Preventing plastic in Nepal rivers by boosting the informal recycling sector (RiPL)

FINAL REPORT

GRID ARENDAL
A UNEP Partner

NGI

creasion
Envisioning the Change

doko

ISWA
International Solid Waste Association

Supported by

Norwegian Retailers' Environment Fund

Norway

This project has received funding from the Norwegian Retailers' Environment Fund through agreement nr. 12439

Preventing plastic in Nepal rivers by boosting the informal recycling sector (RiPL)

FINAL REPORT

© GRID-Arendal/Sabrina Heerema

Executive Summary

While 15-20% of the plastic waste in Nepal is recycled, most of it is hard-to-recycle or not possible to recycle mixed-type plastic. This waste is then disposed of in landfills; thrown into streets, forests, and rivers; burned; or exported to India. Plastic waste mismanagement and its direct leakages into the air and river ways have adversely affected the air quality, water resources, aquatic biodiversity, and socio-economic well-being of communities in Kathmandu. In addition, rivers carry waste downwards, impacting neighbouring countries and ultimately entering the ocean. The Preventing Plastic in Nepal rivers by Boosting the Informal Sector (RiPL) project recognised the untapped potential of women as collectors, segregators, and community organisers, and aimed to prevent plastic pollution in Nepal's rivers by strengthening women in the informal recycling sector. An estimated number of 15,000 are already working to prevent plastics from ending up in landfills, streets, or rivers in Kathmandu.

RiPL, funded by the Norwegian Retailers' Environment Fund, was implemented from March 2022 to February 2025, with additional support from Norad. The project, carried out by GRID-Arendal, the Norwegian Geotechnical Institute (NGI), the Center for Research and Sustainable Development Nepal (CREASION), Doko Recyclers (Doko), and the International Solid Waste Association (ISWA), had two main phases: baseline mapping and setting up collection hubs and a recycling pilot facility. Phase 1 focused on identifying plastic sources, mapping challenges faced by informal recyclers, and assessing plastic waste composition and leakage hotspots. Phase 2 implemented solutions to increase the recyclability and value of plastics, particularly polyethylene terephthalate (PET) bottles, by establishing collection hubs and piloting technical solutions. The project also emphasised capacity building and awareness raising, including workshops for women in the informal recycling sector to enhance their skills and improve gender equity. The project's comprehensive approach combines research, practical solutions, and policy recommendations to address plastic pollution and empower informal recyclers.

The recommendations from the RiPL project emphasise several key strategies to address plastic waste in Nepal. These include continuing to set up collection hubs to formalise the work of the informal waste sector, seeking recycling opportunities for hard-to-recycle materials, and assessing viable business structures for the manual baler to increase collection efforts in rural areas.

Keywords: *Nepal, plastic pollution, waste management, informal recyclers, environmental leakages, circular economy, extended producer responsibility, high-density polyethylene, Low density polyethylene, polyethylene terephthalate, polypropylene, multi-layered plastic.*

Introduction

Kathmandu is the densely populated capital city and main tourist destination for Nepal, generating 100 000 kilograms of waste per day and overflowing with plastic products, yet lacking the infrastructure to sustainably and responsibly manage its waste. Much of the plastic waste could be more easily reused or recycled if it were properly segregated from the beginning of its' journey. Previous studies, including the Gender and waste nexus (UNEP-IETC and GRID-Arendal, 2019), recognise that there is an untapped potential to capture more plastics by empowering women. The RIPL ("Preventing Plastic in Nepal Rivers by Strengthening the Informal Sector") project was financed by the Norwegian Retailers' Environment Fund with co-financing from Norad and implemented from March 2022 to February 2025. It was carried out by GRID-Arendal, the Norwegian Geotechnical Institute (NGI), the Center for Research and Sustainable Development Nepal (CREASION), Doko Recyclers (Doko), and the International Solid Waste Association (ISWA).

The project has been implemented in two phases, one baseline mapping phase, and one phase setting up collection hubs and a recycling pilot facility. Across both phases, we have also had a strong focus on capacity building, and communication and awareness raising. The project activities conducted as part of both phases are as follows:

<table>
<tr><th>Phase 1</th><th>Phase 2</th></tr>
<tr><td>Identifying the main sources of plastic entering rivers in Kathmandu Valley</td><td rowspan="2">Increasing the recyclability and value of plastics
– Establishing collection hubs
– Developing business case
– Piloting technical solutions</td></tr>
<tr><td>Mapping the challenges that Informal recyclers are facing</td></tr>
<tr><td colspan="2">Building the capacity of women in the informal waste sector</td></tr>
<tr><td colspan="2">Communicating and raising awareness on the ability of women informal recyclers to reduce plastics</td></tr>
</table>

© GRID-Arendal/Tina Schoolmeester

Phase 1: During Phase 1 of the project, a research-based approach was executed to assess the plastic leakages and boost the informal sector, fostering better solid waste management. The findings were summarised in a Baseline Report published in 2024 (Bajracharya et. al. 2024). Furthermore, the Baseline Report found that informal recyclers (also known as Kawadi, Safaikarmi, and Fohor Sankalak), despite often being hailed as environmental heroes by waste management sector actors, are undervalued compared to their white-collar counterparts.

The RiPL project research focused on plastic waste composition, leakage hotspots, and ways to empower the informal recycling sector workers. Key findings include quantifiable data on plastic waste leakage into Nepal's river, identification of primary plastic pollution hotspots, and detailed analysis of plastic waste composition. Considering the gap in plastic waste management literature, this project played a pivotal role in illuminating the urgency of addressing plastic pollution. Moreover, the assessment of the current state of informal waste management, including the gaps and opportunities for improving informal recyclers' livelihoods and working conditions, are recognised through this project. The project encompasses both qualitative and quantitative research establishing a compelling case.

Phase 2: Based on the findings from Phase 1, presented in the Baseline Report, we have implemented the second Phase of the project. The activities and results from this phase are presented in this report.

CHAPTER 1

Identifying the main sources of plastic leakage into Kathmandu rivers

The baseline survey was used to establish how to best increase the recyclability and value of plastics. Initially, the project partners hypothesised that the majority of plastic waste ending up in Nepal's rivers consisted of types that were either difficult to recycle or had such low value that no one was willing to collect them. This hypothesis was largely confirmed by the 'Plastics in Rivers Audit' conducted during the first year of the project, the results of which were presented in the Baseline Report (Bajracharya et. al. 2024). The audit revealed that 77% of the plastic waste found was considered 'hard-to-recycle'. Of the remaining 33% that was deemed 'easily recyclable', 73% consisted of polyethylene terephthalate (PET) bottles. Compared to other easily recyclable plastic fractions, PET bottles have a relatively low price per volume. This means that the costs associated with temporary storage, transportation, and other logistics of collecting this fraction are significantly higher than for other plastic fractions.

