

P2G Innovation Protocol

Implementing Localised Circular Empowerment Platform in Nepal



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Disclaimer

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The project, *Plastic 2 Ghar (P2G) Plastic Waste Remanufacturing for Local Housing: Innovation Ecosystem in Nepal* (Principal Investigator: Prof. Steve Evans, grant number G114346), is implemented by the University of Cambridge and Impact Hub Kathmandu, has been awarded a UK International Development grant in order to establish plastic waste innovation ecosystems in Nepal. The grant has been made via the SMEP Programme and has been awarded until 30th June 2026.

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Executive Summary

Viva Circularity!

Closing the loop is easier said than done. Circular Economy transitions, especially in the Global South, are challenging, slow, and often messy. Yet they can also be joyful, full of pleasant surprises, and deeply empowering.

In the Global South, CE transitions often appear to run against the odds, constrained by geographical, structural and contextual barriers. Over the past four years, however, the P2G journey in Nepal has demonstrated that localised circular transitions are possible and can be powerfully transformative.

This innovation protocol documents the process, tools, outcomes, and lessons of Plastic to Ghar (P2G): Plastic Waste Remanufacturing for Local Housing: Innovation Ecosystem in Nepal. It is grounded in lived experience, capturing how plastic innovation ecosystems were seeded and flourished in one of the world's most challenging environments.

What made this transition possible was P2G's meso-level, innovation-driven intervention approach, positioned between grassroots initiatives and top-down policy implementation. P2G responded to gaps in infrastructure, finance, policy, and innovation capacity. Through external facilitation, the project created a localised platform for community-led coordination, experimentation, and entrepreneurship that did not exist before. We introduced new innovation processes and knowledge, created allies across the plastic value chain, fostered a spirit of self-efficacy and nurtured emerging ecosystems. Empathetic leadership that immersed in local culture brought the teams together. Financial support pump-primed participation.

P2G began by inviting ambitious individuals to MAKEathons who have no predefined ideas. These innovation competitions created catalytic spaces that lowered barriers and exposed locals to new ways of thinking. Participants were then encouraged to continue through a follow-up incubation programme offering bespoke training, coaching, knowledge sharing, and iterative experimentation. Ideas evolved from blue-sky concepts to real-world solutions, gradually building local innovation capacity. Eventually, these local-led innovations reached the stage of commercialisation and expansion. Appropriate technologies allowed local

entrepreneurs to truly own the production process. Intellectual inputs were not merely transferred but soon evolved into the co creation of knowledge among the locals.

As a result, five localised ecosystems took root across Nepal. By March 2026, P2G saw three operating circular start-ups, five rural and urban hubs, +100 local jobs, and over 50 tonnes of plastic diverted from open dumping and burning, while simultaneously generating new technical, business, and policy knowledge including ten academic publications and 40+ global disseminations.

Key lessons from the P2G journey include the importance of stakeholder coordination. Progress was driven not by rigid plans, but by an ability to adapt, pivot, and celebrate imperfection. In Nepal's complex geography, scaling out alongside scaling up proved essential for resilience, as local orchestrators quietly emerged and initiated new hubs when conditions aligned.

Respecting local rhythms and practising patience became essential. Circular transitions unfold at the pace of communities, not projects. Supporting personal growth alongside project goals is a defining feature of long term impact and responsible leadership. Above all, a culture of contentment and quiet resilience has remained a guiding Principal. When the project planted seeds, solutions were crafted to meet local needs and ecosystems expanded in their own time.

Technically, prioritising time tested appropriate technologies, rather than imposing sophisticated machinery, enables local entrepreneurs to truly own the production process. A triangle between government actors, suppliers and waste workers, and upcycling businesses functions as an interdependent plastic circular system. Testing across feasibility, performance, and manufacturing processes is required to ensure solutions that are viable and context appropriate.

This protocol is designed for innovators, policymakers, and sustainable development practitioners. It shares

what we wish we had known, helping others avoid common pitfalls in their own circular economy transition. Beyond Nepal, it proposes adapting a Localised Circular Empowerment Platform (LCEP) to other resource constrained contexts and high income settings alike.

P2G demonstrates how meso-level, innovation driven approaches can catalyse circular transitions and nurture lasting impact. **If this platform can flourish in the heart of the Himalaya, it can flourish anywhere.**
Let this cycle of local empowerment continue.

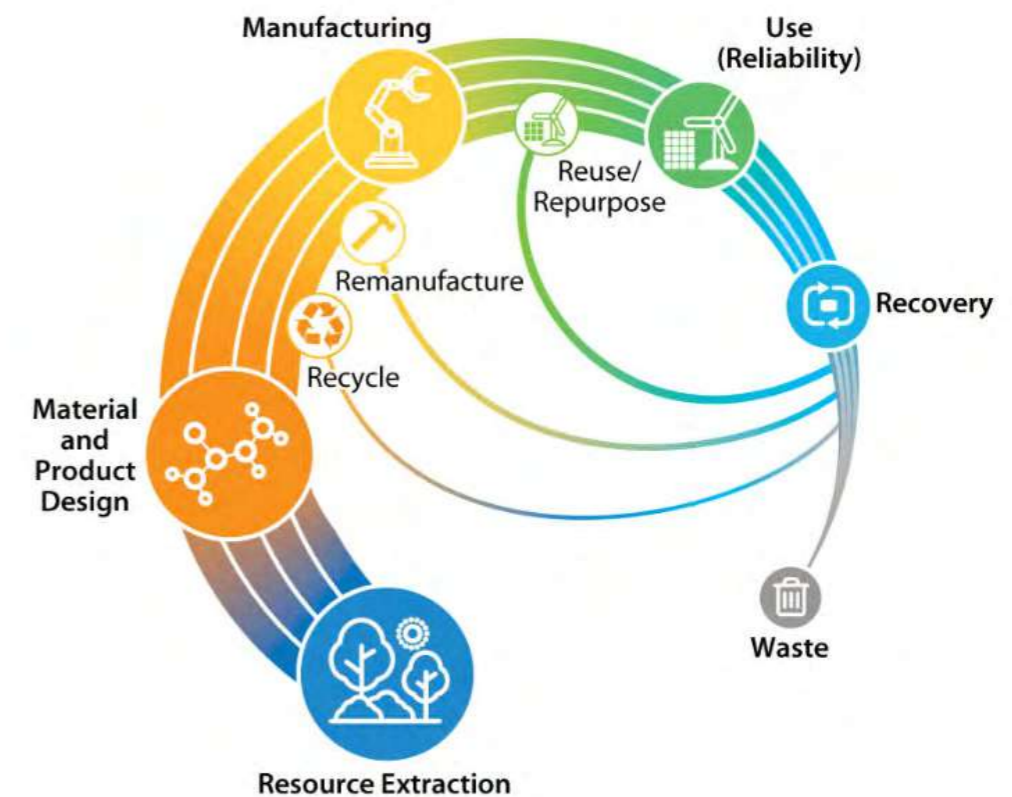


Figure 1
Circular Economy schematic for Lithium Ion Batteries, also applicable for many of manufactured goods including Plastic waste.

Source: Curtis, T.L., Smith, L., Buchanan, H. and Heath, G., 2021. A circular economy for lithium-ion batteries used in mobile and stationary energy storage: drivers, barriers, enablers, and US policy considerations (No. NREL/TP-6A20-77035). National Renewable Energy Laboratory (NREL), Golden, CO (United States).

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For the locals
By the locals
With local waste

Chapter 1

Introduction

Chapter 1 introduces the global and local contexts that shaped P2G. It outlines why the plastic crisis demands new approaches in the Global South, how Nepal's unique challenges call for localised circular solutions, and how P2G's vision, processes and consortium came together to address them.

- 1.1 P2G Vision & Mission
- 1.2 Plastic Waste Issues In The Global South
- 1.3 Nepal's Local Challenges
- 1.4 Localised Circular Transition As A Solution
- 1.5 P2G Consortium & Timeline

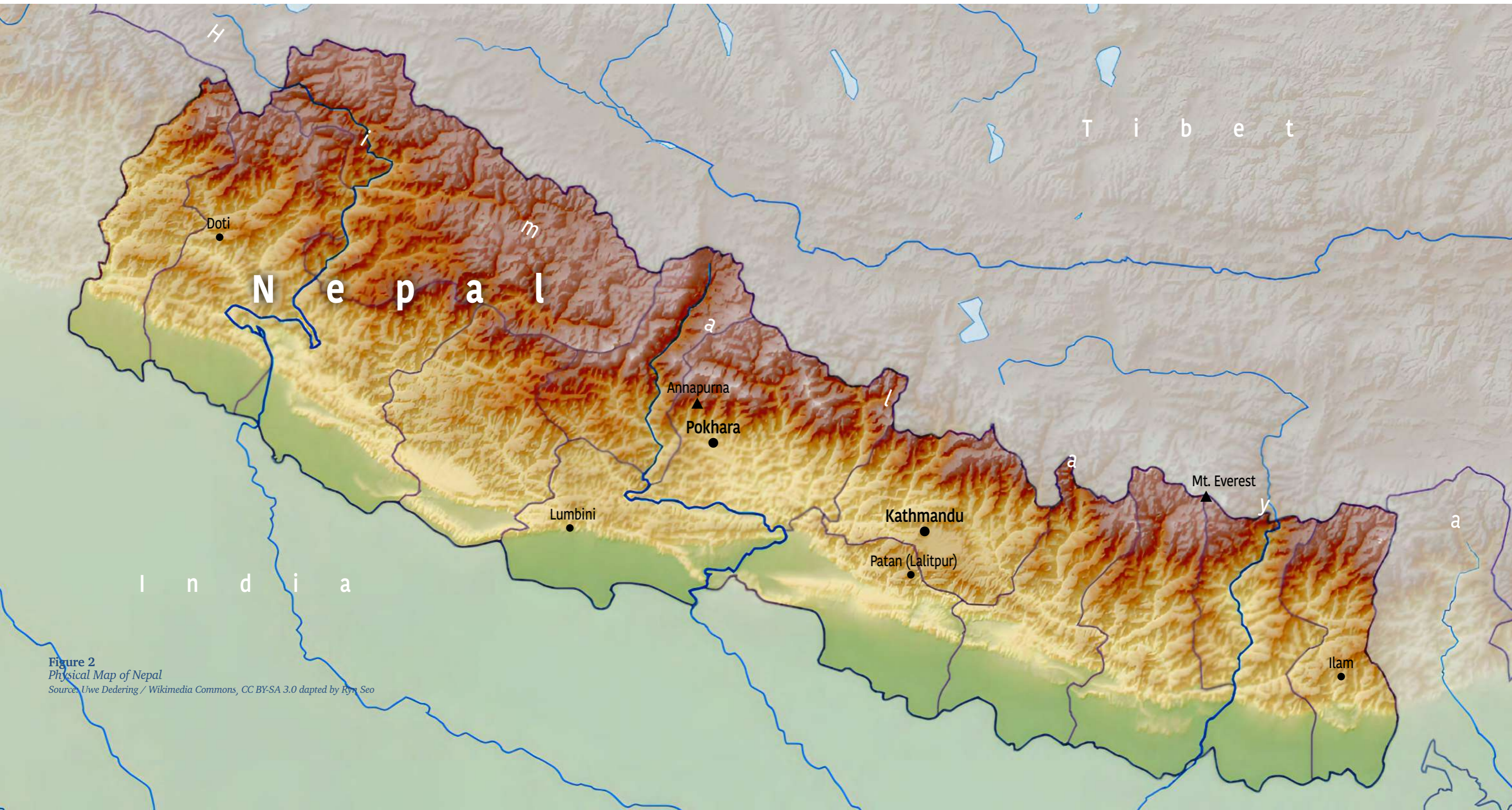


Figure 2
Physical Map of Nepal
Source: Uwe Dederig / Wikimedia Commons, CC BY-SA 3.0 adapted by Ryn Seo



Figure 3
P2G progress across the TRL1 to TRL 9 (Technology Readiness Level)
Source: NASA (2023) Technology readiness levels.
Available at: <https://www.nasa.gov/directorates/somd/space-communications-navigation-program/technology-readiness-levels/>

1.1

P2G Vision & Mission

The Plastic to Ghar (P2G) project aims to establish decentralised, small-scale manufacturing units “by the locals, for the locals, with the local waste” and empower the local community entrepreneurs.

