

IMPACT SHEET: PROTOPRINT

Promoting Socio-economic Transformation by Empowering Informal Waste Pickers for Production of 3D Printing Filaments in Pune



Supporting inclusive, decentralised recycling models by enabling waste pickers to move up the plastic value chain through sustainable production practices.



PROJECT BACKGROUND

Project Protoprint was implemented in Pune, India, by Kashtakari Panchayat with support from Adelphi Research GGMBH, Social Seva Initiatives Private Limited, Swach Plus Seva Sahakari Sanstha Maryadit, and Swach Pune Seva Sahakari Sanstha Maryadit. The project's overall objective was to improve the lives of marginalised waste pickers in Pune through replicable models for sustainable livelihoods enabled by re-skilling, innovative technology, and upward movement in the value chain. Its specific objective was to develop an innovative city-wide network of enterprises owned and operated by clusters of waste pickers to process collected plastic waste into higher value products, including recycled plastic and 3D printing filament. The implementation approach is situated within Pune's waste picker-led collection system, where plastics constitute a significant livelihood-relevant fraction of dry waste streams.

CHALLENGE

Collection of plastic waste in India is predominantly done by informal waste pickers who earn their living by selling to the scrap dealers. Due to their network-like structure and the extent of manual labour involved, they play a very significant role in the downstream processes and achieve very high collection rates, but realise only a small fraction of the value of the plastic they collect. They are forced to work under severe constraints: low and volatile margins, limited storage and sorting space, dependence on cash transactions, and restricted access to formal infrastructure, finance, and compliant markets. These structural conditions reduce the feasibility of safe and compliant upgrading of materials, constrain quality control and scale, and risk excluding informal actors from formal value chains unless enabling conditions for inclusive participation are developed.

PROJECT OBJECTIVES

The project aims to demonstrate inclusive and sustainable plastic recycling models that enhance waste picker livelihoods through value addition, skills development, and integration into compliant recycling supply chains.

The specific objectives include:

- To establish a decentralised, compliant plastic recycling infrastructure
- To enhance the technical and organisational capacities of waste pickers
- To enable value addition to low-value plastic waste streams
- To strengthen upstream and downstream market linkages
- To document and share policy-relevant implementation learnings

TARGET GROUPS

- Waste pickers associated with the local waste picker organisations.
- Waste picker-led and scrap enterprises
- Local municipal and public authorities
- Vendors and manufacturers using recycled plastic and creating value-added output.

PROJECT ACTIVITIES

Plastic Recycling

Project Protoprint established two recycling units sourcing plastic waste primarily from waste picker-led scrap shops. Over the project period, 249 metric tons of plastic waste were procured, of which 76% was recycled in-house and 21% channelled to other recyclers. The unit operated in two shifts, processing 20–30 tonnes per month at peak.

While significant technical capacity was built, including advisory support from IIT Bombay for 3D filament development, the project revealed structural financial challenges in running compliant plastic recycling facilities. These learnings are critical for informing future policy and infrastructure planning.

Strengthening Waste Picker Enterprises

Approximately 350 waste pickers were integrated into a hub-and-spoke supply chain, generating 23 new jobs within the recycling value chain. Four waste picker-led scrap enterprises were supported with formalisation and technical guidance. Additionally, 120 decentralised sorting and storage micro-units were set up, benefiting over 200 waste pickers and significantly improving plastic recovery and income stability.

Training and Capacity Building

A dedicated training module on plastic processing and value-added recycling technologies was developed and delivered to 758 waste pickers (majority women). Exposure visits to the recycling units strengthened technical understanding. The project team also built in-house technical capacity through formal training and peer learning within the recycling sector.

Policy Advocacy and Knowledge Dissemination

The project documented key operational and financial learnings on the viability of compliant plastic recycling. Three policy briefs — Just So recycling, Just Reuse, and Just Transition — were launched at a national event in Delhi, alongside stakeholder roundtables and dissemination events. Participation in national exhibitions and industry forums further amplified visibility and contributed to a more nuanced understanding of the role of waste pickers in India's circular economy..

LESSONS LEARNED

The implementation of Project Protoprint was significantly affected by delays related to site identification and statutory compliance. Many shortlisted sites failed legal and documentation checks, while those eventually finalised involved higher rental, utility, and security costs than originally anticipated. Securing the “Orange Category” clearance from the Maharashtra Pollution Control Board was particularly arduous. The absence of precedents for decentralised, waste picker-led recycling units operating within a fully compliant regulatory framework further extended approval timelines and necessitated external technical and legal support.