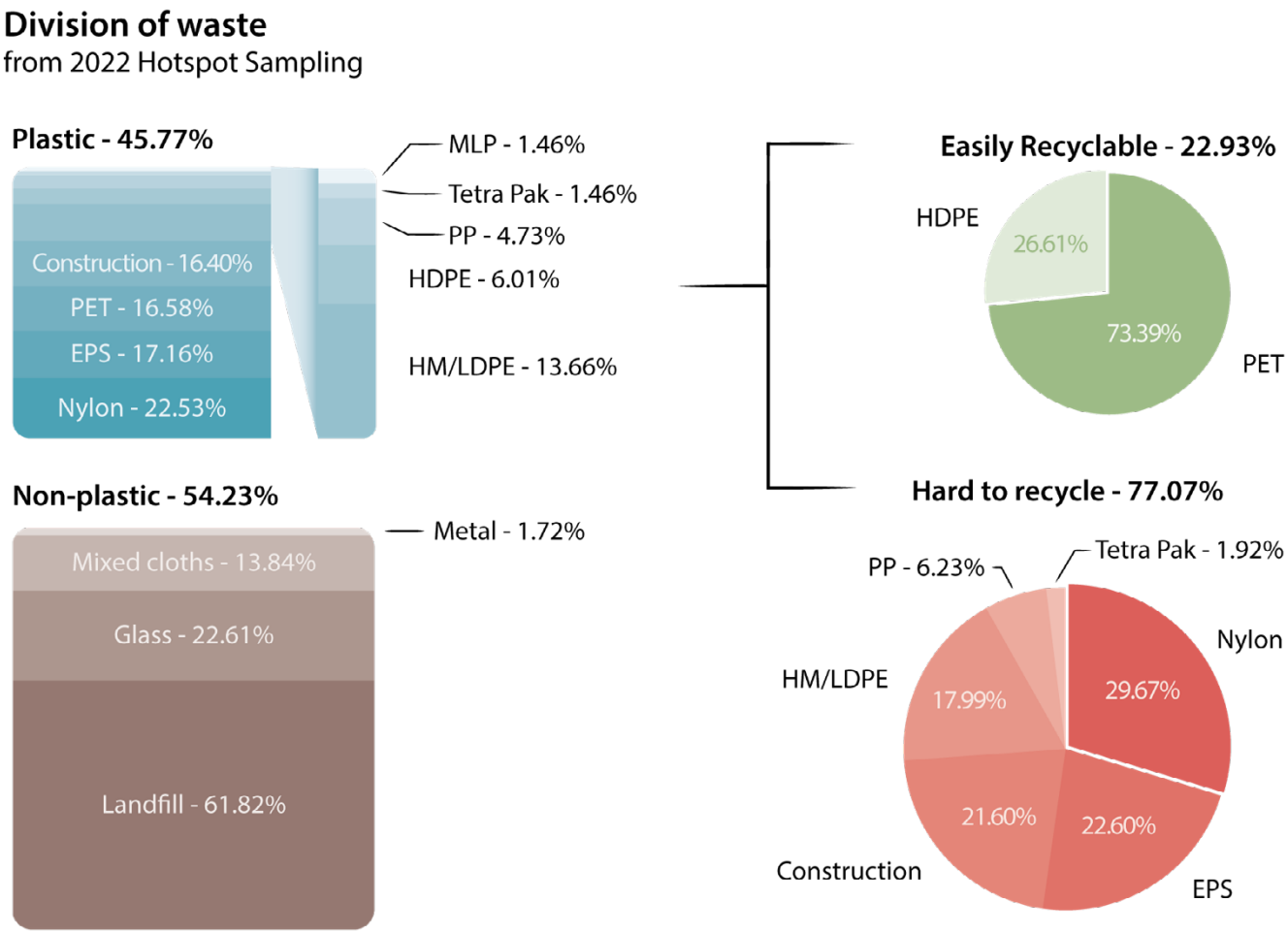


Figure 1: Division of waste into Plastic and Non-plastic, as well as easily recyclable and hard- to-recycle. (GRID-Arendal, 2024). Based on this analysis, our subsequent efforts have focused, in particular, on increasing the recyclability and value of polyethylene terephthalate (PET) bottles and hard-to-recycle fractions. This has been addressed by establishing two collection hubs, developing a business case to strengthen the private sector, and piloting technical solutions.

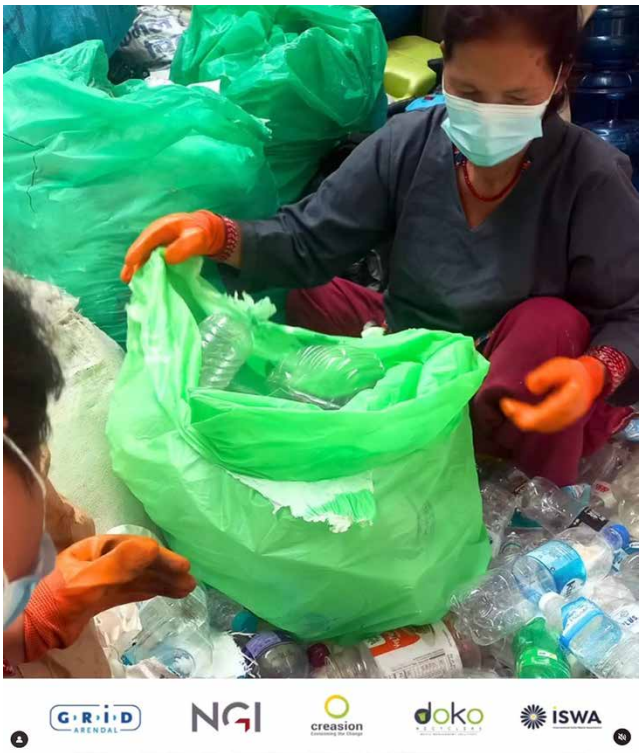
CHAPTER 2

Understanding and mapping the challenges that informal recyclers are facing

RiPL conducted a survey of 40 informal recyclers in the project's first year as part of the baseline study as a basis to co-create tailormade solutions. In addition to the survey, the project conducted two events, serving as both knowledge-sharing opportunities and to raise awareness of the challenges that informal recyclers face among waste management stakeholders.

Project kick-off event and Workshop 1

At the project launch workshop, a group of 10 women working informally in the recycling sector were present and actively participating. In front of over 40 other stakeholders within the sector, including NGOs, waste management actors, local and federal government representatives, they spoke about the main challenges they experience, they provided ideas of what kind of business opportunities they would be interested in, and how their interactions with formal state services have been.



A social media post made by local project partners about the important work of the women working at the RiPL collection hubs.

A group of informal recyclers presenting their business ideas at the project's kick-off workshop.

Regular social media posts were made about the capacity of women working in the informal recycling sector.

© Video: CREASION 2023.

A video released at the beginning of the RiPL project to spread awareness of the challenges faced by informal recyclers.

The project's Instagram account was updated regularly with updates on the progress of the women involved in the project and their work, and these were shared by project partners across their existing communications channels.

Participants provided more details about their challenges in one-to-one interviews, which were recorded and shared in social media campaigns and on the communication channels of our Nepali partners.

Year 2 Capacity-building workshop

The second workshop provided opportunities to share with each other in a safe, private space and insights from these conversations were used to deliver more targeted activities in the project.

© Video: GRID-Arendal/Sabrina Heerema

A social media post to spread awareness of the challenges faced by informal recyclers. Pictured here, Mokhila Khatun who was 9 months pregnant and participating in the training to increase her capacity.


PP

CHAPTER 3

Increasing the recyclability and value of plastics

To address the challenges identified in our project, we established two collection hubs in Kathmandu, which enhanced the recyclability and value of polyethylene terephthalate (PET) bottles and hard-to-recycle plastics, while also creating employment and training opportunities. The project also piloted technical solutions for recycling hard-to-recycle plastics based at these hubs.

Establishing plastic collection hubs at hotspots for plastic pollution

Two decentralised waste collection centres have been established in Kathmandu Valley to collect plastic from two of the identified hotspot areas for plastic leakage into Kathmandu rivers: one in Dallu, Ward 15 of Kathmandu Metropolitan City, and another in Budhanilkantha, Ward 1.

Top: The first hub at Dallu, Bottom: The second hub at Budhanilkantha.

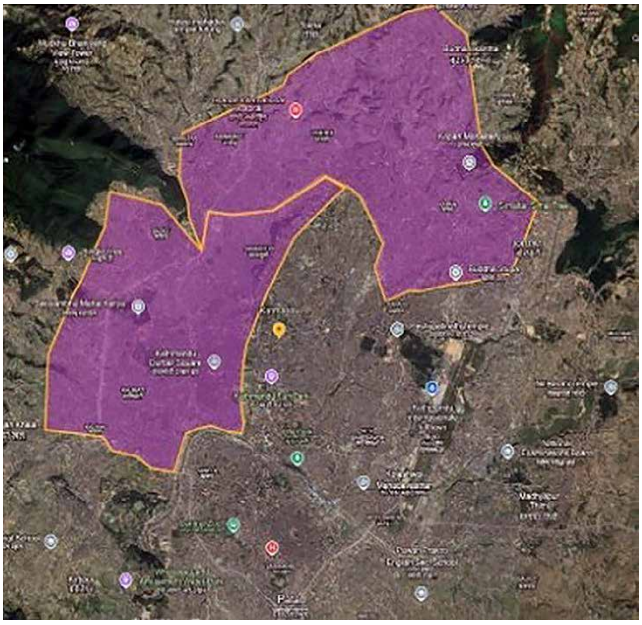
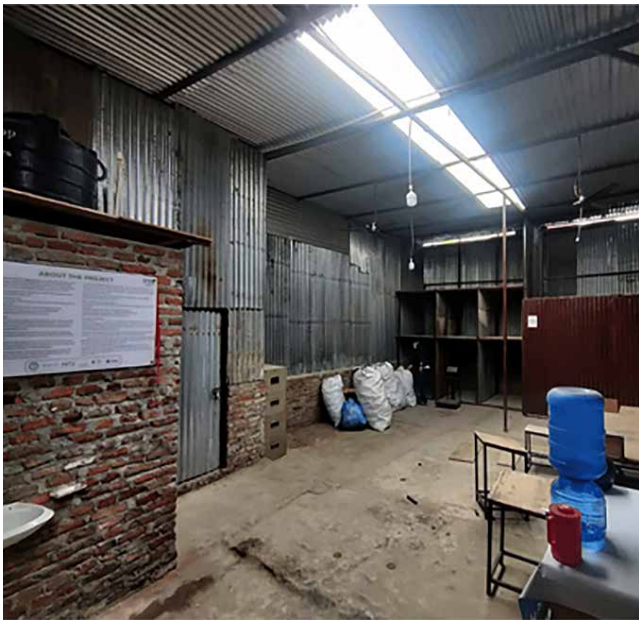


Figure 2: The map shows the area where waste is being collected for the two RiPL collection hubs.