The global plastic crisis has reached unprecedented levels. According to the United Nations Environment Program (UNEP), humanity produces more than 400 million tonnes of plastic waste every single year (UNEP, 2021). To put this staggering figure into perspective, this amount is equivalent to approximately 290 million passenger cars or 44,000 Eiffel Towers worth of plastic materials. This crisis disproportionately impacts developing countries, with over two-thirds of the world's 57 million tonnes of annual plastic pollution originating from the Global South (Cottom, Cook and Velis, 2024). At a global level, less than 10% of the approximately 6.3 billion tonnes of plastic waste generated between 1950 and 2015 has been recycled, with almost 79% ending up in landfills or the natural environment (Global South Hub, 2024).

In much of the Global South, conventional approaches to plastic waste such as recycling, bans on single-use plastics, extended producer responsibility (EPR), and reuse have struggled to contain rising volumes of untreated waste, largely due to limited infrastructure, policy resources and institutional capacity.

The Plastic to Ghar (P2G) project in Nepal seeks to address this gap by establishing decentralised, small-scale remanufacturing units operated “by the locals, for the locals, with the local waste” across Nepal including the Himalayan region to manage plastic waste at its source.

The project represents a Technology Readiness Level (TRL) advancement journey from fundamental research concepts to practical implementation. TRL is a systematic metric originally developed by NASA in the 1970s, using a scale from 1 to 9 to assess technology maturity. TRL 1 represents basic research where scientific Principals are first observed, while TRL 9 indicates a fully proven technology operating in real-world conditions.

The P2G project has successfully progressed from no concrete ideas (TRL 0), to initial concept development

(TRL 1) through proof-of-concept, prototyping, and testing phases to reach full operational deployment (TRL 9), demonstrating the maturation of decentralised plastic remanufacturing technology for remote communities.

The project examines whether local plastic upcycling start-ups can convert accumulated waste into valuable products, and become financially self-sustaining. The approach catalyses local Circular Economy (CE) ecosystems, combining appropriate technology, plastic remanufacturing equipment, and training with local government and NGOs. The P2G project aims to offer a potential model that could be replicated in other remote regions of the Global South for the transition toward a circular economy.

Funded by UK International Development and is implemented in partnership with the UN Trade and Development (UNCTAD), and led by University of Cambridge in consortium with Impact Hub Kathmandu | FabLab Nepal. P2G runs from December 2021 to June 2026. The name Ghar means “home” or “house” in Nepali, reflecting the project's focus on transforming plastic waste into locally relevant, useful housing products, such as lumbers, insulation, pavement blocks, flooring, furniture pieces and roofing materials. By addressing both logistical and economic barriers and through its participatory and contextualised meso-level interventions, P2G has fostered the emergence of localised self-sustaining circular economy ecosystems led by local start-ups. These ecosystems generate a reliable supply of plastic recyclates, create local demand for those recyclates, and helps close material and value loops for plastic waste.

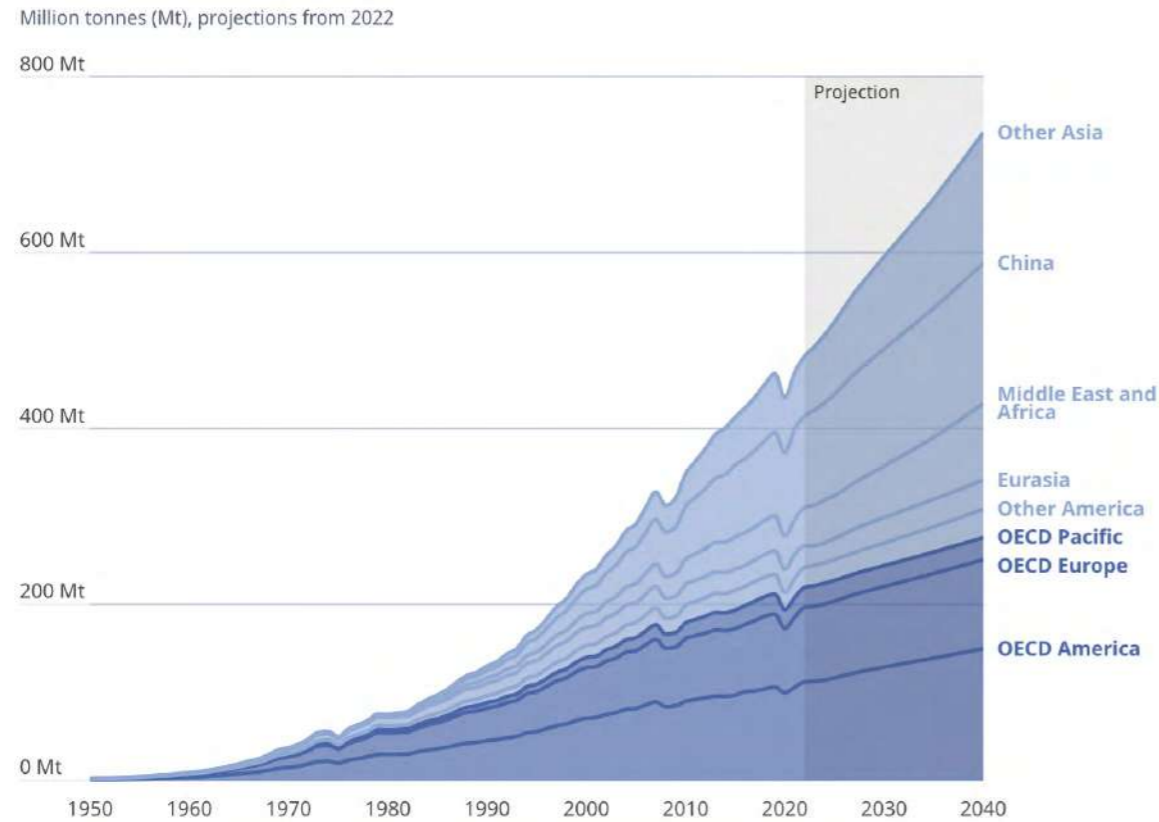


Figure 4 Plastics use projections
Global plastics use is projected to increase by 70% in 2040 compared to 2020. The plastics lifecycle would contribute to minimum 5% (2.8 Gt of carbon dioxide equivalent) of global greenhouse gas emissions.
Source: OECD (2024), Policy Scenarios for Eliminating Plastic Pollution by 2040.

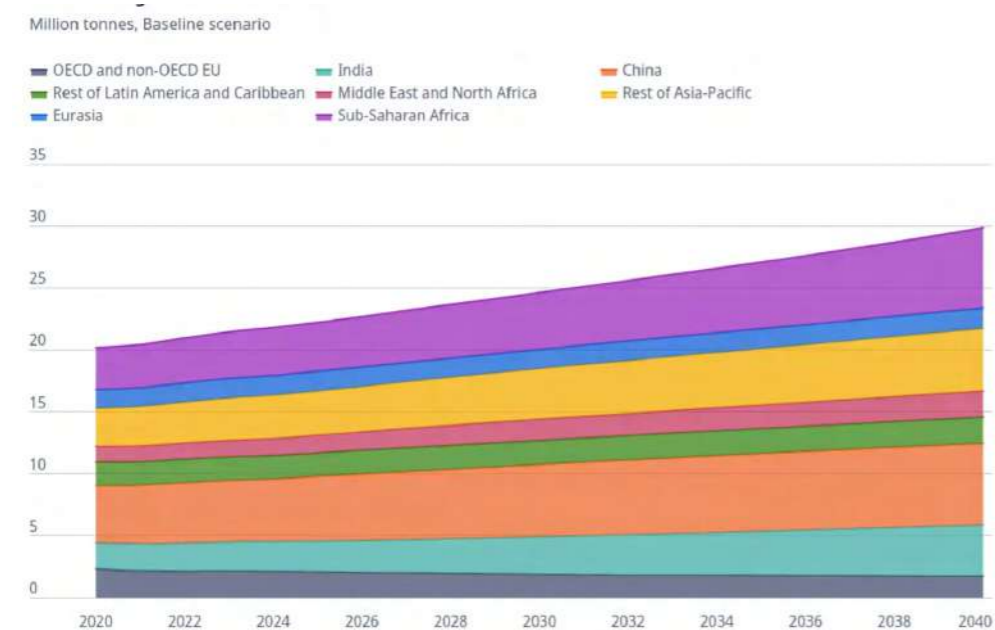


Figure 5 Plastic leakage to environment
Plastic leakage to the environment will increase significantly despite increases in waste management systems, plastics production and use, plastic leakage is set to increase by 50% between 2020 and 2040 (to 30 Mt).
Source: OECD (2024), Policy Scenarios for Eliminating Plastic Pollution by 2040

1.2

Plastic Waste Issues In The Global South

The plastic waste crisis reflects the intertwined environmental, health, and governance challenges especially in the Global South.

Plastic waste has become a central environmental issue. Plastics generated 1.8 billion tonnes of greenhouse gas in 2019, which is 3.4 per cent of the world's total emissions (OECD, 2022). Projections suggest that by 2060, plastic production will triple, half of which will be discarded yet only 9% of all plastic produced to date has been recycled, in part because much of it is not recyclable. The environmental damage extends beyond climate impacts. As plastics break down into micro-particles that infiltrate soil and aquatic environments, they degrade ecosystems and threaten biodiversity. The health consequences are also severe: workers in fossil fuel extraction, plastic manufacturing, and recycling face elevated risks of respiratory diseases, cancers, and other illnesses, with estimated healthcare costs exceeding \$920 billion in 2015 alone. Open burning of plastic, particularly common in the Global South, creates acute health hazards by releasing toxic emissions linked to birth defects, soil and water contamination, and long-term ecological harm.

Plastic pollution remains especially critical in the Global South (Maalouf & Agamuthu, 2023), where waste management and recycling systems are often weak or absent. Policy responses have been largely ineffective due to inadequate infrastructure, weak enforcement, insufficient financial capacity to support sustainable alternatives, entrenched industry interests, and consumer reluctance to change. As a result, 80–90% of waste is mismanaged, often through uncontrolled burning or dumping into waterways.

The plastic waste crisis, especially in the Global South, reflects intertwined environmental, health, and governance challenges. Without comprehensive strategies that integrate stronger policy frameworks, viable economic incentives, and active consumer participation, both the scale of plastic waste and its associated harms are set to escalate in the coming decades (Chen et al., 2021; Pilapitiya & Ratnayake, 2024; Velis & Cook, 2021).



Figure 6
A variety of plastic sachets, bottles and packets commonly sold in a corner shop in Nepal



Waste Mismanagement

Open burning & dumping,
Air, water & soil pollution



Logistics Restriction

Limited road coverages in the mountains,
Difficult to transport housing products,
Three times added transportation cost to products
to carry up the mountains



Deforestation

Firewood for 80-90% heating & cooking,
No insulation culture



Basic Living Conditions

Muddy, wet floors,
Single tin sheets for roofing and walls,
Cold in winter, hot & noisy in summer

1.3

Nepal's Local Challenges

The challenges faced in Nepal are further reinforced by national-level constraints: weak public policies on waste management and recycling, geographical and infrastructural limitations, and cultural and economic conditions that hinder effective waste management.

Nepal exemplifies the challenges faced by countries in the Global South in managing solid waste: an estimated 90% is disposed of in landfills, open dumps, or through open burning, while only about 8% is recycled (Labra Cataldo et al., 2024).

The geography of Nepal hindering waste management

Nepal is a landlocked country, with nearly 75% of its territory covered by mountains. This environment acts as a barrier for effective waste collection and treatment. In remote rural regions, waste volumes are low and irregular, and inaccessible even for informal waste collectors. As a result, most waste is neither collected nor processed, but burned or dumped openly, creating roadside accumulation and informal landfills. Transporting materials in or out of these regions is cost-prohibitive, frequently one to three times higher than the product's value, and further hampered by poor road networks. In high-altitude areas, monsoon landslides and floods regularly disrupt access, making waste export impractical. Touristic areas such as the Everest region face an even greater challenge: high visitor numbers generate large volumes of plastic waste that remain unmanaged. Recycling facilities are scarce in rural and mountainous areas, and technical infrastructure is limited. Few laboratories or testing centres exist, even within universities or the Nepal Standards Bureau, to ensure the safety and competitiveness of upcycled products. This gap is compounded by a shortage of skilled personnel to maintain machinery.

