas (GHG) emissions reductions attributable to the informal sector in Hue City amount to approximately 21,924 tons of CO_2e per year. Among the recovered materials, mixed paper contributed the largest emissions reduction, accounting for 10,923 tons CO_2e per year, followed by metals (8,076 tons CO_2e per year) and plastics (2,925 tons CO_2e per year) (US EPA, 2019). These findings demonstrate the significant contribution of the informal scrap collectors to resource recovery and GHG emissions reduction through the promotion of recycling activities.

3.3.2. Economic contributions

Although activities within the informal sector are not fully reflected in official economic statistics, scrap collectors generate observable and measurable economic value at multiple levels of the recovery-recycling chain.

This workforce helps maintain the supply of input materials for the recycling industry. Globally, approximately 60% of collected and recycled plastic waste is recovered with the participation of

around 20 million informal workers (The Circulate Initiative, 2023). In Viet Nam, the informal sector contributes more than 30% of the total recyclable plastic waste (UNDP Viet Nam, 2024), thereby helping to ensure the continuity of material flows, a critical condition for recycling facilities that depend on a stable supply of raw materials. In Hue City, based on direct interviews with 45 scrap collection facilities conducted during the period 2023-2026, the quantity of plastic scrap supplied by scrap collectors varied according to facility size but accounted for approximately 25-28% of total plastic scrap on average. Meanwhile, small collection depots in peri-urban areas relied entirely (100%) on this source of supply. These findings indicate that, in the absence of scrap collectors, many small and medium-sized recycling facilities would face serious shortages of raw materials, particularly in localities where waste segregation at source has not yet been fully implemented.

Scrap collectors also contribute to reducing the social costs of the urban solid waste management system by diverting part of the waste stream away from the formal collection, transportation, and treatment system. In principle, one ton of recyclable material collected for recycling is one ton of waste that does not need to undergo transportation and final treatment processes, both of which involve substantial costs. As a result, this generates savings in public expenditure, although the full extent of such savings is difficult to quantify due to the lack of systematic statistical data. Evidence from Da Nang indicates that the informal sector reduced the quantity of waste sent to landfills and waste-to-energy facilities by an estimated 6.5-7% of the city's total waste generation of 1,100 tons per day (Leroy, 2022). In Hue City, the corresponding quantity recovered was recorded at 7,679 tons per year (WWF-Viet Nam, 2025). If the public sector were required to manage this entire quantity, the operating costs of the urban waste collection and treatment system would be expected to increase significantly due to the additional burden placed on transportation and treatment services.

Figure 3. *The role of scrap collectors in the circular economy value chain*

Scrap collectors play an important role in providing livelihoods for low-income groups and individuals with limited access to formal employment opportunities. In Viet Nam, an estimated three million people are engaged in informal waste collection and recycling activities. This occupation serves as an essential source of livelihood for groups with limited access to formal employment due to low educational attainment, lack of local household registration, or burdened with family responsibilities (Environmental Pollution Control Department, 2025). Although income from scrap collection is generally modest and unstable, it remains an important source of revenue for covering daily living expenses and, in many cases, constitutes the primary source of household income. Therefore, scrap collectors not only contribute to waste recovery and recycling activities but also form part of the informal urban livelihood and social protection network.

In Hue City, field surveys indicate that many women engage in recyclable-material collection as a supplementary income-generating activity alongside agricultural work or seasonal employment, particularly during the agricultural off-season. For some individuals, however, it has become their primary occupation, with many years of continuous involvement (more than five years), owing to its flexibility, low skill requirements, and ability to generate a daily income.

3.3.3. Social contributions

Scrap collection activities generate significant economic, environmental, and social benefits, while also functioning as an *"immediate employment mechanism"* that can support the development of a comprehensive solid waste management system (Ackerman, 2005; Igwe et al., 2018). In many cities across developing countries, these actors not only recover recyclable materials but also play an important social role in supporting urban circular economy systems, particularly by providing livelihoods for vulnerable groups (low-income workers, the elderly, women, low-skilled workers,

and migrant workers) (see Figure 4). Income from informal collection activities represents an essential household resource: accounting for 85% of household income in Pune, 80% in Nakuru, 66% in Belo Horizonte, 59% in Durban, and 34% in Bogotá (Dias, 2016; Ogando et al., 2017). In the Mekong Delta, the informal sector contributes to livelihood diversification for poor households, but continues to exhibit a high degree of vulnerability due to its heavy dependence on the sale and/or self-use of recyclable materials.