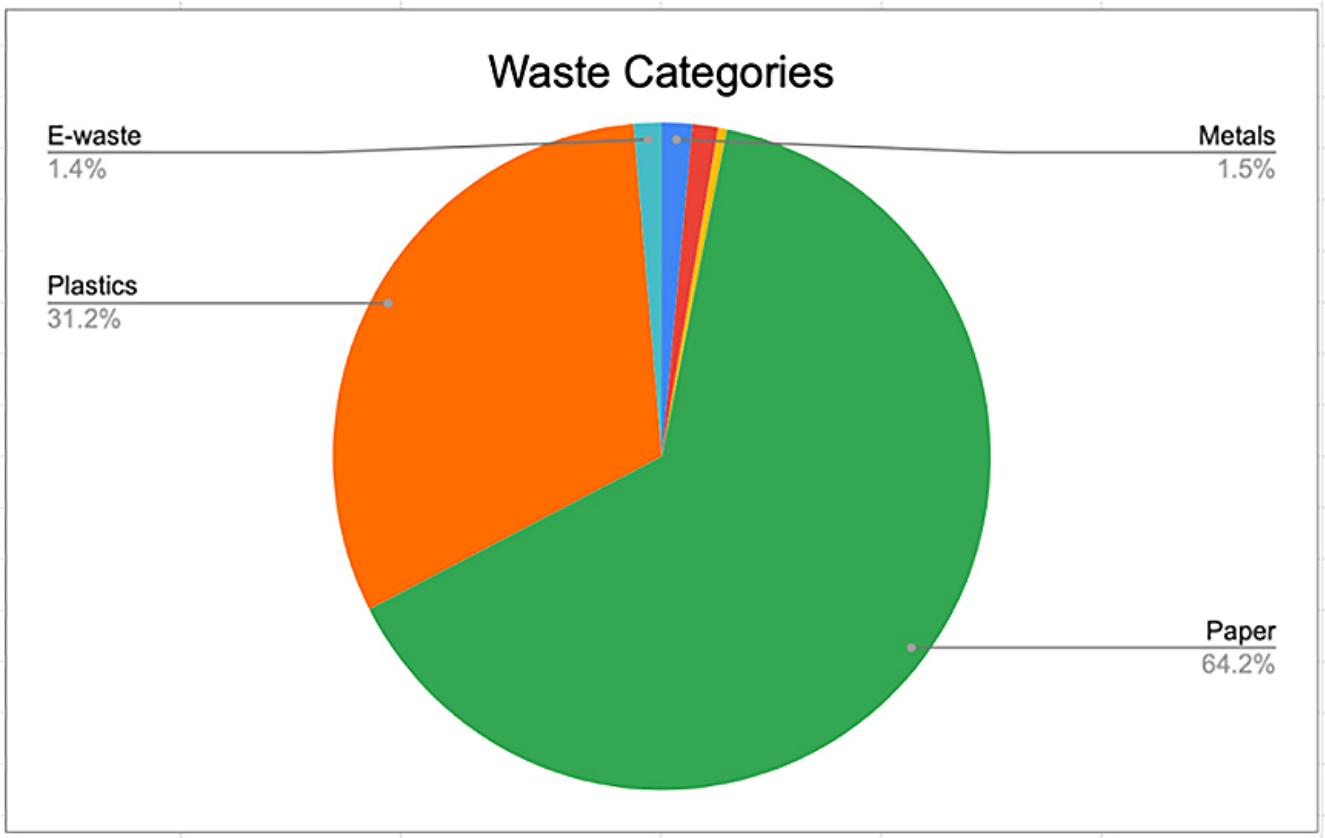
The first waste collection hub at Dallu.

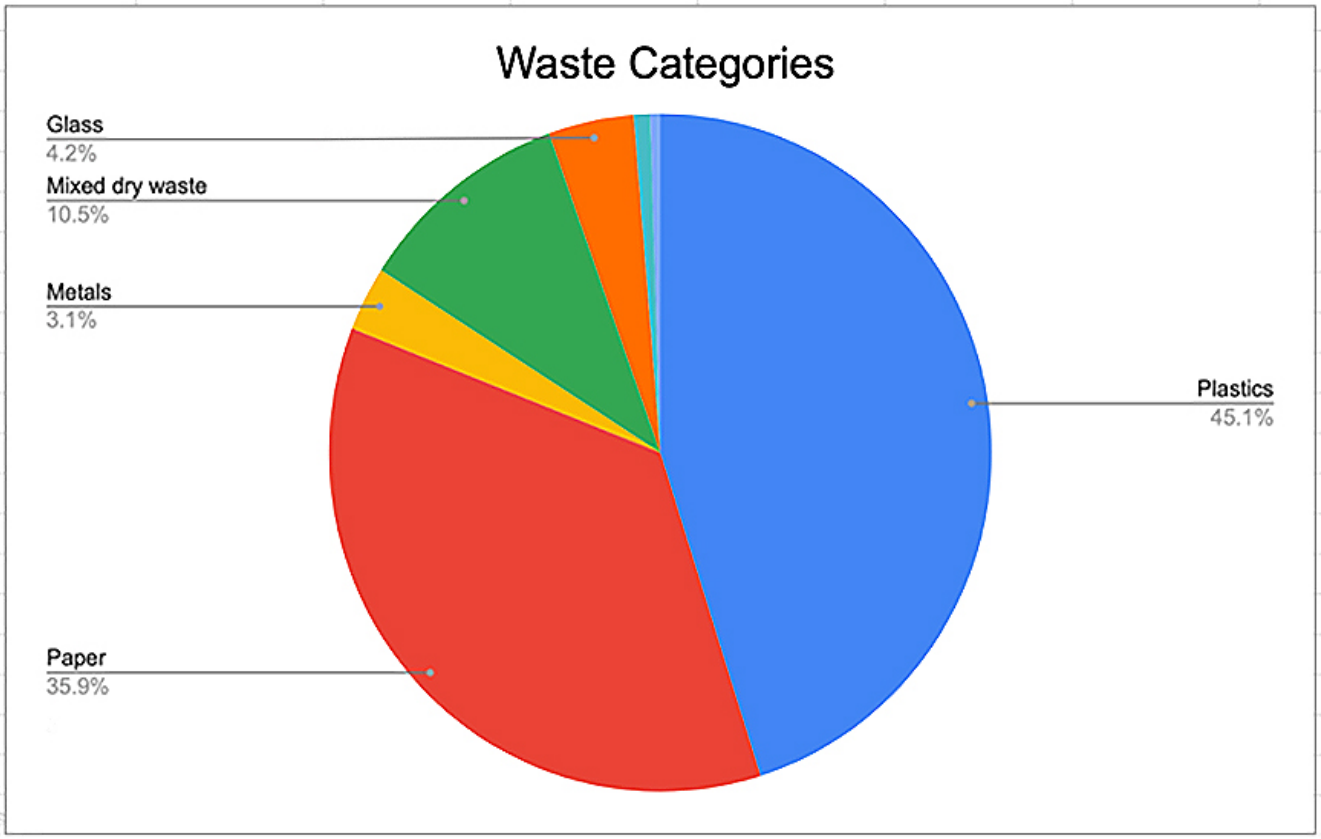
The collection centres increased informal recyclers' knowledge about the operational aspects of waste collection and employ a team of nine people, who have received training on:

- Occupational health and safety
- Proper use of personal protective equipment and efficient fire extinguisher operation
- Social and Environmental Accountability
- Gender Equality and Social Inclusion

The decentralised collection centres have gathered more than 200,000 kilograms of mixed waste over the past two years. The first hub has collected over 111,000 kilograms within 18 months, while the second hub has accumulated over 87,000 kilograms in 12 months. The detailed breakdown is provided below.

As of February 2025, a total of 111,751 kilograms of waste have been collected at the Dallu Hub, with plastics





comprising the largest portion at 50,408 kilograms (45.1%), followed by paper at 40,081 kilograms (35.9%). Mixed dry waste accounts for 11,741.9 kilograms (10.5%), metals for 3,431 kilograms (3.1%), glass for 4,642 kilograms (4.2%), and non-recyclables and other waste making up the remaining 1,446 kilograms (1.3%).

