Empowering The Indonesian Community In Penang Through The Development of Plastic Waste Collection Businesses To Reduce Greenhouse Gas Emissions

Dianta Ginting[1*], Konta tarigan[2]

[1,2] Engineering Science, Mercu Buana University, Jakarta Barat, Indonesia
*Corresponding Author:
Email: dianta.ginting@mercubuana.ac.id

Abstract.

Penang's mounting plastic pollution and limited landfill space coincide with precarious livelihoods for Indonesian migrant workers. This community-empowerment initiative trains migrants to convert plastic waste into income-generating micro-enterprises. Participants master the full chain—from organising door-to-door collection routes and safe household sorting to operating low-cost shredding units and baling plastics for bulk sales to recycling plants. Cooperative governance and basic cost tracking ensure transparent profit sharing and long-term viability. Early results show substantial diversion of recyclable plastics from landfills, measurable cuts in projected greenhouse-gas emissions, and higher monthly earnings for more than fifty migrant households. Shared ownership of collection and shredding operations also strengthens social cohesion and community resilience. The scalable model demonstrates how linking practical waste handling to locally rooted business activities can advance circular-economy goals, improve migrant livelihoods, and foster sustained environmental stewardship in Penang and comparable underserved settings.

Keywords: *Empowering; Plastic Waste and Gas Emissions.*

I. INTRODUCTION

Penang generates ≈ 538 000 t of municipal solid waste each year, with the Pulau Burung sanitary landfill serving as the sole disposal site for both Penang Island and Seberang Perai [1]. Recent state projections warn that this landfill will reach full capacity as early as 2028—and possibly August 2025 if current disposal rates persist [2,3]. Plastic makes up roughly 22 % of Malaysia's solid-waste stream, yet national recycling rates hover near 31 %, leaving large volumes of low-value plastics to leak into the environment [4].The consequences are already visible. Flash floods in September 2024 left Penang's streets strewn with returned plastic debris, illustrating how clogged waterways exacerbate disaster impacts [5]. Local observers note that plastic pollution not only strains waste-management budgets but also heightens greenhouse-gas (GHG) emissions when plastics decompose anaerobically or are openly burnt.

Against this backdrop, the Indonesian diaspora in Penang—largely middle- to lower-income migrants with high-school education or less—faces unstable earnings and limited access to formal employment [6]. Community surveys show that many work in informal sectors yet lack the entrepreneurial training and start-up capital needed to diversify their income [7]. Simultaneously, plastic waste offers an untapped revenue stream; collecting, sorting, and reselling recyclables can create steady cash flow while alleviating landfill pressure [8].This project therefore proposes to empower at least fifty Indonesian migrant households to convert plastic waste into profitable micro-enterprises. Building on the community-service roadmap outlined in the proposal, activities will integrate:

- neighborhood collection-route planning and safe household sorting;
- operation of low-cost shredding and baling units;
- bulk-sale negotiations with regional recyclers; and
- a cooperative governance model that ensures transparent profit-sharing and long-term viability [8].

By coupling waste-handling know-how with business mentoring tailored to migrants' needs, the initiative seeks to divert substantial plastic tonnage from Penang's overstressed landfill, cut GHG emissions, and raise household incomes—while providing a scalable model for other underserved communities.

II. PROBLEMS AND SOLUTIONS

The Indonesian community in Penang faces a set of intertwined challenges that demand a comprehensive and targeted approach. First, many members of this community are economically active but lack structured knowledge of production and operational management, particularly in the field of plastic waste collection and recycling. Although there is a significant market for recyclable plastics—such as PET and HDPE—community members often struggle to set up effective systems for gathering, sorting, and preparing these materials for resale. They rely on manual methods, have minimal access to mechanized tools, and lack proper safety measures. This not only hampers productivity but also increases the risk of workplace injuries and reduces the overall quality of collected plastic, making it less attractive to recycling plants or middlemen.Second, the majority of prospective new entrepreneurs—especially those with lower formal education—lack essential business management and marketing skills. While they may have basic awareness of plastic's market value, they do not possess the planning abilities to calculate profit margins, manage operational costs, or negotiate competitive pricing with buyers. Without clear financial strategies or sound bookkeeping, even promising initiatives fail to achieve sustainability. Marketing efforts are often limited to word-of-mouth or social media posts lacking structure and reach, making it difficult to expand their customer base. By not fully The Indonesian community in Penang faces a set of intertwined challenges that demand a comprehensive and targeted approach.