Figure 4. *Plastic materials purchased from informal scrap collectors*

Since 2015, research on informal waste collectors has increasingly shifted towards a circular economy perspective, emphasizing the informal waste collection sector as a *"labour-absorbing sector"* in the context of rapid urbanization and a shortage of stable employment opportunities (Hayami et al., 2006; Dias et al., 2016). In Mexico City, informal recycling has been described as a flexible survival strategy that remains vulnerable to exploitation (Sanchez et al., 2006); on a broader scale, it serves as a primary or supplementary livelihood for millions of urban poor people (Wilson et al., 2006). Its economic contribution is often underestimated: Tunisia has 8,000 barbechas who recycle 5,000 tons of PET annually, while Brazil achieves recycling rates of 80% for cardboard and 92% for aluminum (Ogando et al., 2017). In Nanjing, this workforce helps save USD 17.6-22 million annually in waste treatment costs and increases resource recovery rates by 1.9-8.0%. However, the share of value they receive within the recycling chain remains low: only 6.8-7.3% in Nanjing (Fu Chen et al., 2018); in Hanoi, women engaged in itinerant waste purchasing earn approximately USD 150-300 per month, while owners of intermediary collection

depots earn USD 6,000-7,000 per year (Mitchell et al., 2009; Minh Thu Nhien Nguyen et al., 2019). These informal networks should therefore be recognized as a component of *"circular infrastructure"* and require appropriate incentive and integration mechanisms to optimize their contributions (Gutberlet & Carenzo, 2020; Dias et al., 2024; Thinh et al., 2026).

3.4. Policy gaps in recognizing and integrating informal scrap collectors

3.4.1. Gaps in recognition of their role

Despite their tangible and measurable contributions, informal scrap collectors are almost absent from Vietnam's official legal and policy frameworks on waste management. This institutional gap is a matter of concern and requires clear recognition.

Lack of recognition in official legislation and policies

The 2020 Law on Environmental Protection and its implementing decrees, including Decree No. 08/2022/ND-CP and, in particular, the recently promulgated Decree No. 110/2026/ND-CP, establish an EPR mechanism requiring producers and importers to take responsibility for recycling post-consumer products. However, these regulations do not refer to the role, rights, or mechanisms for engaging informal waste collectors. Likewise, the Vietnam Environmental Protection Fund (VEPF), which administers EPR financial resources, has not established any payment mechanism or service contracts for informal scrap collectors. In other words, those who carry out most of the initial collection and sorting work remain entirely excluded from the distribution of benefits under the EPR system.

The informal sector has not yet been recognized as a circular economy actor. The circular economy model has been strongly promoted in Viet Nam in recent years, with the expectation that recycling and reuse will gradually replace the linear economic model. However, there is currently no evidence that informal scrap collectors are viewed as strategic partners within the material value chain. Instead, they are often categorized as a *"social issue"* requiring intervention (poverty reduction, occupational safety, and sanitation). This not only reflects a misunderstanding in perception but also leads to flawed policy design: EPR has been structured as a top-down model linking producers to licensed recyclers while overlooking the entire informal collection chain that is actually in operation.

Consequences of the lack of recognition

This recognition gap generates a series of negative consequences. First, informal scrap collectors have limited or no access to health insurance, occupational safety protection, and vocational training, leaving occupational risks (including exposure to hazardous substances and traffic accidents) entirely borne by individuals. According to the authors' field survey, 100% of women scrap collectors had experienced at least one work-related accident involving their hands or other parts of the body. Second, while EPR creates financial resources for recycling, these funds flow to licensed recycling enterprises without any benefit-sharing mechanism for those who undertake the

initial collection and sorting activities, thereby violating the principle of fairness within the circular value chain. Third, in the long term, if informal scrap collectors are excluded because they cannot meet the requirements of the formal EPR system, Vietnam risks losing a flexible, low-cost, and highly adaptive collection capacity that has taken decades to develop.