The collection centres are financially sustainable because they offer collection for all types of waste, from low-value to high-value, including paper, metals, e-waste, glass, and plastics; and the clients being serviced include commercial businesses, households, and educational institutes. The hubs serve both businesses and households within a two-kilometre radius. The collected waste is sold to Doko Recyclers, which functions as the principal aggregator and provides operational guidelines. While the hub operates on a sustainable model, additional measures such as plastic shredding and baling are being introduced to enhance material value and further strengthen sustainability. The hub serves as a model for integrating informal recyclers, allowing them to take the lead in operations while benefiting from stable incomes and safer working conditions. The collection centres have increased informal recyclers' knowledge about the operational aspects of waste collection and employ a team of nine people, who have received training on:

- Occupational health and safety
- Proper use of personal protective equipment and efficient fire extinguisher operation
- Social and Environmental Accountability
- Gender Equality and Social Inclusion (GESI)

The collection centres offer a good working environment for the people working there, with a section for waste collection, an area for sorted waste, a restroom, and a parking area for the collection vehicle.

Based on our findings, we recommend continuing to set up collection hubs to formalise the work of the informal waste sector and to seek recycling opportunities for hard-to-recycle materials. Additionally, we suggest assessing viable business structures for the manual baler to increase collection efforts also in more rural areas of Nepal. These steps will build on the project's successes and further reduce plastic pollution in Nepal's rivers.

CHAPTER 4

Piloting technical solutions

Problem

A key challenge for decentralised collection centres is the high cost of transporting collected waste, as certain types of waste materials such as polyethylene terephthalate (PET) bottles, film plastics, cartons and tin cans occupy large space without processing.

During the establishment of a baseline for our project, we discovered that the largest barriers for recycling hard-to-recycle plastics were a lack of segregation, soiled materials, lack of incentives and motivation to collect these types of plastics, and lack of infrastructure or actors to process these, especially in an environment that was controlled enough to capture all carbon emissions and residues.

Therefore, when setting up a pilot recycling facility, we aimed to:

- Explore solutions that could be implemented in sorting and cleaning for plastics which currently are non-recyclable in nature due to dirt but can be converted into recyclables.
- Consult with relevant technical and private partners - both local and international, for identifying solutions for hard-to-recycle grades of plastics.
- Research and find technical and innovative solutions for hard-to-recycle grades of plastics, especially avoiding types of energy generation with a carbon footprint and including a thorough analysis of the alternatives and impacts on Nepal's climate goals.

Through this project we have sought to establish a small-scale, locally operated pilot plastic recycling facility in Nepal, able to manage both high- and low-quality plastics, addressing a gap in the current recycling capabilities within the country. The project sought to pilot technology that would complement and enhance existing operations in the Kathmandu Valley through enabling recycling or handling a portion of the plastic waste which would otherwise not be managed properly. The plastic being processed with this technology is recovered through collection hubs.

We found already established initiatives recycling Styrofoam into building bricks, making low-grade plastic into insulating floss, and a plastic recycling facility producing granulates for piping out of both hard and soft plastics. We were pleased to observe that these projects already contributed to RiPL's objective of increasing the value of low-value plastics. As RiPL aimed to introduce new technology and innovative thinking to Kathmandu's recycling sector, we explored additional options for managing plastic waste fractions that are not currently being recycled, either partly or entirely. After brainstorming various ideas, two promising alternatives emerged: Developing and constructing a manual baler, and purchasing a shredder.

Both options were considered viable and valuable for the sector. While the high-capacity shredder would have the potential to process loads of plastic for recycling, the manual baler would be a small pilot with a vast potential for upscaling in the future. The manual baler may also be a viable solution for polyethylene terephthalate (PET) bottles in rural areas, which currently are not being collected due to the high logistics costs for the informal recyclers. In the end, RiPL decided to pursue both paths.

The rationale for selecting the two piloted solutions, along with the results from the tests, are detailed in the following sub-chapters.

Solution 1: Developing and constructing a manual baler that is both easy to operate and transport

A baler can compress polyethylene terephthalate (PET) bottles and other spacious materials, thereby reducing the logistics costs associated with this plastic fraction.

Traditional manual baling machines often lack the necessary force to bale materials other than paper or plastic wrapping. This limitation means that waste management companies looking to bale rigid plastics or cardboard are frequently compelled to invest in electric hydraulic baling machines. These machines, while effective, come with high operational and maintenance costs compared to manual balers, and they are bound to one specific location with access to electricity.

Additionally, both informal and formal informal recyclers who collect plastics or cardboard from landfills, dumpsites, streets, door-to-door, or other accumulation points, face volume limitations. They must transport collected waste to an aggregator or temporary storage, which can be challenging. In rural areas, longer transportation routes before recycling can make it unprofitable to collect low-weight plastics like polyethylene terephthalate (PET) bottles.

These issues highlight how the collection and management of rigid plastics, especially polyethylene terephthalate (PET) bottles, are hindered by current collection methods and available machinery. The limited force of manual balers and the logistical hurdles faced by informal recyclers underscore the need for more efficient solutions in the waste management process.

To address these challenges and increase the profitability of collecting low-value plastics, a manual baler has been co-developed with funding from the RiPL project in Nepal and the SUWASO project in Uganda. This baler is designed to be a practical tool for individual or group use by informal recyclers, as well as for plastic waste management businesses, such as aggregators, handling relatively low plastic volumes. Some highlights:

- Portable and Lightweight: The baler is small and lightweight, allowing it to be carried by two people. It also features two wheels on one side for easy mobility.
- Efficient Compression: The compression mechanism is driven by a simple car jack, which ten-folds the force applied on it.
- Secure Baling: Once the bale is ready, two threads along the sides of the baler can be fastened to keep the bale secure when released.
- Simple design: Can be built locally with available tools and materials.

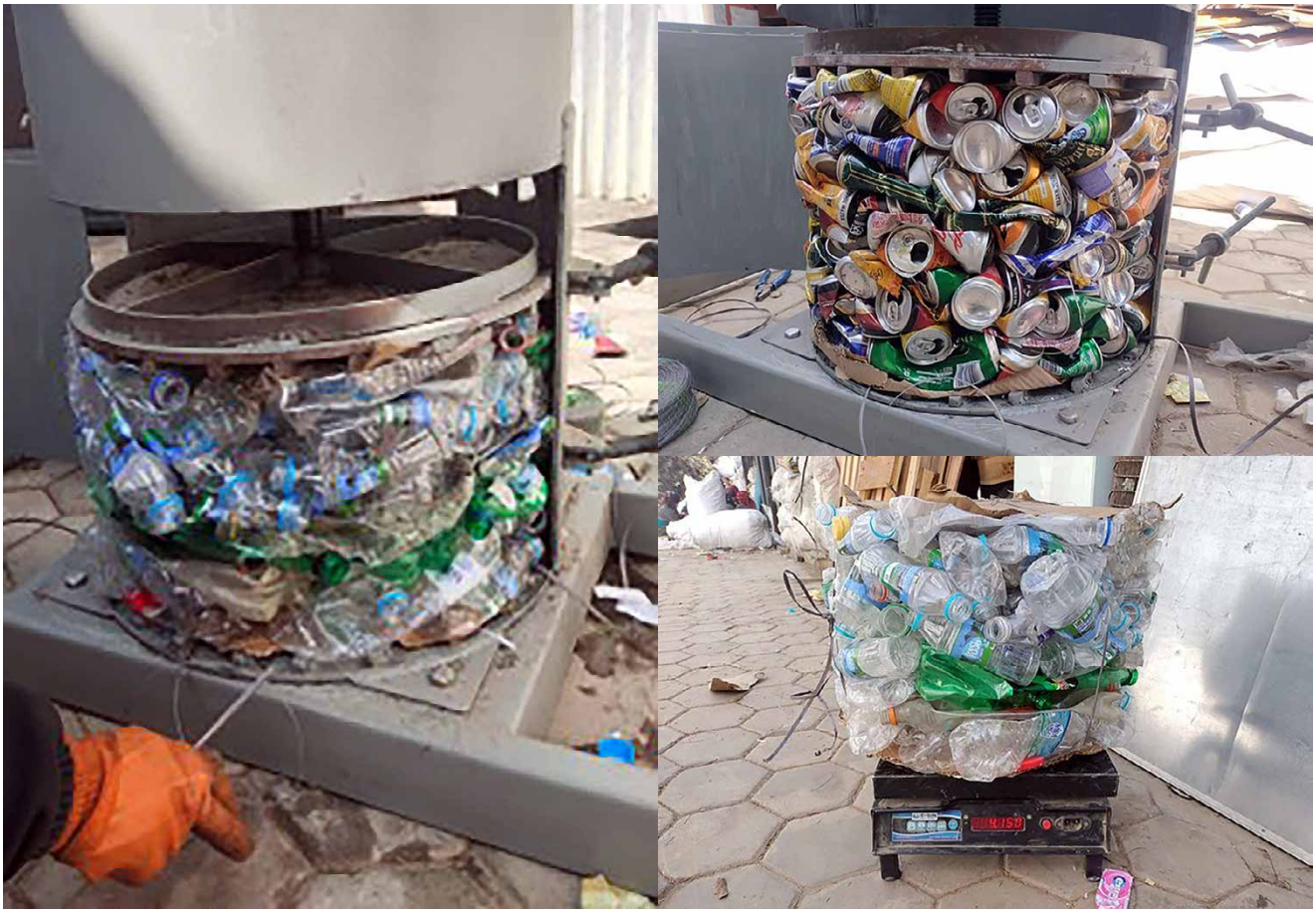
Baler specifications:

- Weight: Approximately 70 kilograms
- Dimensions: 1050 x 460 x 460 mm
- Force: 4000 kilograms-force

A manual baler enables the hubs to compress the collected waste, which will indirectly reduce logistic costs and increase the income of the hubs. Compressed bales of waste materials also optimise space management at the hubs, which are compact facilities operating on an efficient transfer model. The project has installed balers at the two locations where hubs were established.