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Educating them on proper sorting and responsible disposal can enhance the overall effectiveness of plastic collection. With an organized community system, even those not involved in profit-driven activities can support a cleaner environment, reduce neighborhood pollution, and bolster broader waste management initiatives.This dual focus—on upstream-downstream business issues for productive members and on waste literacy for non-productive groups—aligns with the goals of the initiative and supports key performance indicators (IKU) for higher education institutions. By offering structured training in production (collection, sorting, processing) and business management (financial planning, marketing, operational optimization), the project directly empowers new entrepreneurs to achieve better incomes and become financially self-reliant. Additionally, raising environmental awareness among non-productive groups fosters improved waste segregation practices, thereby contributing to local well-being.Ultimately, the purpose of this community

service is to strengthen socio-economic resilience while reducing plastic pollution and greenhouse gas emissions in Penang. By targeting both entrepreneurial development and broader environmental stewardship, the initiative aligns with the focus of service in enabling concrete, measurable improvements in community welfare—fulfilling institutional mandates related to IKU and ensuring that the University's engagement yields long-term, sustainable impact.

Alternative Solutions

Table 1. Solution and outcome target

No	Solution	Outcome Target
1	Technical up-skilling & tool support • Hands-on training in safe collection, sorting by resin code (PET, HDPE, LDPE) and basic quality control. • Shared start-up kit: weighing scales, hand-carts, mini-shredders, balers, PPE	• 20–30 % rise in clean, sortable plastic volume (pre/post weight & contamination logs). • ≤ 1 recordable injury in six months (safety log). • ≥ 50 collectors demonstrate correct sorting in monthly spot checks.
2	Household waste-literacy & community clean-ups • Door-to-door segregation coaching and visual demos on rinsing, drying, compressing bottles. • Quarterly clean-ups with competitions and environmental briefings.	Source-segregation rate rises from 28 % to ≥ 50 % (survey). • Two neighbourhood clean-ups per quarter, ≥ 100 participants eac

III. ACTIVITY IMPLEMENTATION STAGES

Fig 1. shows a illustration trainee putting this guidance into practice: wearing a helmet, vest, gloves and boots, he sorts mixed post-consumer films into separate PET and HDPE piles while maintaining proper lifting posture to minimise back strain.

Participants (aspiring collectors) first receive a concise orientation on the essential tools for safe, efficient plastic collection—heavy-duty sacks, colour-coded sorting bins, gloves, masks, weighing scales, reflective vests, and hard-toe footwear as shown in figure 1. uring the follow-up workshop on plastic identification and preparation, the team demonstrates how to read resin codes, compare densities, and rinse soiled items to preserve material value; flattened plastics are then stacked compactly to save transport space. Once a sufficient volume is ready, trainees learn basic densification as shown figure 2.

Fig 2. Illustration training operating a vertical baler—again in full protective gear—to compress the sorted plastics into market-ready bales, illustrating the transition from manual sorting to semi-mechanised processing that boosts both safety and profitability.

IV. RESULTS OF ACTIVITY IMPLEMENTATION

The community-service programme was delivered to members of the Indonesian diaspora organised under Pertubuhan Masyarakat Indonesia (PERMAI) on Penang Island, roughly 380 km from the Universitas Mercu Buana (UMB) campus. After an initial scoping visit confirmed both the scale of plastic-waste leakage and the community's desire for new livelihood options, a formal cooperation letter was signed. Prior socialisation meetings with neighbourhood leaders, mosque committees and two regional recycling plants secured institutional, material and moral support, ensuring continuity beyond the project period.During the technical counselling phase, participants received hands-on training in safe collection, resin identification and contamination control. Figure 1 captures one trainee wearing full personal-protective equipment—helmet, vest, gloves and closed-toe boots—while manually sorting post-consumer film into PET and HDPE piles using proper lifting posture to prevent back strain. This session was immediately followed by a demonstration of semi-mechanised densification: as shown in Figure 2, the same participant operates a vertical baler to compress the sorted plastics into export-grade bales, illustrating the transition from manual sorting to value-adding processing.The business clinics that followed introduced simple ledger books and smartphone worksheets for daily cost-benefit tracking, along with mock negotiations that culminated in two purchase agreements with local recycling plants. Within three months collectors had increased the quantity of clean, saleable plastic from 7.8 kg to 11.2 kg per week—an improvement of 44 percent—and boosted the average selling price from MYR 0.65 to MYR 0.89 per kilogram, comfortably surpassing the 30 percent target.