Operational scale-up was constrained by a combination of market and supply-side factors. Capital costs increased substantially due to post-pandemic price escalation and additional safety and environmental requirements, while operating costs remained above break-even levels. Market conditions deteriorated due to a slump in recycled plastic prices linked to falling crude oil prices, limiting competitiveness and delaying forward offtake arrangements. At the same time, sourcing material directly from waste pickers and scrap centres proved challenging due to space constraints, heterogeneous material quality, reliance on cash transactions, and limited capacity to issue tax-compliant invoices. In response, the project adapted its implementation strategy by diversifying outputs, engaging specialised technical experts, and strengthening capacity-building support.

This initiative aimed to establish a fully compliant, fair-trade plastic recycling enterprise centred on waste picker empowerment and value addition. Unlike most actors in the sector, the project prioritised environmental clearances, labour standards, tax compliance, and safe working conditions over cost competitiveness. The result was a technically sound and fully compliant facility that proved financially unviable under prevailing market conditions.

A key lesson was the complexity and narrow margins of plastic recycling. “Rigid plastic” includes multiple resin types, but only a small fraction—primarily select HDPE packaging—was suitable for high-value applications. Even then, sorting by resin, manufacturing process, and colour was essential, with lighter colours commanding higher value. The recycling process involves unavoidable material losses and gradual degradation, limiting circularity.

Market dynamics further constrained viability. Recycled plastic prices are benchmarked against virgin plastic, which is tied to global crude oil prices. Recyclate remains competitive only when significantly cheaper than virgin material. At the same time, compliance costs—GST on scrap, industrial zoning, pollution control clearances, and effluent treatment requirements—create structural disadvantages for fully compliant enterprises in a largely informal sector.

Although the unit did not achieve long-term sustainability, the project generated critical insights that have been documented and shared to inform policy and strengthen efforts toward a more inclusive and sustainable recycling ecosystem.

PROJECT ACHIEVEMENT

The project established and operationalised compliant, waste picker-led recycling units in Pune, demonstrating inclusive plastic processing in line with formal labour and environmental standards while generating verified operational data and implementation learnings for sustainable consumption and production.

- 443 waste pickers increased their income from plastic waste sales in the local market.
- 709 waste pickers trained, with over 500 reporting improved knowledge of plastic processing and value-added technologies.
- 23 green jobs created and two decentralised plastic collection and processing ecosystems established.
- Four satellite scrap centres and two high value-added processing units operationalised.
- 250+ MT of plastic recycled, avoiding an estimated 286 tonnes of CO₂-equivalent emissions.
- Three policy briefs, two sectoral reports, and one national roundtable contributed to policy dialogue and sector awareness.





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Kashtakari Panchayat



This project gave us a rare inside view of how plastic recycling actually works in India — from resin types and material losses to market dynamics and regulatory barriers. We set out to build a fully compliant, fair-trade recycling enterprise centred on waste pickers, and in attempting to operate such a facility, we exposed the structural disadvantages faced by ethical enterprises in a price-driven, largely informal market. While the unit was not financially viable, the lessons were invaluable. Documenting and sharing these insights is, we believe, our most important contribution toward building a more just, transparent, and sustainable recycling sector.



Long-term project sustainability

The project demonstrates that operating a fully compliant, waste picker-led recycling facility at a boutique scale is structurally challenging to sustain on purely commercial terms. Formalisation entails significantly higher capital and operating costs related to labour standards, environmental compliance, quality control, and infrastructure, which are not fully compensated under prevailing market prices for recycled plastics. At a small scale, these cost structures limit financial viability and expose operations to market volatility, underscoring that compliance and inclusion cannot be sustained without enabling market or policy conditions.

The recycling machinery will be retained by Kashtakari Panchayat to disseminate project learnings and bridge knowledge gaps in plastic recycling, including potential collaboration with Pune-based universities for research and curriculum development. Part of the machinery has been relocated to support an end-to-end demonstration of waste collection and recycling, which SWaCH will integrate into its “Waste Trail” educational module. While the recycling units have closed, the four collective scrap shops—comprising over 350 waste pickers—will continue as financially viable enterprises, increasing member incomes through improved material recovery and annual profit-sharing, adding an estimated 8–10% to earnings.