More broadly, Nepal's infrastructure has been weakened by successive crises, especially the 2015 earthquake, which destroyed the homes of 40% of low-income households. Despite government compensation, reconstruction placed additional financial strain on communities, leaving them with little capacity to invest in or sustain waste management systems.

To respond to these geographical constraints, the Plastic to Ghar (P2G) project has proposed regional hubs that aggregate plastic from surrounding villages and mobile factories that travel to different regions once sufficient waste is accumulated. In any case, securing municipal support for collection, segregation, and cleaning remains critical for scaling these solutions.

Cultural & economic environment

In addition to these geographical and infrastructural barriers, Nepal also faces cultural and economic challenges that further exacerbate environmental pressures. One key issue is the lack of a tradition of insulation in rural areas, where households rely heavily on firewood for heating and cooking. With around 80% of the Himalayan population dependent on firewood, deforestation has accelerated, driving greenhouse gas emissions, soil erosion, and landslides that further threaten housing stability. Locally produced building materials, such as plastic-based roofing sheets, tiles, insulation panels, and beams, offer an opportunity to reduce reliance on imported materials, cut transportation costs, and address both housing and waste challenges in remote areas.

Capital constraints remain one of the most significant barriers in developing a viable circular economy (CE). Government subsidies for CE startups are rare, and collaboration with local authorities has progressed slowly. The banking sector, being generally risk-averse, hesitates to finance early-stage businesses. In this context, international development aid has served as a key enabler for securing the capital.

Last, but not least, the culture of innovation in Nepal is still in its formative stages. While individual organisations promote innovation, these efforts are often fragmented and lack synergy across the ecosystem. Limited political support, a weak social safety net, and a general reluctance to take risks constrain entrepreneurial activity. Cultural attitudes, such as fatalism, flexible perceptions



Figure 7
Mountain village in Khumbu

of time, and tolerance for delays, can reduce urgency and efficiency, though they may also contribute to lower societal stress levels. Building a cohesive, collaborative innovation culture will require overcoming these deeply embedded social and institutional patterns.

Political Challenges

The gap between the waste policy and implementation in Nepal mirrors broader trends in the Global South and makes it difficult for Circular Economy enterprises to thrive.

Nepal has recognised the importance of waste management and introduced various laws to regulate it. However, recycling and the Reduce, Reuse, Recycle (3Rs) approach remain low priorities and lack integration within a cohesive framework. The circular economy is absent from the legal landscape entirely. Compounding this, enforcement of existing laws remains inconsistent, hampered by significant implementation challenges.

The main laws about waste management

Nepal has symbolically recognised the importance of waste management through several official documents such as the National Adaptation Program of Action (2010) listing waste management as a priority for climate change adaptation, the Nepal Sanitation and Hygiene Master Plan (2011) integrating waste management to the broader sanitation framework, and even indirectly through the “right to a clean environment” enshrined by the Constitution (2015). Reflecting on this symbolical recognition, the Nepali state has organised waste management through different acts and regulations: The Solid Waste Management Act, 2068 (2011) assigns responsibilities to municipalities and organisations producing hazardous, chemical, medical and industrial wastes, while promoting the 3Rs approach; the National Penal (Code) Act (2017) makes it illegal “to generate, transmit, release or stockpile wastages in such a manner as to cause significant adverse impact on the environment”, thus protecting the environment from excessive waste production and mismanagement; the Industrial Enterprises Act, 2076 (2020) allows enterprises to deduct up to 50% of their taxable income for expenses related to systems and equipment that mitigate pollution through recycling or reusing waste, to encourage the mobilisation of waste as a resource through recycling and reuse; the revised National Solid Waste Management Policy (2022) includes encouragement to recycling and enhancement

of public-private partnerships, while clarifying waste management system organisation.

Hierarchy of the waste management system

The Nepali legal framework divides duties as follows:

The Federal Government is responsible for providing legal, financial, and technical support to local bodies, including setting pollution standards and allowing them to establish partnerships with private actors. This policy approach corresponds to the top-down model.

Within the Government, roles are further divided (JICA, 2024):

- The Ministry of Urban Development (MoUD), through its Urban Infrastructure Division, has overseen waste management at the national level since 2023.
- The Ministry of Federal Affairs and General Administration (MoFAGA) holds the mandate to supervise local administration carried out by municipalities. Until 2023, it was also responsible for waste management.
- The Ministry of the Environment sets pollution standards.
- The Ministry of Industry, Commerce and Supplies promotes recycling and reuse industries.
- The Ministry of Health and Population supervises waste management by health care facilities.
- The Provincial Government is responsible for coordinating the efforts of municipalities.
- Municipalities are responsible for the collection, disposal (including landfilling), and processing of waste. They have the authority to license private enterprises operating in the waste management sector and may establish partnerships with them.
- Individuals and organisations generating waste are responsible for transporting it to the collection Centre and may be punished if they “generate, transmit, release or stockpile wastages in such a manner as to cause significant adverse impact on the environment” (“The National Penal (Code) Act”, art. 112, sec. 1).
- Organisations producing hazardous, chemical, medical, and industrial waste are responsible for managing it themselves.
- The National Waste Management Coordination Committee (NWMCC), under the supervision of the Ministry of Urban Development (MoUD), is tasked with coordinating the activities of the various actors and levels involved.

Lack in integrated Circular Economy policy

Though the legal framework around waste management is seemingly robust in Nepal, there is neither specific law to recycling or circular economy nor incentive for viable alternatives, preventing the development of an integrated approach, and instead confining recycling to a low-ranking subject. This could be because of the prevalence of sanitation concerns over the perspective of circular economy development in the process of waste management policy elaboration. Moreover, the waste management policies do not address the need for the integration of the informal waste sector. While the informal waste sector is critical at the collection and segregation stage, there are 10,000-15,000 informal waste workers operating

in the Kathmandu Valley alone (Labra Cataldo et al., 2024), integrating it is crucial to any large extent circular economy or recycling venture.

Gap between policy & implementation

A central challenge lies not in policy design but in implementation. While some guidelines exist, most notably from 2008 (UN-Habitat, 2008), these have been rendered largely outdated by the Solid Waste Management Act of 2011 and the Sixteenth Plan (FY 2024/25–2028/29), which aims to reorganise the urban waste management system. The absence of updated, detailed guidelines means that key policy issues surface at the implementation stage rather than during policy elaboration. Dangi et al. (2017) observe that new rules

are routinely enacted before predecessors are effectively enforced, while jurisdictional tensions between local and federal levels further obstruct progress despite an apparently clear division of responsibilities. Most critically, many municipalities lack the local resources to act: though they are legally empowered to levy fees, impose fines, and generate revenue from waste, Nepal et al. (2023) report that only 30% do so in practice. This gap between policy and implementation reflects broader trends across the Global South and undermines the stable market conditions needed to support circular economy enterprises, stimulate industrial renewal, and attract investment.

Figure 8
A garbage dump on top of the hill, Illam





Figure 9
Local female workers segregating waste collected by Doko Recyclers, private local waste management business

1.4

Localised Circular Transition As A Solution

Circular Economy (CE) is an economic system that “closes the loop” of the material flow. Since the local conditions of the waste, infrastructure and policy support are inevitably variable, localisation and adaptation are essential to move from the linear system to a circular system.

The unsustainable future of linear economy is increasingly acknowledged, Circular Economy takes on added significance in the Global South. CE goes beyond mitigating the environmental impacts of production and consumption, it offers potential social benefits, including improved wellbeing, equitable access to education and resources, stronger citizen participation, and enhanced social cohesion.

A Circular Economy (CE) is an economic system designed to “close the loop” by increasing resource efficiency and minimising waste. Popularised over the past decade by the Ellen MacArthur Foundation (2013), the CE is closely linked to industrial ecology and the natural resource-based view (NRBV). Many CE policies and practices draw on the 3Rs, reduce, reuse, recycle, as well as the broader hierarchy of R-strategies (Reike et al., 2018). By embedding such Principals, CE is widely regarded as a pathway to achieving the Sustainable Development Goals (SDGs), particularly SDG 12: Responsible Production and Consumption. Concerns have been raised about a growing “circularity divide” between North and South (Barrie et al., 2022), as many Southern countries risk replicating policy pathways developed in the Global North rather than tailoring approaches to local contexts.

The Plastic to Ghar (P2G) project in Nepal seeks to enable a plastic CE transition in the Global South setting. Shifting from a linear model of extraction and disposal to a closed-loop CE is challenging, requiring coordinated efforts across micro-, meso-, and macro-levels. Among the key changes are the creation of circular start-ups (CSUs), the development of circular eco-innovations, and the adoption of circular business models (CBMs). P2G represents a meso-level intervention that engages local stakeholders through participatory Principals (Velenturf & Purnell, 2021). By catalysing the creation of plastic hubs and CSUs that transform waste into housing products, it demonstrates how circularity can be rooted in citizen participation and localised change.

While bans, conventional recycling, and extended producer responsibility (EPR) frameworks may eventually provide private-sector-driven solutions, governance limitations in the short term make upcycling one of the few practical avenues for immediate action. Upcycling converts accumulated plastic waste into usable products while reducing reliance on centralised, state-led systems. Yet building a sustainable upcycling market requires an entirely new supply chain vertically integrated, encompassing sourcing, sorting, washing, shredding, pelletising, remanufacturing, and market development. Key barriers include the low recyclability of certain plastics, limited sorting infrastructure, difficulties in achieving economies of scale, and high logistics and capital costs. The dominance of the informal sector both complicates coordination and transparency, though it also offers opportunities for collaboration.

P2G addresses these barriers directly by supporting rural start-ups that upcycle plastic waste into construction materials, particularly in the context of post-2015 earthquake reconstruction. Rooted in the Principal of “for the locals, by the locals,” the project illustrates how a localised circular economy can transform waste management challenges into opportunities for sustainable enterprise in remote regions of the Global South.

1.5

P2G Consortium & Timeline

To address the identified challenges, University of Cambridge teamed up with local and international NGOs, businesses and academia, adopting a participatory action research method.

In 2021, a consortium was formed bringing together a UK university, a UK-based NGO, a Nepali social enterprise, a Nepali not-for-profit with a digital fabrication lab and a Nepali makerspace. With funding secured from UK Aid, the project formally launched in January 2022 under the shared goal of building a circular economy innovation ecosystem that empowers local entrepreneurs to transform plastic waste into valuable community products. To advance these objectives, P2G partnered with a range of organisations: Nepali partners such as Clean Up Nepal, Doko Recyclers, Moware, and Sagarmatha Next; international machine suppliers PolyFloss Factory and Recosolution; and knowledge partners including Kathmandu University, Korea University, Precious Plastic, and Plastic Odyssey.

The project follows a participatory action research (PAR) approach to study Nepal's transition toward a circular economy. PAR emphasises collaboration between researchers and participants in setting goals, designing methods, collecting and analysing data, and

applying findings to generate tangible benefits (Kidd & Kral, 2005). The project leader from Cambridge has overseen research activities since inception, covering project design and execution, the development of start-up incubation and acceleration processes, and ongoing collaboration with the P2G team and Community Support Units.

Data collection involved direct engagement with stakeholders including government officials, local businesses, project participants, and community members. Documentation was maintained through daily project notes, weekly meeting minutes, bi-weekly coaching notes, interview transcripts, and quarterly reports. All interactions were carried out in English, with Nepali colleagues supported by simultaneous translation and basic Nepali language learning by the project leader to foster trust. To ensure reliability, data analysis was cross-checked with members of the P2G project and P2G start-ups.