3.4.2. Gaps in institutional integration

Informal scrap collectors play a pivotal role in recycling recovery activities in Viet Nam. Their contributions are reflected in the recovery of recyclable materials equivalent to 5.2% of total solid waste generated in Hue City (WWF-Viet Nam, 2025) and in reducing the volume of waste sent to landfills in Da Nang by 6-7.5% (UNDP, 2022). However, they have yet to receive formal recognition within Vietnam's solid waste management system in general and Hue City's system in particular. Neither the Law on Environmental Protection No. 72/2020/QH14 nor Law No. 146/2025/QH15 amending 15 laws in the fields of agriculture and environment formally recognizes informal waste collectors within the solid waste management system. More recent legal instruments, such as Decree No. 48/2026/ND-CP and Circular No. 07/2025/TT-BTNMT, grant provincial-level People's Committees greater flexibility in decisions regarding solid waste classification and collection, yet still fail to acknowledge the role of this group.

There is no formal coordination mechanism between scrap collectors (informal sector) and the formal waste collection sector. The two sectors operate in parallel without any institutional linkage. For example, HEPCO operates in accordance with regulations, approved collection routes, and official supervision, whereas informal scrap collectors operate independently and define their service areas based largely on customary practice. The types of recyclable materials collected by scrap collectors are determined by market demand and are neither regulated nor connected to, or supported by, the formal sector. The informal sector's collected volumes and contributions are likewise not recorded within the city's solid waste management system.

At present, no formal model exists in Hue City to support the organization of these groups or officially recognize the role of informal scrap collectors. Nevertheless, initiatives such as the Green House model managed by the Women's Union and the mGreen application have demonstrated effective support mechanisms for this group. Through the collaboration of the City Women's Union and the wards of An Dong and Huong So, the mGreen collection models recovered 55,596 kg of recyclable waste in 2024, 121,884 kg in 2025, and 33,406 kg during the first four months of 2026 (WWF-Viet Nam, 2025). Although this model has generated positive results and enhanced the position of informal scrap collectors, it currently relies on support from the TVA Project, raising concerns about its sustainability once the project ends. It is indicated that a cooperative-based model integrated into the solid waste collection system can increase recycling rates when waste pickers are formally recognized as a legitimate occupation by the government (Gutberlet, 2020).

The absence of institutional integration creates discontinuities within the circular material chain. Currently, transactions involving informal scrap collectors are conducted through direct payment arrangements without legally recognized documentation of material origin, resulting in a

disconnect between the informal sector and the EPR mechanism. Although traditional scrap collectors make substantial contributions during the initial collection and transportation stages, their recovered volumes are rarely recorded, preventing them from accessing EPR financial resources. Nevertheless, recyclable waste volumes collected through the mGreen application in Hue City are now being recorded, as mGreen has been authorized by producers and importers to organize the collection and recycling of packaging and products in fulfilment of their EPR obligations.

3.4.3. Gaps in social protection and working conditions

Although scrap collectors contribute to maintaining the flow of recyclable materials and reducing the burden on municipal solid waste treatment systems, they face significant socio-economic challenges, including poverty, social stigma, lack of legal recognition and social protection, precarious livelihoods, and hazardous working conditions. Due to the informal nature of their work, their income is highly dependent on fluctuations in scrap material markets, demand from the recycling industry, and access to recyclable materials. As a result, their earnings are often unstable, and they lack employment contracts and long-term job security (Hayami et al., 2006; Dias, 2016). In the Mekong Delta, the informal sector has likewise not been recognized in formal waste management policies (Yen Dan Tong et al., 2021). In the context of increasing competition within the recycling value chain and growing trends toward mechanization and modernization, their livelihoods are becoming even more vulnerable as the formal sector competes directly for waste streams and larger actors may restrict waste pickers' access to recyclable materials. Occupational and health risks are also substantial: collection, sorting, and transportation activities are typically conducted outdoors, involve intensive physical labour, and take place under hazardous conditions. Workers are exposed to hazardous waste, sharp objects, dust, smoke, and biological contaminants, yet often lack adequate protective equipment and access to appropriate healthcare support (Cardozo & Moreira, 2015; Dias et al., 2024).

A key gap lies in social protection. Most scrap collectors have limited access to social insurance, health insurance, pension schemes, and vocational support programs because they are not recognized within labor policies and urban governance frameworks, despite providing services of public value (Dias, 2016). Certain policies that focus primarily on technical and infrastructure solutions may further increase exclusion by restricting access to waste streams or replacing informal collection activities with mechanized systems without providing livelihood transition mechanisms (Gutberlet & Carenzo, 2020). In contrast, integration models have demonstrated clear benefits, including improved welfare (childcare services and scholarships), better working conditions (uniforms, handcarts, and sorting spaces), and more stable incomes through formal payment mechanisms.