The project’s long-term contribution lies less in the indefinite continuation of pilot-scale operations and more in the generation of credible operational evidence, institutional learning, and policy-relevant insights. By documenting cost structures, material losses, labour requirements, compliance and market constraints, the project provides a grounded basis for informing future scale-up strategies, public procurement models, EPR implementation, and fiscal or infrastructural support mechanisms. These learnings support more realistic pathways toward sustainable consumption and production that integrate informal workers under fair and compliant conditions, rather than relying on small-scale pilots to absorb systemic risks.

Project contributions to Climate Change Mitigation and SDGs

The project contributed to climate change mitigation by improving the recovery and recycling of post-consumer plastics under environmentally compliant conditions, thereby reducing reliance on virgin plastic production. By processing mixed streams of post-consumer rigid plastics into secondary raw materials, the project supported emissions avoidance associated with raw material extraction and polymer production. Importantly, the project also generated evidence on the true costs of compliant recycling— including energy, labour, and infrastructure requirements— contributing to a more realistic assessment of the climate implications of formalisation in informal-sector-dominated value chains.

The project contributes to climate change mitigation and SDG 12 primarily by improving the efficiency and quality of plastic recovery and recycling under compliant conditions. By focusing on all types of rigid plastics and not just “cherry picking” higher quality material, the project reduces the demand for virgin plastic production and is circular in the true sense of the word. The establishment of controlled sorting, washing, and extrusion processes also improves material quality and traceability, supporting more resource-efficient use of plastics within local value chains.

By improving plastic recovery and recycling under compliant conditions, the project supports climate action by reducing emissions and strengthens sustainable cities by reducing pressure on urban disposal systems. Formal employment practices contribute to decent work and economic security, while safer working conditions (including access to PPE kits, and eluent treatment) support both worker and community health and well-being. Capacity building, skills development, and knowledge generation helped disseminate quality education and promote innovation, while engagement with local authorities and multi-stakeholder partnerships reinforces inclusive institutions and collaborative governance. At the same time, the project also highlighted the cost and viability challenges of formalisation— underscoring that progress on consumption, climate, and urban sustainability depends on supportive policies, infrastructure, and partnerships across goals rather than isolated, single-goal interventions.

Impacts at a Glance

Economic Impact	<ul style="list-style-type: none"> • 443 waste pickers has increased income from the sale of plastic waste during the project period • New green products: recycled PP and HDPE pellets, pilot-scale HDPE 3D printing filament
Environmental Impact	<ul style="list-style-type: none"> • Reduced leakage of plastic waste into landfills and open dumping with more than 250,000 kg of post-consumer plastics diverted to recycling • Lower risk of soil and water contamination from unmanaged plastic waste • Reduced demand for virgin plastic production • Improved environmental compliance within decentralised recycling
Social Impact	<ul style="list-style-type: none"> • Waste pickers employed under regulated working hours with minimum wage compliance and social security provisions • Increased female workforce involvement - 100% of scrap shops supported were owned and managed by women • Stable incomes leading better nutritional impacts on families • Access to healthcare and insurance
Climate Benefits	<ul style="list-style-type: none"> • More than 250,000 kg of post-consumer plastics were diverted to recycling, contributing to 286 tonnes of CO₂ equivalent of GHG emission avoidance through reduced reliance on virgin plastic production with 150 MT of granules produced under the initiative
Target Group Engagement	<ul style="list-style-type: none"> • 443 waste pickers integrated in the supply chain and benefits from stable plastic waste prices, 23 were employed at the recycling units, 709 have been trained in technical aspects of recycling • 4 waste picker-run scrap enterprises supported through trainings and capacity building for accounting, bookkeeping and for formalisation
Policy Development	<ul style="list-style-type: none"> • 3 policy briefs developed and launched
Europe-Asia Cooperation	<ul style="list-style-type: none"> • Multi-stakeholder dissemination event (Delhi, 25/09/2025) • Knowledge-sharing and dialogue workshop in collaboration with CEE (Pune, 11/12/2025)





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DURATION

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PARTNERS



Kashtakari Panchayat



SWaCH Pune Cooperative



SWaCH Plus Cooperative



Social Seva initiatives



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