Figure 10
P2G online Kick-off meeting on 6th January 2022

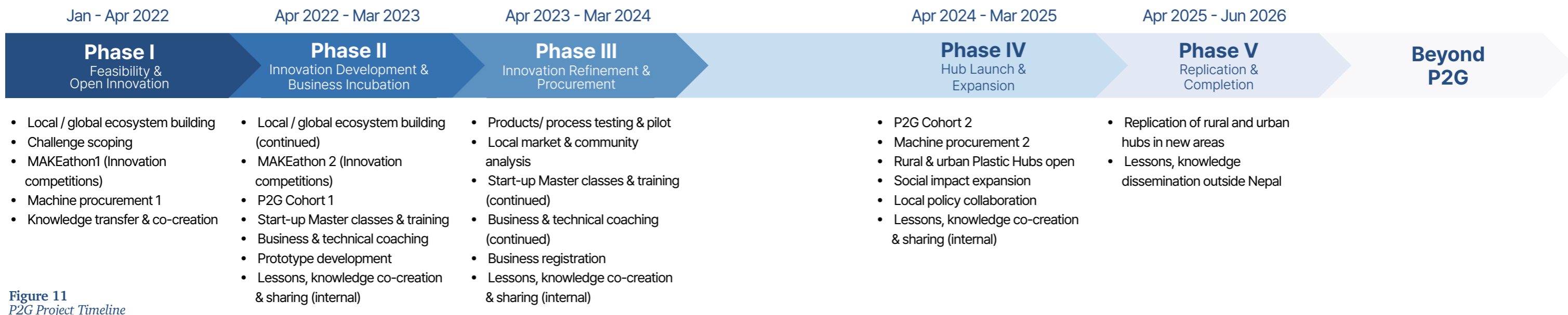


Figure 11
P2G Project Timeline

Chapter 2

The P2G Innovation Process

Chapter 2 walks through how the P2G innovation pathway unfolded in practice: from early challenge scoping and stakeholder engagement to MAKEathon-driven ideation, business incubation and the emergence of local start-ups and hubs. As innovation advanced from TRL 0 to TRL 9, localised circular innovation systems took shape through iterative, hands-on experimentation and continuous learning.

2.1 Stage 1. Challenge Scoping

2.2 Stage 2. Local Stakeholder Ecosystems Networking

2.3 Stage 3. MAKEathon: Initiating Innovation_TRL 0-4

2.4 Stage 4. Business Incubation_TRL 5-8

2.5 Stage 5. Business Launch_TRL 9

2.6 Stage 6. Ecosystem Propagation

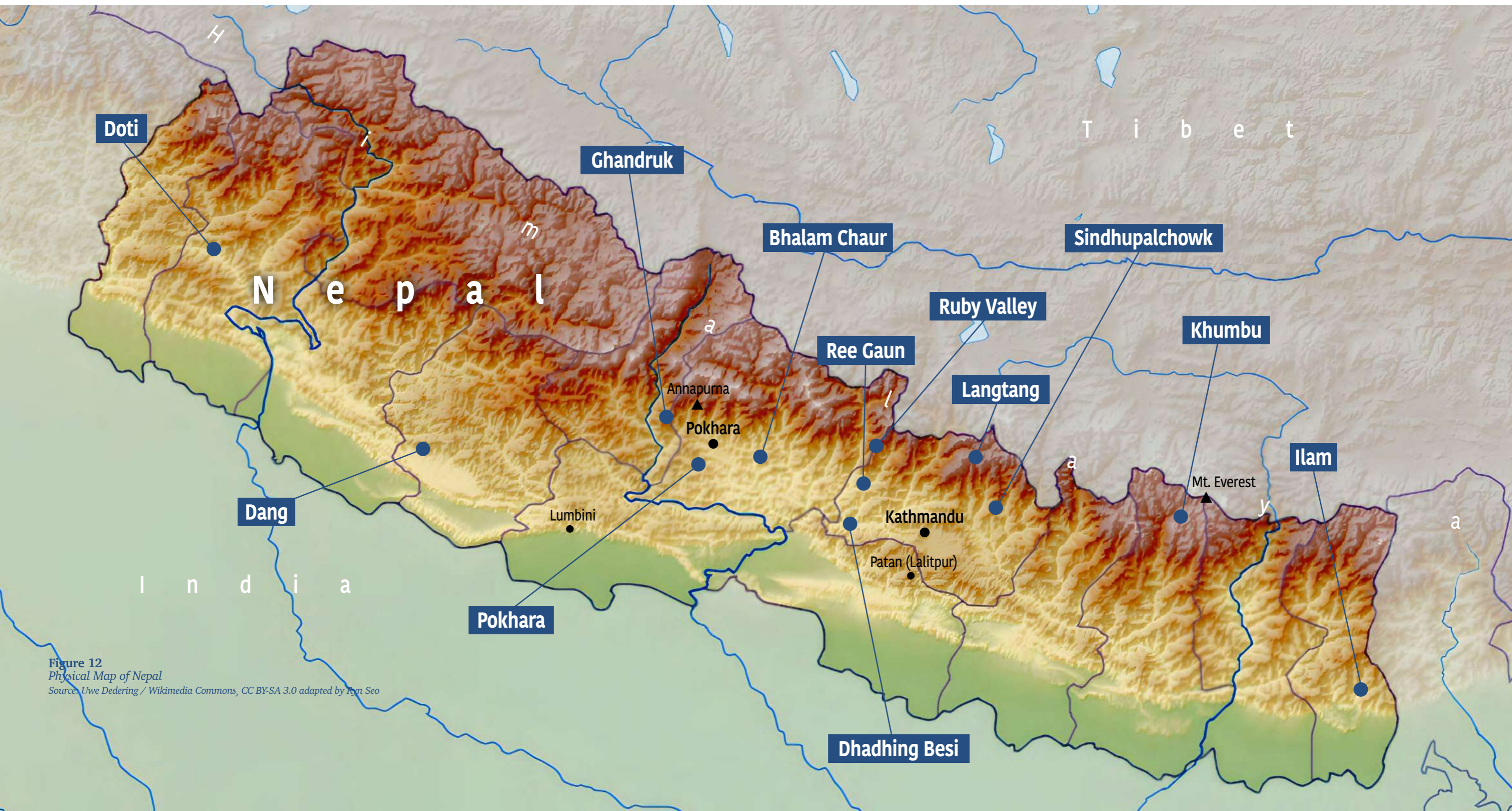


Figure 12
Physical Map of Nepal
Source: Uwe Dederig / Wikimedia Commons, CC BY-SA 3.0 adapted by Ryn Seo

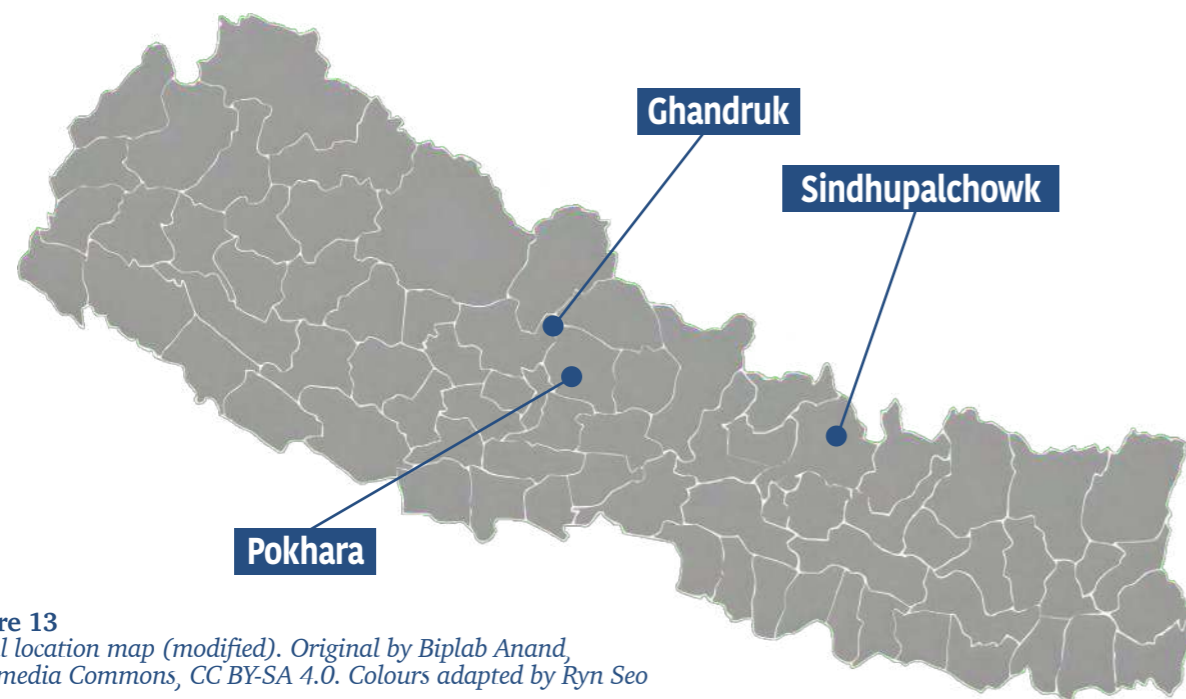


Figure 13
Nepal location map (modified). Original by Biplab Anand, Wikimedia Commons, CC BY-SA 4.0. Colours adapted by Ryn Seo



Figure 14, 15
Site visit and local resident interviews to understand the local housing conditions and challenges in Sindhupalchowk



Figure 16
Sindhupalchowk village houses along the hill

2.1 Stage 1. Challenge Scoping

Circular economy initiatives must respond to local needs rather than impose external solutions. We conducted field research across Nepal through stakeholder interviews, community consultations, and site visits to identify genuine priorities and ensure solutions addressed real-world contexts.

Over the course of the project period, eleven locations were visited in three phases, each representing different socio-economic contexts and environmental challenges. Key informant interviews and surveys, focus group discussions were conducted to understand local housing characteristics, plastic waste management problems, existing challenges, and potential opportunities for circular economy innovations.

Visits Before MAKEathon 1

The purpose of the first round of the visits was twofold: a) to explore the local challenge contexts for the foundation of the MAKEathon challenge themes, b) to start building the local connections by introducing the P2G project, we visited roughly three areas.

a. Sindhupalchowk

Sindhupalchowk district in north-central Nepal (Province 3), though relatively close to Kathmandu, remains in recovery from the devastating 2015 earthquake and the frequent floods. Despite its proximity to the capital, reconstruction is still underway, and the demand for housing materials is evident. During our visit, we toured local homes and interviewed residents about their living conditions and specific needs.

Housing in the area has shifted from traditional mud and stone structures to makeshift dwellings using second-hand tin sheets for roofs and walls, an economical yet problematic solution. These thin, corrugated sheets offer little insulation and are prone to leaking during heavy monsoon rains. Compounding these challenges, the district struggles with inadequate waste management infrastructure, leading many residents to dispose of rubbish by dumping or burning it in natural areas. Plastic bags are the most commonly found waste material.

b. Ghandruk

Ghandruk is a traditional Gurung village in Nepal's Annapurna region (Province 3), located along a popular trekking route to the Annapurna massif. Known for its peaceful atmosphere and modest number of lodges, it is a well-known destination for both domestic and international trekkers. The region presents distinct housing needs, particularly for tourists and trekkers. During our visit, we visited local lodges and interviewed their owners, and the local government officers to better understand current housing conditions and specific requirements.

Tourism is the backbone of Ghandruk's economy, with many residents operating lodges and guesthouses catering to trekkers travelling between Pokhara and the Annapurna Circuit. In the cold winter months, locals insulate their homes using red mud on both interior and exterior walls, burn firewood for cooking and heating, and use charcoal under tables to stay warm.

c. Pokhara

Pokhara, Nepal's second-largest city, lies about 200 kilometres west of Kathmandu in Province 4. Renowned for its scenic lakes and panoramic views of the Annapurna Range, which includes three of the world's ten highest peaks: Dhaulagiri, Annapurna I, and Manaslu, it serves as a major tourist hub and the gateway to the Annapurna Circuit.

The city is also home to several plastic recycling enterprises, such as Green Road and Himalayan Plastic, which primarily process post-industrial plastic waste from local industrial clusters. During our visit, we met with three recycling businesses to understand their key challenges and explore potential opportunities for collaboration.