More broadly, the transition towards a circular economy and green cities should be framed within the context of social and labor justice. If material efficiency and technology are prioritized without considering social dimensions, the green transition may reproduce existing urban inequalities.

Therefore, the concept of "inclusive circular economy" emphasizes the need to recognize informal labor and integrate social protection, labor rights, and the participation of scrap collectors into municipal waste management systems (Gutberlet & Carenzo, 2020; Dias et al., 2024).

3.4.4. Data gaps

One of the most prominent gaps at present is the lack of official and systematic data on the scale of operations and the actual contributions of scrap collectors within the recovery-recycling chain. At the urban level, reports often describe the informal sector as an important link in the system; however, quantitative data on the number of participants, collection routes, quantities collected by material type, and recovery rates by season or location are generally available only through project surveys or investigations of collection depots and have not been incorporated into routine statistical reporting. The UNDP policy brief also highlights that this group has not been formally recognized, making data collection and standardization even more challenging.

The direct consequence is the difficulty of quantifying the role of the informal sector within recycling and waste management systems. It is not possible to attribute the contribution of scrap collectors to material flow analyses with certainty; the actual effectiveness of policies such as source segregation and EPR cannot be accurately assessed; and there is a risk of underestimating real recovery rates or designing interventions that are overly focused on the formal sector alone.

Therefore, a data system for policy development should be established in a manner that is both practical and inclusive. This should include: (i) minimum data collection by actor category (waste pickers/collectors, intermediaries, and pre-processing facilities), material type, quantity, and destination; (ii) data verification mechanisms (registration, reporting, and random inspections) to reduce inaccuracies and support EPR compliance monitoring; and (iii) integration of data into local waste management and EPR systems, accompanied by guidance on reporting templates and verification procedures.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

Scrap collectors play an indispensable role in the circular economy value chain in Hue City in particular, and in urban areas in general. They perform initial sorting, mobile collection, and the transfer of recyclable waste streams to scrap collection facilities and subsequently to recycling facilities. The findings indicate that, in the absence of scrap collectors, many small and medium-sized recycling facilities would face serious shortages of raw materials, particularly in localities where source segregation systems have not been fully implemented.

The informal sector recovers approximately 8,550 tons of recyclable waste annually in Hue City (accounting for a dominant proportion of 93% of the total volume of recovered scrap materials), contributing to an estimated reduction of 21,924 tons of CO_2e emissions per year.

Scrap collection is the primary livelihood of vulnerable worker groups, 99% of whom are women in Hue. It enables them to maintain an income during the agricultural off-season or when formal employment opportunities are unavailable. Despite playing a critical role, these workers continue to face social stigma and precarious working conditions. 100% surveyed workers reported having experienced occupational accidents, yet their situation has not been addressed within existing occupational safety policy frameworks.

4.2. Policy recommendations

Provisions recognizing the informal sector should be incorporated into legal instruments such as the Law on Environmental Protection and the Extended Producer Responsibility mechanism.

Coordination mechanisms should be established between scrap collectors and formal-sector entities to harmonize source segregation and collection processes. Payment mechanisms or service contracts financed through EPR funds should be developed for informal collectors to ensure that they receive benefits commensurate with their contributions to collection and primary sorting activities.

Support should be provided to facilitate access to health insurance and social insurance, as well as the provision of personal protective equipment and vocational training, in order to reduce occupational health risks.

A data management system (including registration and quantity reporting) should be developed to accurately quantify the contributions of the informal sector, thereby supporting EPR compliance monitoring and policy formulation.

The establishment of self-managed groups, social organizations, or cooperatives should be encouraged to strengthen workers' bargaining power and protect the rights and interests of scrap collectors.

4.3. Limitations and future research directions

This study relies primarily on secondary data and existing legal documents. Consequently, the findings may be influenced by differences in data completeness, measurement approaches, and reporting objectives across sources, and some aspects may not be reflected consistently. In addition, the analysis focuses on the context of Hue City; therefore, the extent to which the findings can be generalized to other localities may be limited due to differences in solid waste management capacity, scrap material markets, the level of implementation of source segregation, and the structure of participating actors. Therefore, future research should examine in greater depth the impacts of digital transformation and technological applications on the income and social position of scrap collectors. Further studies should also assess the long-term impacts of the EPR mechanism, once fully operational, on the livelihoods of informal sector workers.

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