Polyethylene terephthalate (PET) bottles.

Manual baler.



First model of manual baler design under trial process.

A second model of manual baler design under trial process.

Solution 2: Investment in high-capacity shredder for processing large volumes of multiple plastic fractions

Problem

Only beaten by Sub-Saharan Africa, Central and South Asia are the regions with the second highest percentage of municipal solid waste ending up uncontrolled, meaning ending up in nature and/or openly burned (UNEP, 2024). In 2020, this applied to almost 80% of the municipal solid waste in the region (UNEP, 2024). In the context of Nepal, it is estimated via the RIPL projects' Baseline Survey (Bajracharya et. al., 2024) that 1,262,000 kilograms of municipal solid waste was generated every day in Kathmandu in 2021, with 65% ending up at landfills or as uncontrolled waste. Of these, 350,000 kilograms were recycled (material recovery), out of which an estimated 36,000 kilograms was plastic waste (Pathak, 2021).

As can be seen in the figure below, UNEP (2024) expects that the global amount of uncontrolled fractions will almost double between 2020 and 2050.

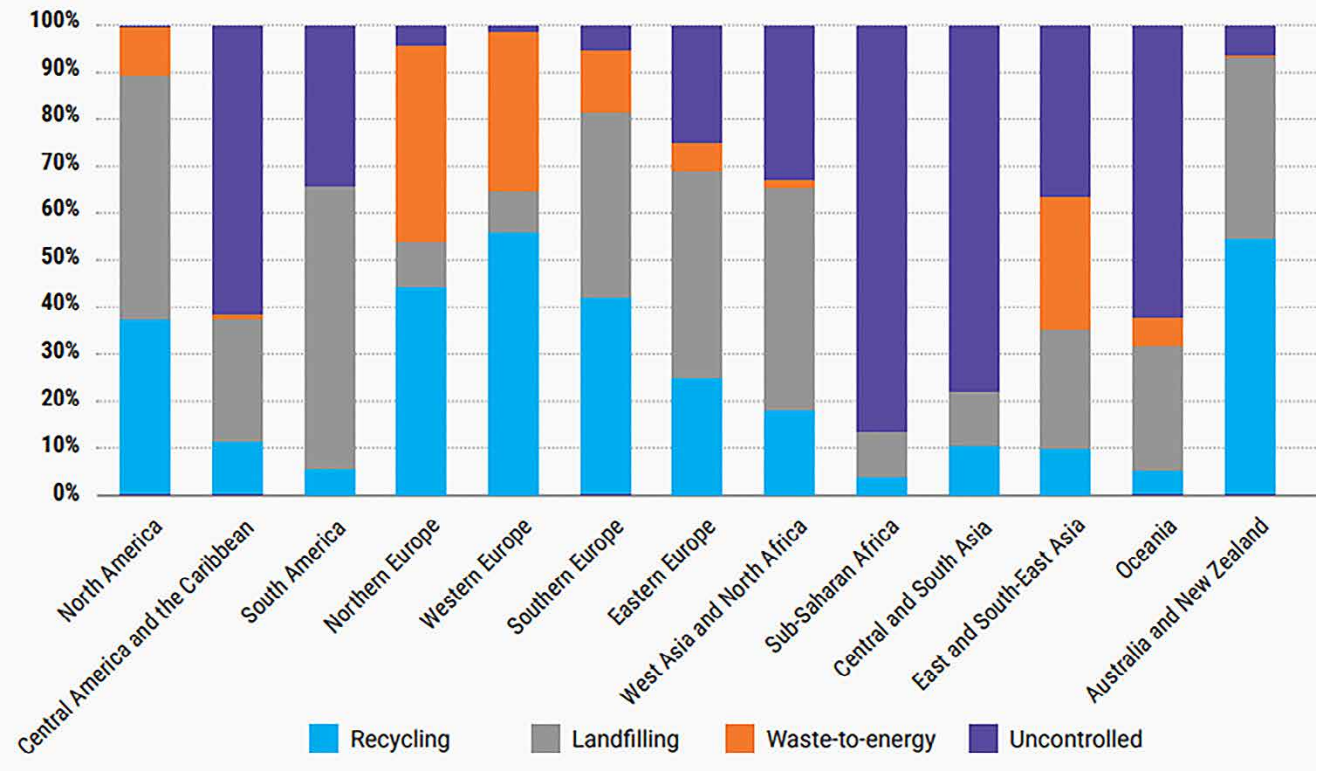


Figure 3: Regional distribution of Municipal solid waste destinations (2020). Source: UNEP (2024).

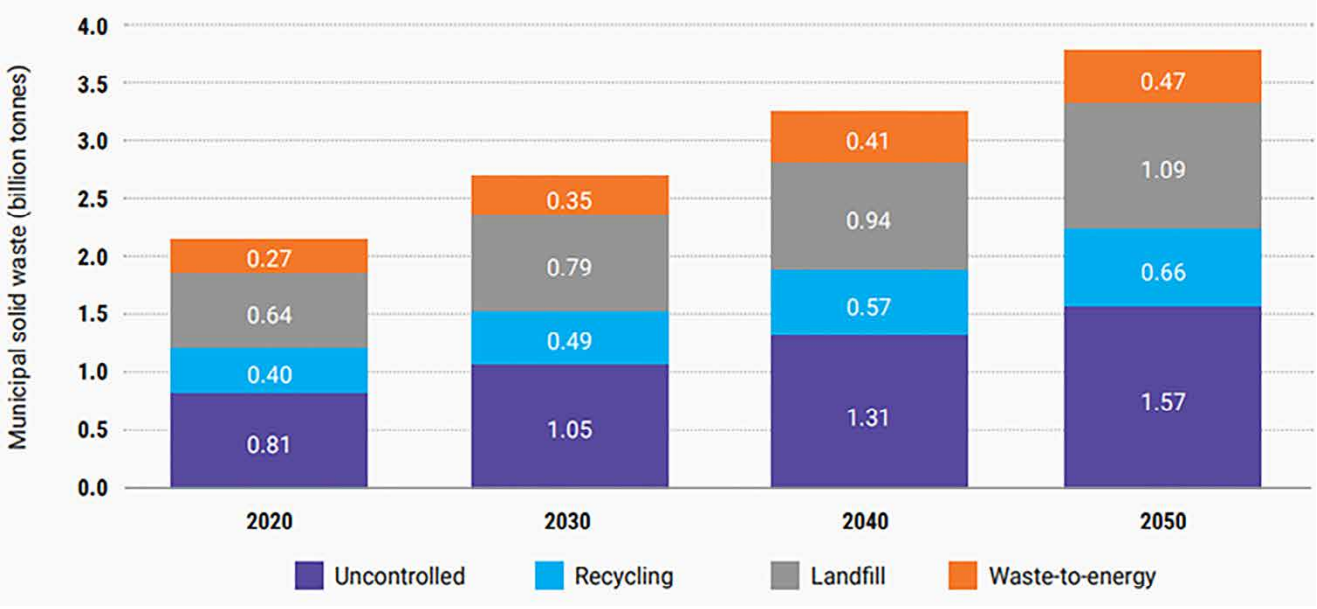


Figure 4: Regional distribution of Municipal solid waste destinations (2020). Source: UNEP (2024).