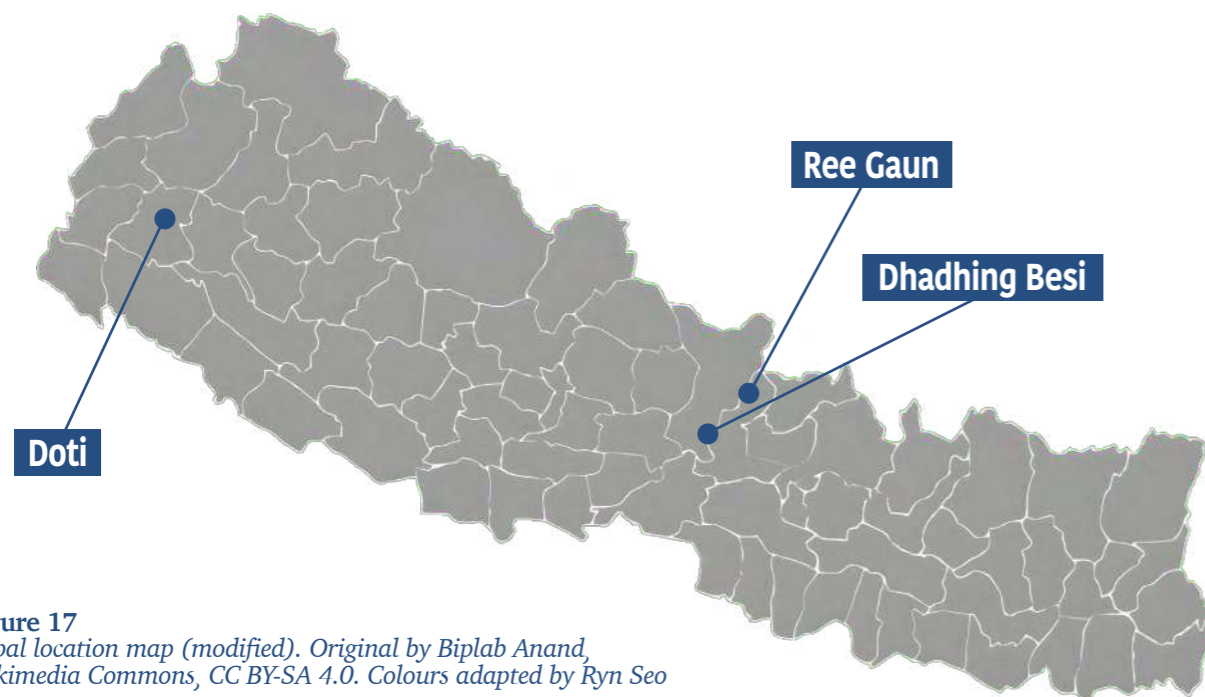


Figure 17
Nepal location map (modified). Original by Biplab Anand, Wikimedia Commons, CC BY-SA 4.0. Colours adapted by Ryn Seo



Figure 18
Waste dump on top of the hill in Doti



Figure 19
Local resident interviews to understand the local plastic waste challenges in Doti



Figure 20
Firewood kitchen in one of the households in Ree Gaun



Figure 21
Typical house built with tin sheets, the traditional stone slates roofing tiles are occasionally used

Visits Before MAKEathon 2

In addition to further exploring the challenge contexts in new regions, building more local connections, and introducing the P2G project, the second round of the visit aimed to invite the locals to the P2G MAKEathon 2 more widely.

a. Dhadhing Besi

Dhadhing Besi, the district headquarters of Dhadhing District in Bagmati Province (Province 3), is located in the lowlands between the Arun Khola and Thopal Khola rivers. The Prithvi Highway, which connects Kathmandu, Chitwan, and Pokhara, runs through the southern part of the district, providing vital access to the Kathmandu Valley.

We visited Dhadhing Besi several times en route to Ree Gaun, using the opportunity to engage with local housing material suppliers. As a bustling market town serving surrounding rural communities with limited infrastructure and connectivity, Dhadhing Besi plays a key role in regional trade. The influx of people from nearby villages for essential shopping contributes to significant market activity and a corresponding increase in waste generation. Our interviews with local suppliers provided insights into the housing material supply chain and the challenges faced in meeting rural housing needs.

b. Ree Gaun

Ree Gaun is a traditional Tamang village located in Dhadhing District, within the Gangajamuna Rural Municipality (Wards 1 and 2) of Bagmati Province (Province 3), central Nepal. The local economy is primarily based on agriculture, and homes are often constructed using tin sheets for roofing, and walls (along with some stones, mud and timbers).

During our visits, both before and after the MAKEathons, we engaged with the community through home visits, focus group interviews, and a workshop at the local

school to introduce the P2G approach and recycling technologies. We were also introduced to a village leader involved in a waste management initiative, who had recently completed a Community Recycling Centre (CRC) project with support from a foreign NGO and in collaboration with Doko Recyclers. While the CRC was established to collect plastic and other recyclables, the lack of viable end-use applications has meant that much of the processed waste ends up buried in large pits.

c. Doti

Doti is a remote district in Nepal's far western region (Province 6), characterised by limited infrastructure and challenging accessibility. We were introduced to the area due to its pressing need for effective solid waste management, as increasing volumes of waste are generated without any proper disposable systems.

Traditional housing in Doti typically features slate roofing, which is prone to leakage during the rainy season, leading to water seepage through walls and roofs. The district also contends with frequent wildlife intrusions e.g. bears, foxes, and leopards pose threats to livestock and agricultural livelihoods. Despite these challenges, there is growing local interest in plastic upcycling for use in concrete construction. However, transporting construction materials to the region remains a major logistical hurdle.

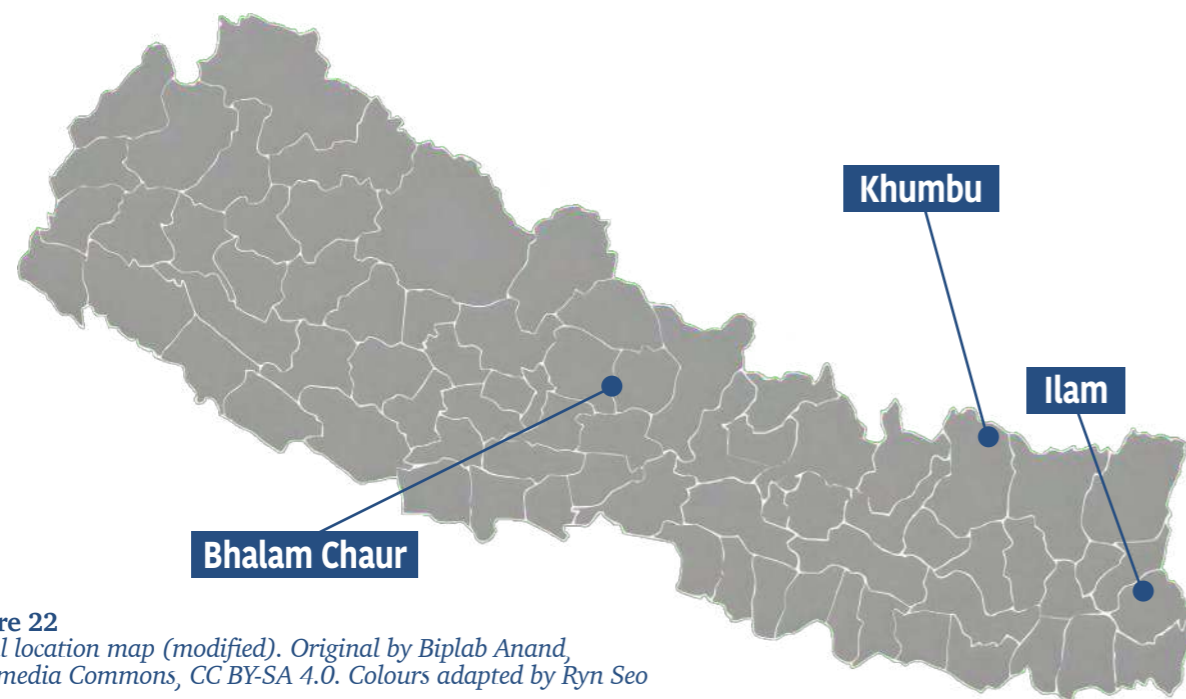


Figure 22
Nepal location map (modified). Original by Biplab Anand, Wikimedia Commons, CC BY-SA 4.0. Colours adapted by Ryn Seo



Figure 23
A homestay family in Balamchaur, a potential insulation customer



Figure 24
Visit to the local dump site with the local residents in Ilam



Figure 25
Trekking route to Namche Bazaar in Khumbu. Everything must be carried by humans, donkeys or yaks.

Visits during business incubation

These visits were made after the MAKEathons, during the business incubation when the P2G cohorts are further developing their innovation ideas and exploring the potential target markets to apply the developed ideas.

a. Khumbu

Khumbu, located in northeastern Nepal (Province 1), lies on the Nepalese side of Mount Everest. The region spans elevations from 3,300 metres to the 8,848.86-metre summit of Everest, the highest point on Earth. Home to high-altitude Sherpa communities, Khumbu symbolises the delicate balance between tourism development and environmental conservation, while grappling with the substantial plastic waste generated by trekkers and climbers.

The region includes key settlements such as Lukla, Thame, Khumjung, Pangboche, Pheriche, Kunde, and Namche Bazaar. Lukla (2,860 metres), with its Tenzing-Hillary Airport, serves as the main gateway for Everest-bound trekkers, while Namche Bazaar (3,440 metres) is the largest settlement and a vital acclimatisation stop.

In April 2023, we visited Lukla and Namche Bazaar to assess plastic waste management practices, particularly in relation to tourism. We conducted interviews with lodge owners and ward chiefs in Lukla, as well as rural municipality mayors, representatives from the Sagarmatha Pollution Control Committee (SPCC), and lodge and restaurant owners in Namche Bazaar.

b. Ilam

Ilam, a hill district in eastern Nepal's Koshi Province (Province 1), is widely known as the country's "tea capital," with a legacy of orthodox tea cultivation dating back to 1863. Renowned for its scenic landscapes and cool climate, Ilam is a peaceful and popular destination for domestic tourists, supported by a vibrant local

market and a range of visitor accommodations.

During our visit, we explored the local landfill, conducted two focus group discussions with youth groups, and held interviews with housing material suppliers, local politicians, and community activists. A recurring concern raised was the significant outmigration of young men from the region, contributing to a growing issue of brain drain and labour shortages.

c. Bhalam Chaur

Bhalam Chaur is a village in the Annapurna region of Gandaki Province (Province 3), situated in north-central Nepal at the foothills of the Himalayas, offering scenic views of the snow-capped Annapurna peaks. As part of the broader Annapurna trekking corridor, the village community is highly interested in promoting community-based homestay tourism, aiming to provide international trekkers with authentic cultural experiences.

During our visit, we interviewed local homestay owners and met with local politicians to understand the village's tourism and housing dynamics. Traditional stone houses with tin and slate roofing define the settlement's architecture. While the homestay accommodations are modest, many feature wooden panels beneath the tin roofs and maintain relatively high standards of hygiene. Although insulation is not commonly used in local homes, there is a clear willingness among residents to insulate homestay rooms to enhance comfort for international guests.