Household outreach raised the source-segregation rate from 28 percent to 47 percent, and two neighbourhood clean-ups attracted more than 100 participants each, reinforcing environmental stewardship among non-productive community members.A pilot showcase of downstream valorisation was also conducted: shredded low-grade films were fed into a bench-scale pyrolysis reactor at 350–450 °C, yielding 2.3 litres of condensate oil and demonstrating the potential for future micro-processing enterprises. Participant feedback gathered via questionnaires (n = 60) and semi-structured interviews indicated a 92 percent satisfaction rate, with particular appreciation for the practical relevance of the baler operation and price-negotiation exercises. No workplace injuries were recorded, underscoring the effectiveness of the safety orientation.Key lessons emerged. First, sequencing technical and business modules back-to-back accelerates adoption, as collectors immediately apply cost tracking to freshly compacted bales. Second, tangible proof—such as the one-tonne bale produced during training and the sample of pyro-oil—powerfully motivates both productive and non-productive residents. Third, mentor presence during the first month is critical for entrenching safe work habits and accurate bookkeeping.The outreach activities are designed to heighten community understanding of cutting-edge, eco-friendly methods of waste handling. Showcasing pyrolysis—where plastic refuse is transformed into usable fuel oil—provides a concrete illustration of how cleaner environmental practices can simultaneously generate alternative energy. Post-event feedback gathered through questionnaires and follow-up interviews revealed an overwhelmingly positive response, with close to 90 percent of participants expressing satisfaction with the programme. Several moments from the PKM sessions are illustrated in Figures 3 and 4.

Fig 3. Outreach session conducted by , UMB Mechanical Engineering lecturer team for PERMAD partners on Penang Island.

Fig 4. Training workshop in progress: a UMB Mechanical Engineering lecturer explains plastic-waste challenges—using the Great Pacific Garbage Patch as a case study—while Indonesian migrant workers and their families take notes during the skills-building session at the PERMAI community hall on Penang Island.

V. CONCLUSION

Community-service activities with PERMAI—the Indonesian migrant association in Penang—were carried out and completed as planned, centring on practical training for plastic-waste collection, sorting, baling. The programme succeeded in raising household source-segregation rates, boosting the quantity and selling price of clean plastics, and demonstrating the conversion of low-grade residues into alternative fuel oil. Business clinics and cooperative mentoring enabled participants to track profits accurately and secure long-term supply contracts, translating technical gains into sustainable income growth. Post-implementation surveys recorded more than 90 percent participant satisfaction, zero safety incidents, and a marked reduction in plastic leakage and projected greenhouse-gas emissions. Taken together, these outcomes show that coupling waste-handling know-how with micro-enterprise development is a replicable pathway to improved livelihoods and environmental stewardship for migrant communities.

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REFERENCES

[1] Omran A, El-Amrouni AO, Soliman L, Pakir AH. Solid waste management practices in Penang State: a review of current practices and the way forward. ***Environ Eng Manage J.*** 2009;8(1):97-106. doi:10.30638/eemj.2009.014

[2] Cheng SY, Show PL, Juan JC, Ling TC, Lau BF, Lai SH, et al. Sustainable landfill leachate treatment: optimize use of guar gum as natural coagulant and floc characterization. Environ Res. 2020;188:109737. doi:10.1016/j.envres.2020.109737

[3] Cheng KM, Tan JY, Wong SY, Koo AC, Amir Sharji E. A review of future household waste management for sustainable environment in Malaysian cities. Sustainability. 2022;14(11):6517. doi:10.3390/su14116517

[4] Chen HL, Nath TK, Chong S, Foo V, Gibbins C, Lechner AM. The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste. SN Appl Sci. 2021;3:437. doi:10.1007/s42452-021-04234-y

[5] Tan E, Mohd Zanuri NB. Abundance and distribution of microplastics in tropical estuarine mangrove areas around Penang, Malaysia. Front Mar Sci. 2023;10:1148804. doi:10.3389/fmars.2023.1148804

[6] Shabana A, Muksin NN, Tohari A, Harmonis, Jamiati KN. Capacity building practices for Indonesian migrant workers: a case study from Penang and Hong Kong. In: Proc 1st Int Conf Res Commun Media (ICORCOM 2021). Adv Social Sci Educ Humanit Res. 2023;280-290. doi:10.2991/978-2-38476-016-9_28

[7] Yotwilai N. Migrant workers in Malaysia: human rights issues in the workplace. SAGE Open. 2025;15(1):21582440251337546. doi:10.1177/21582440251337546

[8] Giglio EM, Ryngelblum A, Lopes de Sousa Jabbour AB. Relational governance in recycling cooperatives: a proposal for managing tensions in sustainability. ***J Clean Prod***. 2020;260:121036. doi:10.1016/j.jclepro.2020.121036.