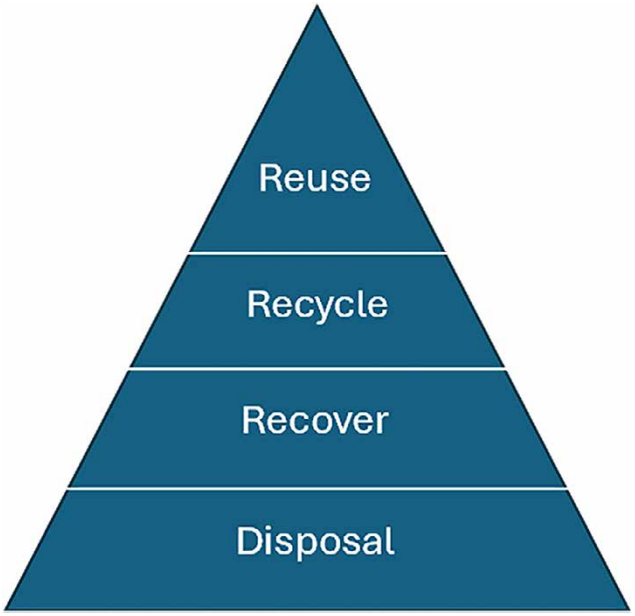


Figure 5: The waste management hierarchy was given consideration during decisions on investments. Credit: NGI.

The shredder is a solution which is envisioned to keep high amounts of plastic away from landfills and Nepal rivers. The shredder selected for the pilot testing within the project budget, and at the same time of good quality, has a capacity of 500 kilograms per hour, enabling the shredding of up to 4000 kilograms of plastic during an 8-hour daily shift. By collecting and shredding up to 4000 kilograms of plastic waste from municipal waste streams on the streets, which would otherwise end up in rivers or landfills, we can significantly reduce plastic pollution in Nepal's rivers.

The waste management hierarchy prioritises the following methods for handling already disposed waste: 1) Reuse, 2) Recycle, 3) Recovery (including energy recovery), and the least preferable, 4) Disposal. Therefore, for plastics that can be reused or recycled, these options should always be the first and second choice. This has been a key focus when seeking buyers for the low-value shredded plastic waste. For multi-layered plastics, RiPL has succeeded in establishing contact with BioComp Nepal, which will repurpose the plastic into plastic composite boards. However, for the remaining plastic waste that cannot currently be reused or recycled, the RiPL project partners have concluded that energy recovery is a better option than disposal, provided this is a short-term solution while reuse and recycling options are explored.

Shredder technical specifications:

- Capacity: 500 kilograms per hour
- Power: 2 motors x 15 HP (11.2 kW)
- Weight: Approximately 4000 kilograms
- Maximum monthly output: 100,000 kilograms

While the shredder will not directly impact the informal sector's work, it will indirectly impact the types and amounts of plastic which can be collected, and as such improve livelihoods.

Testing the plastic shredder

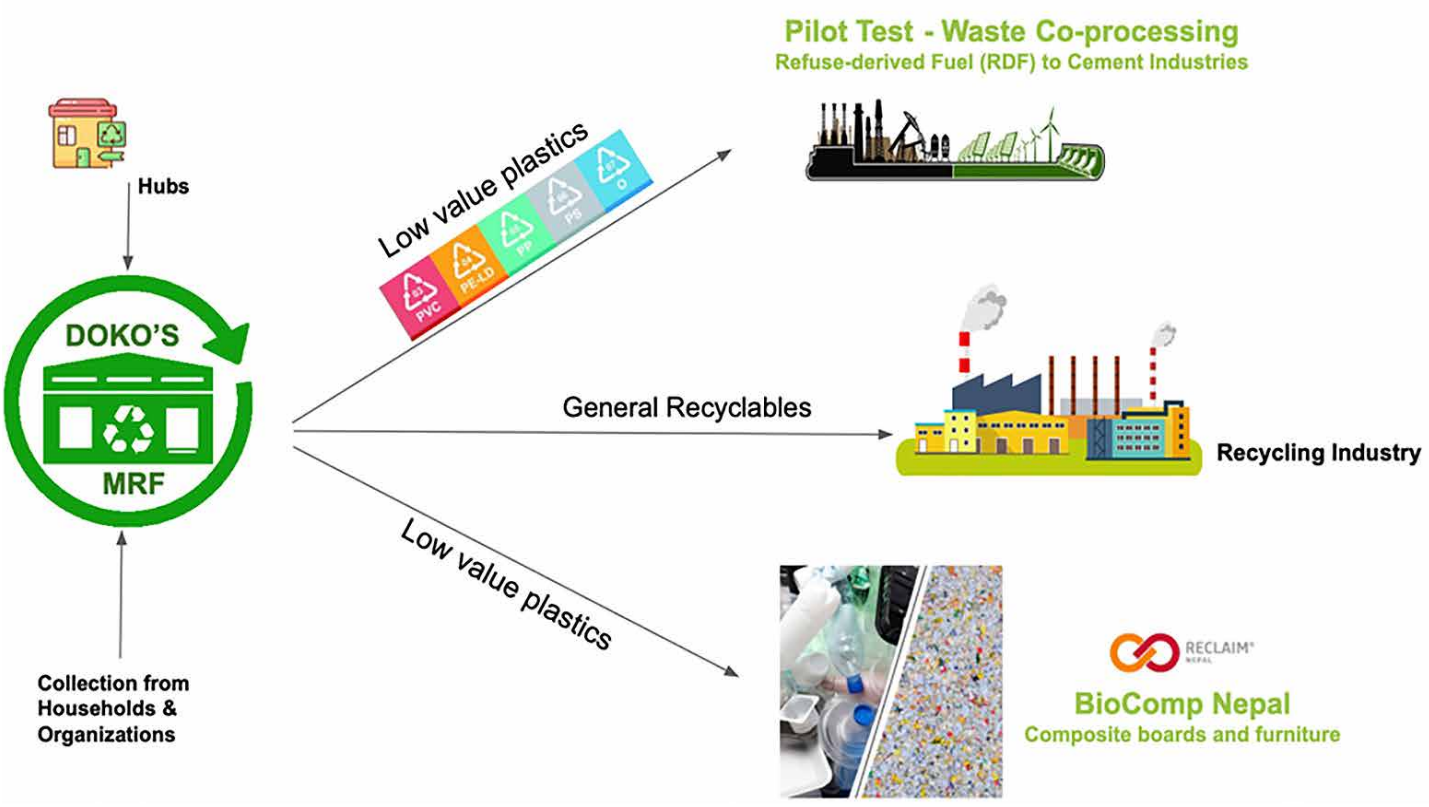


Figure 6: The decision-making process for handling of low-value plastics in the RIPL project. Illustrated by NGI.

The actual demand for plastic waste processing is much higher in the area where Doko is operating the pilot facility. The Kathmandu Valley alone generates over 1,200,000 kilograms of waste daily. It lacks large scale infrastructures to sort valuable resources using modern equipment, as the scale of waste produced cannot be managed manually. Low-value plastic waste, including heavily soiled or non-recyclable plastic items like multi-layered plastics, is ignored or discarded. The majority of low-value plastics such as single use plastics, composite plastics, pharmaceutical packaging, cosmetic packaging, or cement bags do not have an established recycling value chain. Much of this waste ends up in landfills or is littered in the environment. Research reports indicate that low-value plastics or non-recyclables comprise a significant portion of municipal solid waste in both India and Nepal. In India, estimates suggest that about 43% of the total plastic waste is made up of low-value items, which are often not recycled due to their composition and lack of economic viability. Therefore, this pilot operation will lay the foundation for scaling up in the near future, with a focus on low-value plastics.

The shredder would enable the preparation of low value plastic fractions for recycling or energy recovery. Two potential plastic buyers were identified, and it was anticipated that more would arise if this alternative was pursued. One option is to shred multi-layered plastic and sell it to a composite board factory, which was built in 2024. The other option is to shred all plastics that cannot currently be recycled and would otherwise be sent to landfill, and sell it to a cement factory as a substitute for coal used as fuel in the production chambers.

Sustainability considerations

There are several sustainability aspects of investing in a shredder that need to be considered, as there is a risk of potentially ending up shredding high amounts of plastic for burning in cement plants or other energy recovery units. This is a complex concern, with further questions needed, such as:

- What would happen to the plastic if it was not sent to the cement plant?
- What would be used as fuel in the cement plant if plastic is not used as fuel?
- Will there be more, less, or equal pollution from burning plastic as a fuel in cement production instead of the main source of fuel?
- Will the use of plastic as fuel in cement plants in the long term reduce willingness and eagerness to find better solutions for the plastic waste higher up in the waste hierarchy?

© DOKO Recyclers

The purchased shredder at DOKO's Materials Recycling Facility.