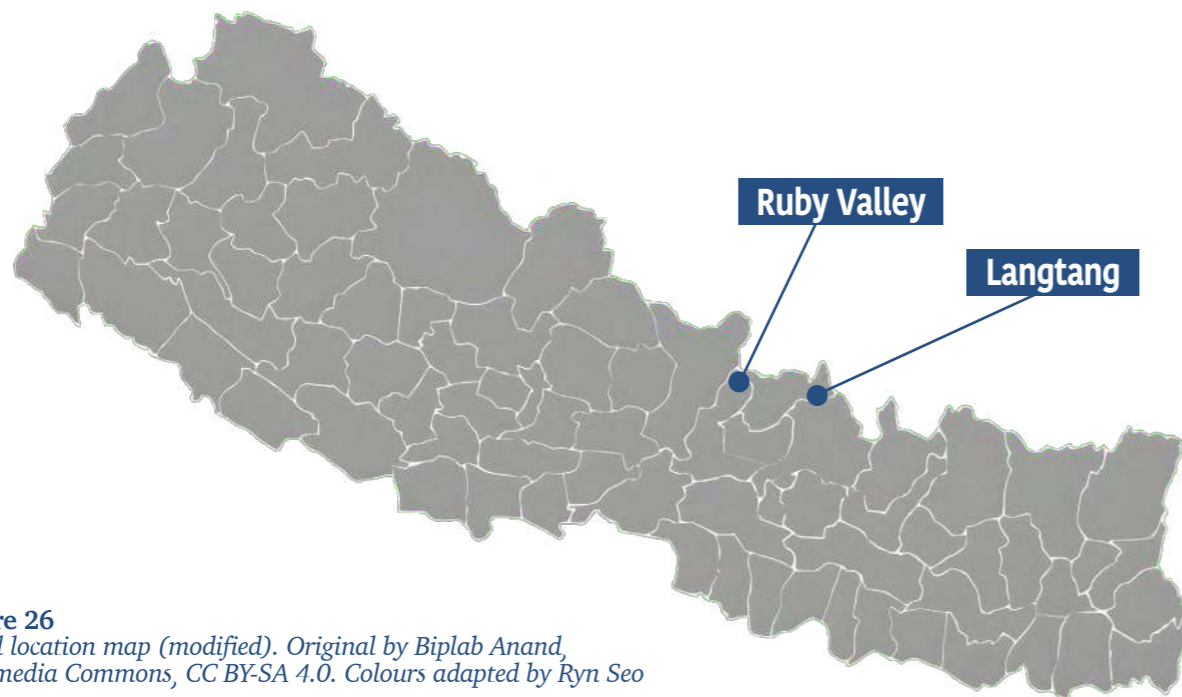


Figure 26
Nepal location map (modified). Original by Biplab Anand, Wikimedia Commons, CC BY-SA 4.0. Colours adapted by Ryn Seo



Figure 27
Visit to the local lodges in Langtang to understand their tourism-related plastic waste challenges



Figure 28
A typical kitchen in Langtang



Figure 29
Focus group discussion with the local volunteers in Ruby Valley



Figure 30
A dump site in Ruby Valley

d. Langtang

Langtang Valley is located in Rasuwa District of Bagmati Province (Province 2) in northern Nepal, lies within Langtang National Park at an elevation of approximately 3,500 metres. Nestled beneath several peaks over 6,000 metres including Langtang Lirung (7,246 metres), the valley is a popular trekking destination, offering proximity to the Kathmandu Valley and a gateway to high-altitude Himalayan landscapes.

The mountain communities in Langtang are actively engaged in sustainable practices and eco-friendly initiatives, aiming to balance tourism with environmental stewardship. In collaboration with Korea University's Carbon Neutral Village project, we visited four villages in the region. We conducted interviews with local lodge owners and community members, and introduced the P2G approach to explore the potential for replicating recycling and sustainability initiatives in this high-altitude context.

e. Ruby Valley

Ruby Valley, located in Dhading District of central Nepal (Province 3), is a remote trekking destination known for its community-based tourism and scenic alternative routes such as Pasang La Pass, Kalo Kunda, Seto Kunda, and Singla Pass. The valley offers panoramic mountain views and is home to traditional village settlements that attract adventurous trekkers seeking off-the-beaten-path experiences.

Current waste management practices in Ruby Valley primarily involve open dumping in natural areas, resulting in widespread litter across the landscape. In March 2025, site visits were conducted to identify existing dump sites and assess a potential location for establishing an innovation hub. Meetings were held with the Ruby Valley Municipality Chief, Ward 3 Chief, and sanitation project volunteers to discuss land allocation, waste collection systems, and infrastructure support.

In May 2025, a waste audit was carried out, and

Memorandums of Understanding were signed with Ruby Valley Municipality and Shechen Karuna, securing commitments for land and building resources for the innovation hub. Community education sessions were also conducted, and discussions were initiated with Paramendo as a potential business collaborator in the project.

P2G Process Insight 1

Challenge Scoping is more than completing a survey form. Making the journey across rugged terrain for in-person visits and interactions played a key role in helping the project team understand the local context and integrate with the community.



Figure 31
Focus interview at the village leader's home with local residents to understand the living conditions and their challenges

Survey Findings

Surveys across the locations revealed common challenges and priorities. When asked about plastic waste disposal, 60% of respondents reported burning waste whilst 40% relied on municipal landfill services. For heating, 60% used firewood and 20% used electric heaters powered by hydroelectricity. Housing improvement priorities centred on insulation using red mud for walls and blocking roof-wall gaps. Key challenges identified included the difficulty and cost of transporting construction materials such as slates, timber, concrete, bricks, and iron rods to remote mountain locations, alongside limited access to natural resources. These findings informed the development of the innovation framework, ensuring solutions addressed genuine local constraints.

Reflections

Over the first three years, we engaged with a wide range of local communities across Provinces 1, 2, 3, 4, and 6. What initially began as a scoping exercise evolved into an iterative process, as we continuously identified new application areas and opportunities for expansion throughout the project.

Each region, particularly the more remote ones, presented distinct challenges shaped by its geography, infrastructure, and socio-economic context. This place-based approach not only deepened our understanding of diverse local realities but also enabled us to engage meaningfully with a broad spectrum of stakeholders including village residents, local organisations, community groups, and representatives from local and provincial governments.

Through this process, we were able to identify context-specific needs and assess the feasibility of scaling and commercialising appropriate solutions. The iterative nature of our engagement proved essential in aligning innovation with local priorities and capacities.

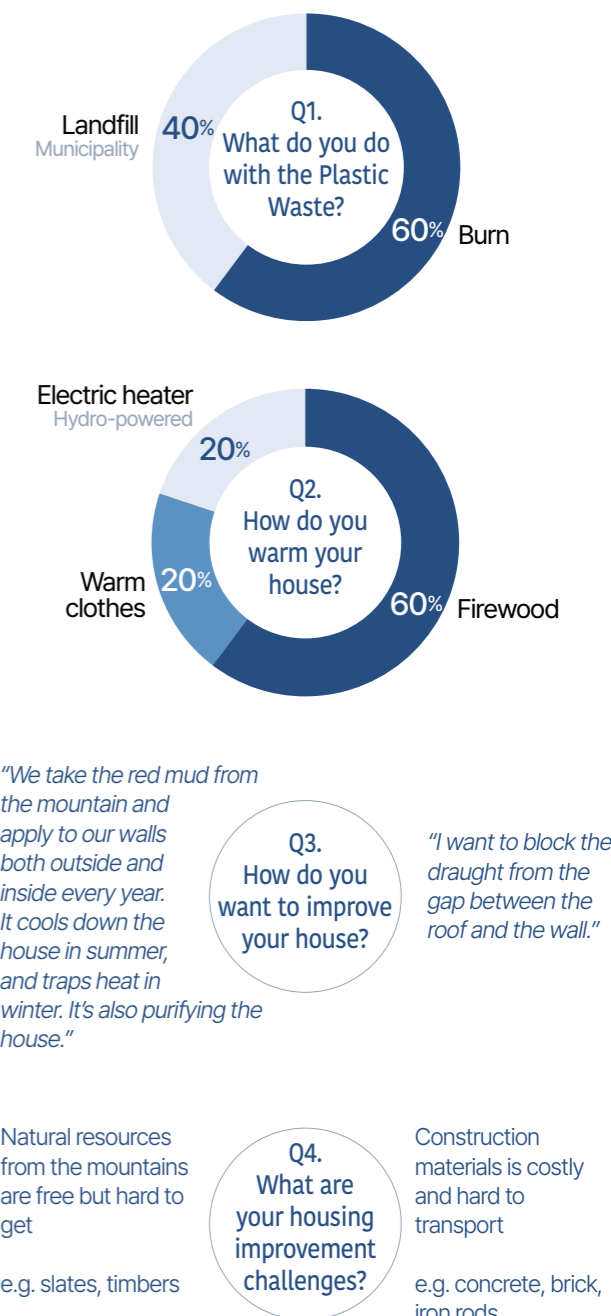


Figure 32
Survey based on the Ghandruk visit in 2022

Consortium Partners



Centre for Industrial Sustainability

The leading organisation of P2G, the Centre for Industrial Sustainability (CIS) collaborates with Impact Hub Kathmandu and FabLab Nepal. CIS provides overall direction for every aspect of P2G, from project design and work planning to the execution of activities.

CIS, led by Prof. Steve Evans, is one of the research centres within the Institute for Manufacturing (IfM), Department of Engineering, University of Cambridge. CIS focuses on the transition toward more sustainable industrial systems by helping industries respond to environmental, economic, and social challenges while remaining competitive. CIS collaborates worldwide with academia, industry partners, and policymakers on the research themes including regenerative manufacturing, eco-efficiency, sustainable business innovation, and industrial system transformation. It also develops research-based tools and frameworks that support sustainable business practices, and the decision making of government and policy makers. CIS leads the IfM Sustainability Association, a network of manufacturing leaders and researchers committed to advancing sustainability in manufacturing.

Impact Hub Kathmandu (IHK)

The sole local implementation partner of P2G, providing the business incubation and financial expertise. IHK enables P2G entrepreneurs by encouraging open discussions and unconventional problem-solving approaches of iterative learning and experimentation. The organisation provides hands-on business support and prototyping services, complemented by masterclasses on business development, financial planning, and technical coaching in operating the appropriate machines for plastic upcycling. By offering a safe, vibrant, inclusive, and well-structured innovation space, IHK enables entrepreneurs to move from concept to implementation.

Impact Hub Kathmandu (IHK) is a female-led, not-for-profit organisation in Nepal as part of a global network of 100+ Impact Hubs across 60+ countries. IHK was established in the aftermath of the 2015 Nepal earthquakes, founded on the belief that the crisis can be a catalyst for innovation. IHK applies its innovation-led, human-centred approach to support start-ups in their entrepreneurial journey, from idea to prototyping and business readiness.

FabLab Nepal

The local technical partner of P2G, a technical wing of Impact Hub Kathmandu, providing prototyping, fabrication, and machine expertise and technical coaching. As the first and only full-scale makerspace in Nepal, it serves as the primary R&D arm of P2G, supporting from MAKEathon prototyping through follow-up development, testing, piloting, and machine procurement. Its dedicated P2G Plastic Room includes a shredder, PolyFloss machine, extruder, and hot press for plastic upcycling, ensuring immediate access for iterative experimentation. It also coordinates raw materials and machine maintenance, reducing barriers and enabling teams to focus on innovation.

Beyond plastic processing, FabLab Nepal offers comprehensive fabrication facilities including 3D printers, laser cutters, CNC, sewing machines, electronic resources, moulding facilities, and various hand tools that enable full product development and customisation. Its local presence provides critical advantages to P2G and the manufacturing industry in Nepal, such as equipment access, bespoke technical support, machine knowledge, public training and connection to the global maker communities.

Collaborators



Precious Plastic

The primary source of plastic waste innovation knowledge and technical capability for P2G. Most of the P2G machines are procured from Precious Plastic inspired machine builders in India, found through the global Precious Plastic online marketplace.

Precious Plastic is a groundbreaking open hardware plastic recycling project started in 2013 by Dave Hakkens. It provides open-source machine plans and tools online that enable anyone to begin small-scale plastic recycling locally. Over the years, it has grown into a powerful global community with more than 80,000 active users in over 100 countries across Europe, Asia and Africa.

The machines include the shredder, injection, extrusion and compression machines. The shredder transforms plastic waste into uniform flakes that feed into other machines. The injector melts shredded plastic in a vertical pipe and presses it into moulds, while the extruder produces a continuous paste horizontally, which is then pressed into a mould. The compression machine, the hot press, forms melted plastic into flat boards.



PolyFloss

The pioneer of plastic floss making, inspiring the insulation concept for P2G

The PolyFloss Machine is an innovative small-scale system that transforms thermoplastic waste into soft, fine fibre through controlled heating and extrusion. Inspired by cotton candy machines, the PolyFloss Factory is a spin-off start-up founded in 2012 from the Innovation Design Engineering MA programme run by the Royal College of Art and Imperial College London. The technology converts polypropylene or PET pellets into a cotton like material suitable for multiple housing applications.

The floss can be used directly as insulation, providing thermal and acoustic benefits, or compressed into panels, bricks, and other structural elements using heat pressing techniques. It can also be used as filling for duvets and plush toys. PolyFloss technology is designed to be mobile and low-tech, enabling deployment in disaster struck and remote areas. It has been used for humanitarian insulation efforts in Turkey, Syria, Sudan and France through initiatives such as Waste for Warmth.



Plastic Odyssey

P2G's global knowledge partner, connecting plastic upcycling entrepreneurs across the Global South. P2G participated in Plastic Odyssey's Workshop on Plastic Upcycling Technology and Businesses in Chennai, gaining exposure to cross-sector learning and technical exchange with start-ups in India. P2G and Plastic Odyssey also co-authored the conference paper Plastic Upcycling Business Entrepreneur Typology, presented at the EcoDesign Conference at Waseda University in Tokyo in 2025.

Plastic Odyssey is a global-scale French initiative launched in 2022 that travels the world on a dedicated vessel to interact with plastic innovators and document low-cost, replicable solutions. Founded by two French merchant navy officers, the initiative aims to build a worldwide network of recycling entrepreneurs across Africa, South America, and Southeast Asia. Their work focuses on identifying locally developed technologies, sharing them through open-source platforms, and strengthening community capacity through courses, webinars, workshops, and incubation programmes.



Figure 35
P2G team and GD Labs visiting Plastic Odyssey ship in Chennai for plastic recycling knowledge exchange



Figure 36
P2G visiting Doko Recyclers facility in Kathmandu for understanding of the private sector waste management



Field Ready UK

One of the initial P2G consortium partners that helped shape the project outline at the outset. A non-governmental, non-profit organisation operating in ten countries, it addresses the causes and consequences of disasters, using cutting-edge technology, innovative design, and community-led solutions. Field Ready is founded on the belief that local production of essential items can make humanitarian aid faster, more cost effective, and more responsive to real needs.



Doko Recyclers

A visionary Nepali social enterprise specialising in integrated waste management, including household collection, recycling, material repurposing and EPR consultancy. It aims to scale zero waste to landfill solutions nationwide. Doko's Community Recycled Centre (CRC) in Ree village played an important bridge with P2G, forming the foundation of the Ree Hub, Paramendo. Their enthusiasm for knowledge sharing strengthened P2G's understanding of the local waste sector. Doko operates Nepal's only dedicated e waste facility.



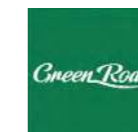
PLASTIC People

PLASTIC People, based in Ho Chi Minh City, Vietnam transforms plastic waste into premium quality construction materials. Although the attempted technology transfer did not materialise ultimately, their people-centred approach, relentless experimental pioneer spirit, superior product quality, and technical maturity in working with multiple polymer types deeply inspired P2G to aim high.



FlipiFlopi

Kenyan initiative building boats and furniture from plastic waste in remote coastal communities. As a fellow SMEP (Sustainable Manufacturing and Environmental Pollution Programme) partner, their shared operational experiences and comprehensive toolkit: Recycling Solutions for Remote Communities, drawn from Kenya's remote islands contexts, helped P2G with broaden its understanding of common challenges and solutions. In particular, their early plastic credit system experience greatly informed the plastic credit viability assessment research for Nepal.



Green Road

Pokhara-based Nepali company converting plastic waste into infrastructure materials e.g. road, bricks. As MAKEathon 1 mentor, they shared expertise in infrastructure-grade plastic upcycling, mixing waste with aggregates to create asphalt and concrete alternatives piloted in Pokhara, providing insights into construction applications and market opportunities.



Clean Up Nepal

Clean Up Nepal is a non-governmental and non-profit organisation dedicated to reducing waste through creative upcycling and recycling initiatives. Focused on community engagement, environmental education, and promoting circular economy practices across local communities, it brings extensive on-the-ground experience from across Nepal. Clean Up Nepal provided P2G with valuable local insights drawn from its rich community-based work.



Sagarmatha Next

The Sagarmatha Pollution Control Committee (SPCC) is a Sherpa-led community NGO in Nepal dedicated to keeping the Everest and Khumbu region clean. Since 1997, it has developed waste management infrastructure along the trekking routes, promoted recycling and segregation, and manages climbing routes, permits, and waste strategies at Everest Base Camp and beyond. PCC also helped P2G understand the grassroots challenges facing plastic initiatives in mountain regions.

MOWARE

MOWARE (Mountain Waste Repurpose) is a Nepal-based upcycling initiative transforming Himalayan waste into high-quality design products. Founded in 2013, it empowers low-income women through creative craftsmanship while diverting waste from landfills. Through partnerships, MOWARE has repurposed over 60,000 kg of waste across Kathmandu Valley and the Khumbu region.

Seoul Innovation Park FabLab

A digital fabrication laboratory in Seoul specialising in advanced manufacturing and prototyping. It was invited to provide international technical support and fabrication resources for P2G MAKEathon 1, enabling remote participants in Seoul to prototype using their Precious Plastic extruder. This collaboration demonstrated the potential for cross-border technical partnerships.

Simon Fraser University

Simon Fraser University, a public research university in British Columbia, Canada, collaborated with P2G to publish research outcomes from the project. Through interdisciplinary education, industry partnerships, and applied research, it cultivates innovation, entrepreneurship, and leadership, preparing the next generation of technology leaders with real world impact.

Korea University

Korea University is one of the leading universities in South Korea. Through its BK Centre for Sustainable Living Systems, Korea University supported the project on multiple levels, including co funding and sending online participants for P2G MAKEathon 1. In 2022 and 2025, three undergraduate interns were delegated to the project, contributing to the CO₂ reduction potential study and documenting key project lessons.

Kathmandu University

Nepal's leading private research university in Dhulikhel, recognised for its engineering and technology programmes. P2G commissioned the engineering department to conduct specialised testing on different thicknesses and densities of Poly+ Roll, the PolyFloss inspired insulation material, to evaluate its optimum thermal insulation properties (R value) on behalf of GD Labs.



Tri Haut pour l'Everest

French initiative addressing the plastic waste issues left by trekkers in Nepal's Khumbu region. Since 2021, the team partnered with local organisations e.g. SPCC to build a community-managed recycling centre in Pangboche, producing boards and injection moulded souvenirs. Their detailed and precise hot press building report helped P2G strengthen its technical understanding.

Nepal Bureau of Standards and Metrology

Nepal's national standards body that provided advisory support on compliance requirements, ensuring that the developed housing products meet local building standards critical for market entry and scaling. P2G consulted NBSM to understand the performance certification criteria for its products.

Accelerated Weathering Laboratory

Commercial testing organisation in the UK that conducts weathering experiments. As part of MA dissertation research, P2G commissioned AWL to test the performance of upcycled products under harsh outdoor conditions, providing technical validation for product warranties, lifecycle assessments, and market confidence for the Nepali context.

UNDP-KOICA

The UNDP-KOICA project Green Job Creation through Recycling and Upcycling (GCRU) aims to transform Pokhara's waste management landscape by fostering a green and circular economy. Two P2G start-ups participated in the programme. The project aims to create 680 green jobs, establish 30 recycling enterprises, and develop a Green Venture Zone to promote sustainable waste practices in the region.

P2G Process Insight 2

An innovation ecosystem is an organic, ever-evolving living structure. At times it is tightly connected; at other times it can become loose or dormant. Nurturing, reciprocation and care create the conditions for serendipitous opportunities to emerge.



Figure 37
MAKEathon 2 participants at Impact Hub Kathmandu courtyard

2.3 Stage 3.

MAKEathon: Initiating Innovation_TRL 1-4

The MAKEathon process enables participants to begin at TRL 0, with no concrete ideas, to progress through basic concept formulation (TRL 1), early validation and breadboard experimentation (TRL 2), and hands-on iterative prototyping (TRL 3). By the end of this stage, participants are equipped to develop tangible, viable early-stage innovations (TRL 4).

2.3.1 What is MAKEathon?

MAKEathon is an interdisciplinary innovation platform that brings together people from diverse fields to generate creative, practical solutions to complex sustainability challenges. Originating from the [MAKEit](#) project (funded by EIT Food, 2019-2020) at the Centre for Industrial Sustainability, University of Cambridge, Dr Curie Park has co-developed the concept and continued honing the mechanism by leading 28 MAKEathons worldwide so far.

Blending the open innovation spirit of hackathons with hands on making, MAKEathon integrates rapid prototyping and digital fabrication. This combination enables participants to turn ideas into tangible prototypes quickly, drawing on shared tools, materials, inspirations and expert mentoring support. Within a few days, participants are encouraged to experiment, iterate, and “fail fast” in a supportive environment that cultivates collective creativity and entrepreneurial confidence.

Key Features

Interdisciplinary Innovation	Sustainability Challenges	Prototyping at Makerspace
------------------------------	---------------------------	---------------------------

Interdisciplinary Innovation

- Fosters cross sector knowledge exchange and co-creation
- Brings together experts who would not typically meet or collaborate

Sustainability Challenges

- Addresses complex, persistent environmental and social problems
- Prioritises solutions with potential for large-scale positive societal impact

Prototyping at Makerspace

- Utilises state of the art makerspace facilities for rapid proof of concept
- Provides access to materials and tools for sketching and making
- Encourages experimentation through an open “trial and error” approach



Figure 38
14 MAKEit MAKEathons across Europe funded by EIT (2019, 2020)



Figure 39
MAKEit SUGAR hack at Cambridge MAKEspace (2019)



Figure 40
Inspirational talk by Gren Road, P2G MAKEathon1



Figure 41
Padmakshi Rana mentoring, P2G MAKEathon2

Interdisciplinary Collaborative Innovation Framework

The MAKEathon operates through an interdisciplinary collaborative innovation framework built on five structural pillars:

- disciplinary diversity
- systematic structure
- inspirational stimuli
- a supportive collaboration environment
- access to essential hardware and technical guidance

Together, these elements create the conditions for intensive collaboration, rapid prototyping, and meaningful innovation outcomes that siloed innovation efforts cannot easily achieve [Figure 42](#).

Sustainability Innovation Capacity Building Dynamics

Beyond generating immediate solutions to the presented challenges, the MAKEathon model fosters sustainability focused innovation capacity among participants and, ultimately, strengthens community level resilience. This capacity building process unfolds through five reinforcing dynamics:

1. creating momentum,
2. exposure to diverse worldviews,
3. serendipitous insights,
4. enhanced creative problem solving, and
5. individual empowerment.

These dynamics work together to stimulate systems thinking, enabling participants to explore the interconnections among technological, social, economic, and environmental dimensions [Figure 43](#).

Discipline Diversity Quadruple	Systematic Structure	Inspirational Stimuli	Supportive Collaboration Environment	Hardware & Intellectual Support
Creativity Technology & Science Subject expert Business	Detailed timetable Application process Submission templates Evaluation criteria e.g. Catalyst table, Ideation board, Innovation sustainability assessment spiderweb	Task refinement Challenge briefing Expert webinars Pre-reading materials Innovation catalysts	Teambuilding activities Recreational space Facilitators Nutritious catering	Secure venue Prototyping facilities & materials Expert guidance Mentors