© GRID-Arendal/Tina Schoolmeester

Many are sceptical towards the solution of burning plastic waste in cement factories, particularly due to the last question above. However, in a region where uncontrolled waste is expected to grow over the next 25 years, there needs to be a balance between having a long perspective on finding better technical solutions which can make hard-to-recycle plastics easy to recycle, against existing solutions that can address the plastic types which cannot be recycled now.

UNEP's Waste Management Outlook for 2024 (UNEP 2024) notes that waste reduction, reuse, and recycling should be considered before waste-to-energy. The RiPL project will only consider fractions for burning in cement plants that cannot currently be reused or recycled. It is also emphasised in the Outlook that waste-to-energy may impact the livelihoods of those who rely on sorting out recyclables from waste.

In the RIPL project, however, we are building on existing structures, a formal waste collection and sorting sector, in addition to letting the informal sector continue their collection and sorting efforts and selling their sorted material. Therefore, there will be more livelihoods connected to recycling of multi-layered plastics and other non-recyclable or hard-to-recycle plastic waste fractions, as the alternative for these would be landfilling without any value.

Other concerns are also raised in UNEP's Waste Management Outlook as a set of questions to policymakers regarding thermal treatment technologies. These are presented in Annex 1, together with responses for the RiPL project.

The best current solution for reuse of low-value plastics

If we do not collect the hard-to-recycle plastic fractions, it is very likely that this plastic will end up in nature or landfills. In these environments, some of the plastic may catch fire, polluting the local air and emitting greenhouse gases into the atmosphere. The remaining plastic that does not catch fire will lie around, leaking plastic additives into the environment and slowly breaking down into microplastics. In this project it has been concluded that a better alternative for this plastic is to collect it, shred it, and send it to a cement factory.

The factory can use it to substitute part of their coal demand in cement production. The coal being substituted would, similar to the plastic, release carbon dioxide (CO2) and other emissions into the atmosphere. However, under controlled conditions, the plastic emits less pollutants.

After reaching out to SINTEF, who were working on a project called Ocean Plastic Turned into an Opportunity in Circular Economy (OPTOCE), they agreed to look into conducting a pilot with a cement plant in Nepal. RiPL would help find a feasible plant and provide plastic waste for the test. We expect the results to favour continuing to send plastic to cement plants. However, the RiPL project partners wished to wait until after the pilot test was conducted before regularly sending plastic to such facilities.

It has proven difficult to find a cement plant in Nepal available to conduct such a test on relatively short notice. The search for plants began in April 2024, and there have been promising discussions with several plants. However, we have not managed to reach a final agreement to run the pilot test within the project period as hoped. We hope that the test can still be conducted after the project period ends.

© DOKO Recyclers

A cement factory using low-value plastics as refuse-derived fuel in a controlled way.

The business case: Ensuring sustainable operation after project completion

Shredder

Ensuring the continued operation of the shredder beyond the project period requires a focus on sustainability and business viability. Doko Recyclers have agreed to take on the responsibility for the shredder after the RiPL project ends. They will ensure both operation and maintenance of the machine, as well as continue working with the business case such as collection/purchase of raw material and sale of the processed plastic to recycling or waste management companies. Considering the close geographical proximity between India and Nepal (the shredder was purchased in India), Doko can leverage the ease of travel and transport between the two countries to facilitate timely maintenance and repairs, thereby ensuring the shredder's optimal performance and longevity.

Doko's current employees bring valuable experience in operating shredders, which is a significant advantage. This expertise ensures a smooth transition and immediate operational capability with the new equipment. For long-term success, it's crucial to assign responsibility for the shredder's maintenance, including regular upkeep and arranging for repairs as needed. With Doko taking on this responsibility, the project can be confident that the shredder will remain in good working condition, which is essential for continuous operation. Moreover, a viable business model that guarantees monthly profit when the shredder is in use provides Doko with the motivation to invest in repairs as necessary.

A financially viable business model is the cornerstone of sustainability, and it is crucial that the income from the sales of shredded plastic exceeds the costs of collection and operation. Achieving this balance will provide a solid foundation for ongoing operations and demonstrate the economic feasibility of the project.

For multi-layered plastics, which are very light compared to other non-recycled plastic waste fractions, collection of one kilogram of material takes time. Therefore, it is key to pay a high enough price for this material to incentivise informal recyclers so that they collect and deliver it to our facility. The indicated price we can receive from the composite board factory can match the collection price of the multi-layered plastics; however, it remains to see if the composite board factory can actually pay the same price as informal recyclers are expecting.

By addressing these factors, the project can transition from a pilot to a sustainable operation. This approach not only helps in managing plastic waste effectively but also creates a business model that can be replicated and scaled, contributing to environmental sustainability and economic development.

Baler

Ensuring sustainable operations after the project period is crucial for long-term success. Two different balers have been built by two manufacturing companies in Kathmandu. The collection hub, with Doko as owner, will also be responsible for the balers after the project ends. This ensures that the balers will continue to be operated by staff who has already been trained in its use before the project concludes. As the machines are produced locally in Kathmandu, it ensures that they can be repaired or even remade if needed.

It's important that the use of the balers generate a higher income than the employee costs associated with its operation. As long as this condition is met, the daily use of the baler should be ensured. The baler can significantly reduce logistics and transport costs. A truck can carry only 500 kilograms of unbaled plastic, but up to 2000 kilograms of baled plastic. This translates to a saving of one Nepalese Rupee per kilogram on logistics and transport for the collection hubs.

An alternative business model and ownership structure that could more directly benefit informal recyclers is one where an individual waste worker or a cooperative of waste workers owns the baler. However, it's important to establish a system that ensures funds are available for baler maintenance and repairs, as informal recyclers typically do not have significant savings for such expenses. Additionally, the ownership structure needs careful consideration.

Would it be more advantageous for a single individual or multiple individuals to own the baler? Or should it be owned by a cooperative, or even by a waste management company that lends or rents out the baler? These are complex questions that could not be fully addressed within the scope of this project. As a result, it was decided that the collection hub would own the baler developed in this project.

This decision was made to ensure the sustainability and operational efficiency of the baler, as the collection hub is better positioned to manage the maintenance and financial aspects associated with the baler's operation. By doing so, the project aims to create a more structured and reliable system for waste management, benefiting both the environment and the community. However, we recommend addressing the production of multiple balers for informal recyclers in a separate project. In this future initiative, it would be crucial to co-develop a suitable business model with informal recyclers. This collaborative approach will ensure that their needs and constraints are adequately considered, leading to a more inclusive and sustainable solution.

CHAPTER 5

Capacity building for women in the informal recycling sector

The RiPL project conducted two workshops for women in the informal recycling sector. The first workshop was presented in the Baseline report. The second workshop was conducted in November 2023 and aimed at empowering and building the capacity of 19 women in the informal recycling sector. The training covered solid waste management, health and safety, social security, networking, financial literacy, and business planning.

Workshop 2

RiPL partner CREASION organised a four-day training on empowerment and capacity building of women in the informal recycling sector in Nepal between the 27th and 30th November 2023 at Nepal Administrative Staff College, Lalitpur. The workshop's main purpose was to empower and build the capacity of women in the informal waste sector in Nepal. Nineteen women from different working areas (picking, sorting, machine operator) of the informal waste sector participated. The training aimed to empower women in the informal recycling sector and improve gender equity in the workplace by enhancing their skills in solid waste management, health and safety, social security, networking, financial literacy, and basic business planning.

We conducted key informant interviews of the potential participants prior to the workshop to assessing their demographics, status, working area, education level and expectation from the training. A module was developed along with support from ISWA and GRID-Arendal. Representatives of GRID-Arendal, NGI and Doko Recyclers attended all four days of the training session. The training session was divided into four themes:

- Preliminaries and Solid Waste Management
- Protect myself/ Self-empowerment
- Basic Business Skills Development
- Advanced Business Skills Development

Each day was divided into group discussions, presentations, and experience-sharing sessions. Each session was moderated by trainers according to their expertise. A field visit was organised to the Dallu collection hub built by Doko Recyclers as a part of the RiPL project. The trainees were provided with accidental insurance worth 7 lakhs Nepalese Rupees (7,00,000 Nepalese Rupees) by CREASION. The training certificate was distributed by the Mayor of Lalitpur Metropolitan City, Mr. Chiribabu Maharjan.

Following the training session, a monitoring and evaluation survey was conducted from May to June 2024 for all participants. However, CREASION could only interview 13 participants, six of them had travelled outside of Kathmandu. The monitoring and evaluation consisted of face-to-face interaction to obtain feedback on the workshop's impact and outcomes. A questionnaire was used as a key tool to assess the workshop's impact and overall effectiveness and evaluate how these have sustained in the time between the workshop and questionnaire distribution – over six months. During the survey, it was found that the sessions, particularly on self-empowerment, had encouraged some of the women to start a venture of their own. Two of the women had started their entrepreneurial journey conducting animal husbandry and indigenous liquid fermentation, and one woman was about to start her own tailoring business. The session on gender empowerment and rights, which distributed contact details of helplines and authorities in case of emergency, was appreciated and seen as helpful. Moreover, the flyers distributed during the training session consisting of helplines also helped them to reach out for help in one of the women's cases.

Follow-up hybrid training

The second RiPL workshop was so successful that there was a request from participants to consider more long-term, ongoing capacity building as part of the project. While this was not possible, Norad funds were used to provide an additional follow-up hybrid training to the women by ISWA's Dr. Anne Scheinberg, and also provided each participant with their own scale for weighing their collected materials. This follow-up was greatly appreciated and the request for more long-term capacity building was noted for future project funding possibilities.

Final results sharing event

The participants made final presentations in a similar setting for the final results sharing event, where they spoke about the positive impact that the project training has had on their lives. This included escaping an abusive relationship, being aware of self-worth and self-help options, feeling happy, proud, safe, and supported by

© CREASION

Ten women working informally to recycle participated in the hybrid follow-up training provided by ISWA.

the project and network they have created, and also that they have promoted their new knowledge to others they meet or work with.

The final impact of the project was promoted in a video produced and published by CREASION on their YouTube channel in collaboration with GRID-Arendal and reshared by project partners.

Other training

DOKO Recyclers are providing ongoing training on plastic collection, sorting, upscaling, occupational health and safety, social and environmental accountability, and gender equality and social inclusion.

A video released at the end of the project to promote the impact of RiPL capacity building on informal recyclers as well as the impact their knowledge has on the community.

© iStock/3yephotography

CHAPTER 6

Conclusions and recommendations

The challenge of addressing plastic waste requires innovative strategies, community engagement, and policy reforms. Ten specific recommendations for policymakers are:

1. Identify hotspots for pollution in rivers to target interventions
2. Support entrepreneurs to establish plastic collection and processing centres in the plastic pollution hotspots
3. Engage with the informal recycling sector
4. Implement Extended Producer Responsibility for plastic producers to manage the entire lifecycle of their products
5. Establish complimentary responsibilities for plastic consumers
6. Strengthen the collaboration between local authorities and government bodies on waste management
7. Prioritise technical solutions
8. Learn from international best practices
9. Increase public awareness on waste segregation
10. Prioritise exploring sustainable solutions for multi-layer plastics and low-value plastics

The full details are available in the RIPL policy brief (GRID-Arendal, 2025), which provides clear recommendations and mitigation measures with a concise and logical policy direction for the future.

The RiPL project's findings in Nepal highlighted crucial intervention areas for reducing plastic leakages in the Kathmandu Valley and empowering informal recyclers. These findings emphasised the identification of significant plastic waste hotspots near major markets and the critical role of the informal sector in waste collection and processing. It is essential to support and implement safety measures for these workers. The project recommends targeted waste management, engagement with the informal sector, and a sustainable business model. The focus is on preventing plastics from entering rivers by enhancing collection and processing efforts in hotspot areas, with continued mobilization and engagement with informal recyclers for improved planning and capacity building.

Over the decades, Nepal has made significant strides in environmental protection through a series of legislative and policy measures aimed at addressing plastic waste and promoting sustainability. The Constitution guarantees citizens' right to a clean environment, while various policies, such as the 15th Development Plan and the Solid Waste Management National Policy 2022, underscore the importance of transitioning to eco-friendly alternatives and improving waste management practices. Despite these advancements, challenges remain, particularly in enforcing bans on substandard plastics and curbing their continued use. Effective implementation of existing laws and policies, combined with enhanced public awareness and engagement, is crucial for achieving the nation's environmental goals. This can be further enhanced by adopting Extended Producer Responsibility (EPR) alongside innovative recycling technologies embracing a circular economy model. Nepal can effectively tackle plastic pollution and promote environmental sustainability by implementing these recommendations and fostering collaboration among stakeholders.

ANNEX

Questions for policymakers from UNEP GLOBAL WASTE MANAGEMENT OUTLOOK regarding WASTE TO ENERGY (W2E)	*RIPL project considerations*
Is the technology the best available, and can it meet stringent emission and discharge limits, including for any hazardous waste residues?	*For the MULTI-LAYERED PLASTICS, and other potential plastic waste fractions to be included, this is the best available option, as the alternative is landfilling and/or being illegally sent to India. Regarding emissions, a pilot test is planned before making a final decision, however this could not be done within the project period.*
Can a guaranteed quantity of feedstock be supplied within the required window of calorific value and moisture content for the entire lifespan of the facility? If not, will contractual penalties be affordable?	*Quantity can be agreed between cement factory and Doko, dependent on available resources and collection capacity.*
Is a suitable system in place to divert the majority of food waste from the feedstock?	*Suitable waste streams will be sorted out of the municipal and industrial waste and sent to the cement factory. Therefore, food waste will not be an issue.*
If recyclables such as plastic, paper and cardboard are to be used as feedstock, how will livelihoods within the recycling value chain and sustainability/zero waste/ circular economy ambitions be impacted?	*Since more plastic will be diverted towards waste management systems instead of being landfilled, there will likely be more jobs for formal and informal recyclers.*
Can the facility be operated by local people, or will employment opportunities mainly be available to those from elsewhere?	*Cement factory will be operated by the same team as today.*
Do appropriate national regulations exist, and does the environmental regulator have sufficient capacity to monitor emissions and enforce these regulations?	*No national regulations. The planned pilot study (see next page) can give important data to the government so that regulations can be implemented.*
Will a hazardous waste landfill cell (a waste-holding unit within the landfill) be required for any of the outputs, and is this feasible?	*No dust outcome, all dust is used in the cement clinker. This was observed during visit.*
Can the technology be developed at an appropriate scale for the population it is designed to serve, and are transport networks suitable for a centralised facility?	*With time, it is believed that the collection levels and transport can match the installed capacity of the REFUSE-DERIVED FUEL burning technology installed at the cement factory. It cannot take out all non/hard-recyclable plastic waste in the Kathmandu Valley, however, based on the results from this cooperation, it can be established whether more cement factories in Nepal should be encouraged to invest in similar equipment. The same truck that is transporting cement to the town can carry the plastic to the facility.*
Will it be possible to utilise the heat and electricity generated in order to achieve minimum efficiency standards?	*Energy will be utilised directly in cement production.*
Will airborne emissions meet air quality targets, climate change goals and countries' pledges in their NATIONALLY-DETERMINED CONTRIBUTIONS?	*This will be assessed during and after emission pilot. Meanwhile, Nepal NATIONALLY-DETERMINED CONTRIBUTIONS also state: "By 2030, adopt and implement waste segregation, recycling and waste-to-energy programs in at least 100 municipalities."*

REFERENCES

Bajracharya, Pratik, Mahto, Raghavendra, Alfthan, Björn and Heerema, Sabrina (2024). A Baseline Survey for the RIPL project: Preventing Plastic in Nepal Rivers by Boosting the Informal Sector.

Bajracharya, Pratik, Schipperton, Anna and Heerema, Sabrina (2025). POLICY BREIF: Curbing river plastic pollution and empowering Nepal's informal waste sector.

UNEP-IETC and GRID-Arendal (2019). Gender and waste nexus: experiences from Bhutan, Mongolia and Nepal.

United Nations Environment Programme (2024). Global Waste Management Outlook 2024: Beyond an age of waste – Turning rubbish into a resource. Nairobi. https://wedocs.unep.org/20.500.11822/44939

RiPL, funded by the Norwegian Retailers' Environment Fund, was implemented from March 2022 to February 2025, with additional support from Norad. The project had two main phases: baseline mapping and setting up collection hubs and a recycling pilot facility. Phase 1 focused on identifying plastic sources, mapping challenges faced by informal recyclers, and assessing plastic waste composition and leakage hotspots. Phase 2 implemented solutions to increase the recyclability and value of plastics, particularly polyethylene terephthalate (PET) bottles, by establishing collection hubs and piloting technical solutions. The project also emphasised capacity building and awareness raising, including workshops for women in the informal recycling sector to enhance their skills and improve gender equity. The project's comprehensive approach combines research, practical solutions, and policy recommendations to address plastic pollution and empower informal recyclers.

The recommendations from the RiPL project emphasise several key strategies to address plastic waste in Nepal. These include continuing to set up collection hubs to formalise the work of the informal waste sector, seeking recycling opportunities for hard-to-recycle materials, and assessing viable business structures for the manual baler to increase collection efforts in rural areas.