Figure 42
Interdisciplinary Collaborative Innovation Framework ©Curie Park, 2026

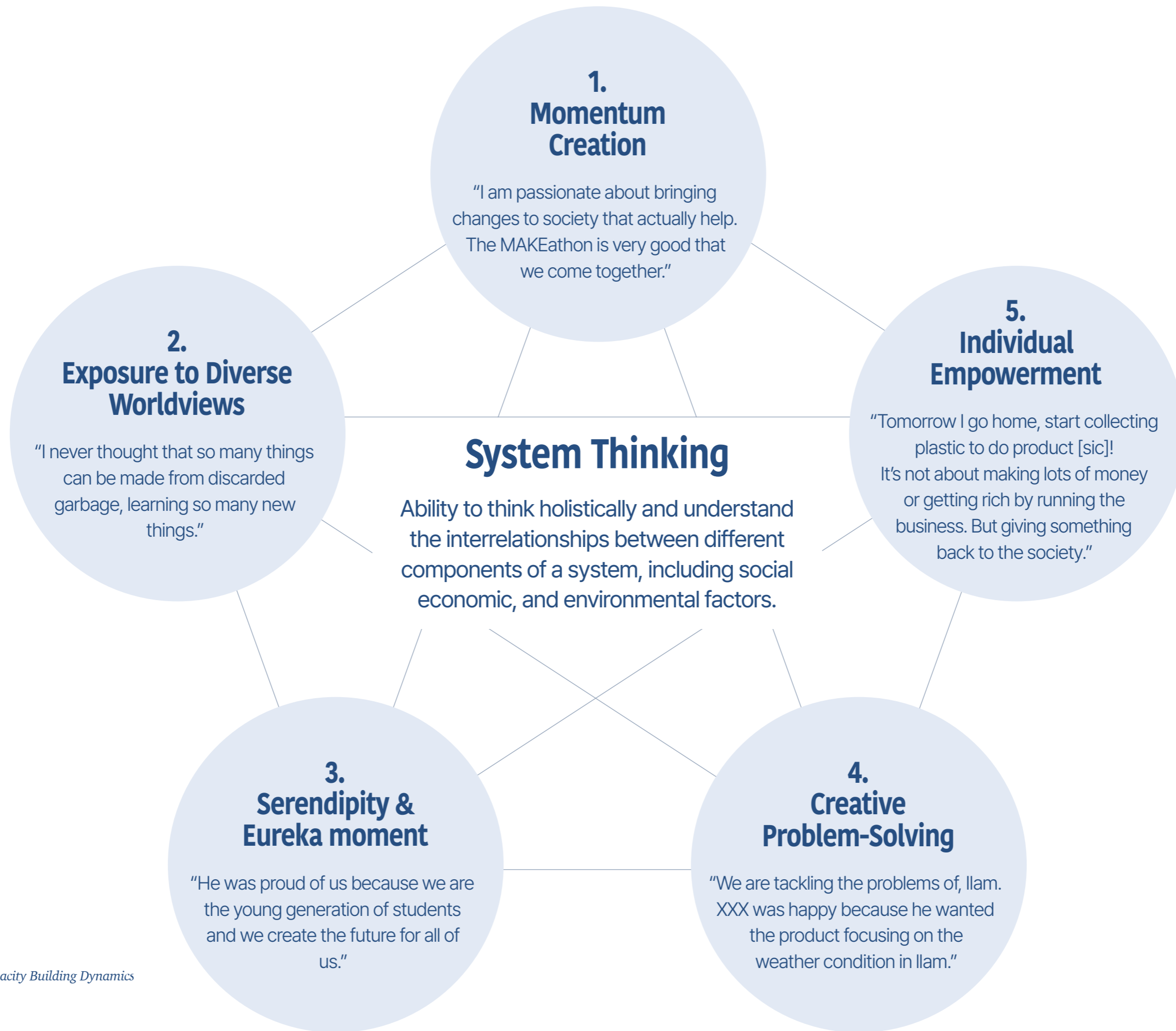


Figure 43
 Sustainability Innovation Capacity Building Dynamics
 ©Curie Park, 2026

Figure 44
Pallab & Denjing collecting plastic packaging
during MAKEathon2



MAKEathon Challenge

Develop a product using existing technology to transform plastic waste into durable housing products for Nepali homes

2.3.2 P2G MAKEathon Challenges

The P2G MAKEathon adapts the broader MAKEathon mechanism to Nepal's plastic waste realities, focusing on local-driven innovations enabling small scale plastic upcycling enterprises across the country. It is designed as a practical innovation challenge that deploys proven, appropriate plastic technologies through local-international collaboration, helping communities turn their own plastic waste into valuable housing products.

Recognising that Nepal's plastic waste crisis requires localised, economically viable, and community maintainable solutions, the P2G MAKEathon prioritises small, distributed operations rather than centralised processing facilities. This decentralised approach lowers logistical barriers, reduces transportation costs, and strengthens local ownership of both the environmental and economic outcomes.

At its core, the initiative is rooted in the Principal that environmental problems are solved most effectively when they also create economic opportunities. By nurturing a network of micro entrepreneurs who can upcycle plastic into marketable housing materials, the P2G MAKEathon simultaneously supports waste reduction, livelihood creation, community level capability building, and community wellbeing.

2.3.3 Setting the technical scene

The strength of this project lies in its deliberate adoption of proven, easy to operate, appropriate technologies that carry minimal novelty or technical complexity. This choice enables rapid deployment in Nepal and lowers the barriers for local entrepreneurs who may not have formal technical training. By anchoring the initiative in appropriate technologies, P2G can allocate resources towards business development, market creation, and community engagement rather

than fundamental R&D. (See P2G Technical Toolkit for full details of the adopted machines and technologies.)

Core Technical Collaborations

The MAKEathon's technical foundation is built on three complementary technology partnerships, each contributing a distinct function within the overall plastic processing ecosystem. These national and international collaborations were selected for their reliability, accessibility, and suitability for small scale, locally-maintainable operations.

- FabLab Nepal
- Precious Plastic
- PolyFloss

(See p. 40-41 for detailed description of the three core technical partners.)

Additional Collaborators

Beyond the core technology collaborators, the P2G MAKEathons benefited from a broad network of partners, mentors, and research institutions that strengthened the initiative with market insights, technical know-how, and hands on guidance. These collaborations exposed participants to diverse perspectives across the plastic value chain and enriched the innovation environment.

- Green Road
- Plastic People
- Doko Recyclers
- Clean It Nepal
- Reco Solutions
- Seoul Innovation Park FabLab
- Field Ready
- Korea University

(See p. 43-45 for detailed descriptions of each collaborator.)



Figure 45
Team Ragnath prototyping, MAKEathon2

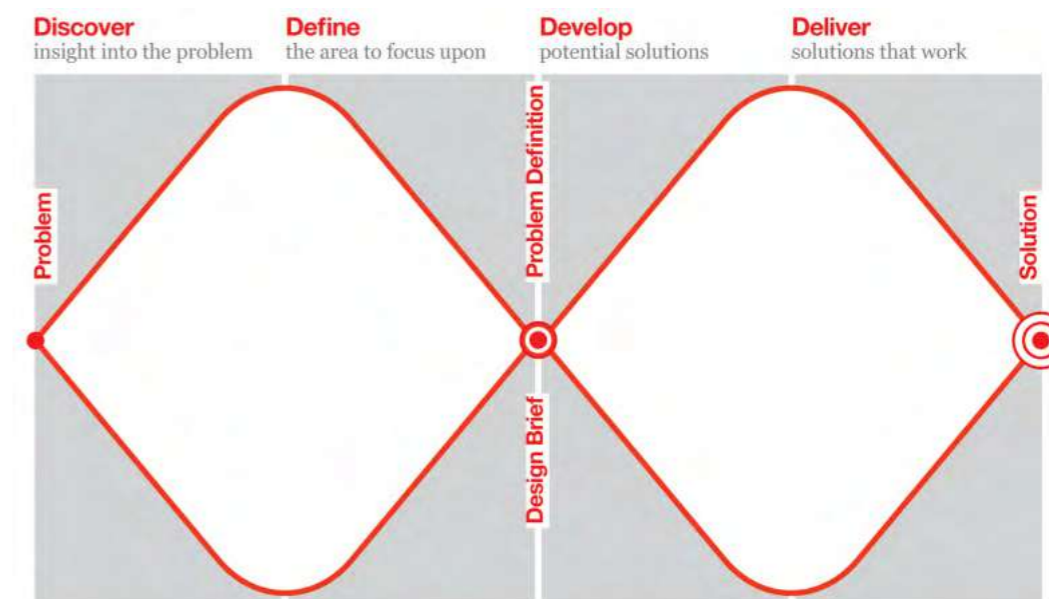


Figure 46 The Double Diamond Design Process Model

Source: Design Council (2004) The Double Diamond [diagram]. CC BY 4.0.
Available at: <https://www.designcouncil.org.uk/our-resources/the-double-diamond/> (Accessed: 10 March 2026).

2.3.4 MAKEathonToolkit

A range of circular innovation ideation tools was utilised throughout the MAKEathon process to guide teams from initial problem identification through to solution development and business model creation. The toolkit included facilitation templates for problem scoping, idea generation, prototyping, and idea refinement, delivered in both offline and online formats using collaborative platforms such as Google Drive and Jamboard.

The Double Diamond Innovation Framework

The innovation process was structured around the internationally recognised Double Diamond methodology, which provides a systematic approach to innovation through four distinct phases: Discover, Define, Develop, and Deliver.

🕒 Discover: Divergent Problem Exploration

- Focuses on understanding broader contexts and identifying potential problem areas
- Emphasises gathering insights, conducting research, and understanding user needs and market contexts
- Encourages exploration of various challenges without immediately jumping to solutions
- Supports wide-ranging investigation across environmental, social, and economic dimensions

🕒 Define: Convergent Problem Articulation

- Represents the first convergent stage where teams synthesise discoveries
- Involves moving from problem exploration to specific problem definition
- Ensures teams establish a clear and focused challenge to address
- Transforms broad insights into actionable problem statements

🕒 Develop: Divergent Solution Generation

- Returns to divergent thinking for generating multiple potential solutions
- Encourages creative thinking, ideation, and exploration of various approaches
- Supports comprehensive examination of possibilities before convergence
- Promotes innovative thinking across different solution pathways

🕒 Deliver: Convergent Solution Implementation

- Involves refining, testing, and implementing chosen solutions
- Focuses on creating viable, sustainable solutions that effectively address identified problems
- Emphasises practical implementation and real-world applicability
- Ensures solutions meet commercial and sustainability requirements

[1 Discover]
Problem Scoping Framework

What are the most urgent scaleable problem areas?	Where is the problem area that the team likes to focus on?
---	--

Figure 47
 Problem Solving Framework designed by Curie Park

- **Purpose:** Facilitates broad exploration by encouraging expansive thinking about urgent and scalable problem areas
- **Key Components:**
 - "What are the most urgent, scalable problem areas?" - Supports identification of multiple potential challenge areas across environmental, social, and economic dimensions
 - "Where is the problem area that the team wants to focus on?" - Identifies problems aligned with team members' interests, expertise, and values to sustain motivation throughout the process
- **Impact:** Supports the divergent nature of the Discover phase by encouraging teams to cast a wide net in their problem identification process

[2 Define]
Research and Context-Building Activities

Brainstorm solutions to address the chosen problem
 Aim to have 10 ideas each, 30 sketches Add Slides If Needed.
 The more the merrier!

Figure 48
 Brainstorming Framework designed by Curie Park

- **Purpose:** Builds comprehensive understanding of the problem landscape before narrowing focus
- **Key Components:**
 - Comprehensive background materials on various circular economy challenges
 - Preliminary research activities to explore problem contexts
 - Evidence-gathering processes to inform decision-making
- **Impact:** Facilitates evidence-based problem definition and informed focus area selection

[3 Deliver]
Business Model Canvas

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
	Key Resources		Channels	
Cost Structure		Revenue Streams		
Environmental Costs		Societal Costs	Societal Benefits	Environmental Benefits

Figure 49 Business Model Canvas
 Source: Adapted by the author from Osterwalder, A. and Pigneur, Y. (2010) Business Model Generation. Hoboken: Wiley.

- **Purpose:** Facilitates convergent thinking by systematically addressing essential components of viable business models
- **Key Components:**
 - Key Partners - Strategic alliances and supplier networks essential for business operations
 - Key Activities - Core actions required to deliver value proposition and operate successfully
 - Key Resources - Critical assets needed to create and deliver value to customers
 - Value Proposition - Unique benefits and solutions offered to address customer needs
 - Customer Relationships - Types of relationships established and maintained with customer segments
 - Channels - Methods and pathways used to reach and deliver value to customers
 - Customer Segments - Distinct groups of customers with common characteristics and needs
 - Cost Structure - Major cost elements and drivers required to operate the business model
 - Revenue Streams - Ways the business generates income from each customer segment
- **Impact:** Ensures teams converge on commercially viable solutions through comprehensive business model framework

[4 Deliver]
One-Page Summary

- Innovation Title
- Team Name & Team Member
- Problem Statement (max 50 words)
- Innovation Concept & How it works (max 80 words)
- Business Model & Target Market (max 50 words)
- Sustainability Impact (max 50 words)
- Next Steps: Necessary Resources & Implementation Plan (max 30 words)
- Link to the Loom Pich Video

Figure 50
 MAKEathon One-Page Summary designed by Curie Park

- **Purpose:** Enforces convergent thinking through structured constraint-based documentation
- **Key Components:**
 - Innovation Concept and Functionality - Core innovation description and how it works
 - Business Model and Target Market - Commercial approach and intended customer base
 - Sustainability Impact - Environmental, social, and economic benefits generated
 - Implementation Plan - Practical steps and timeline for bringing solution to market
- **Impact:** Word limit constraints require teams to distill developed concepts into clear, communicable formats

[4 Deliver]
Sustainable Innovation Assessment Spiderweb

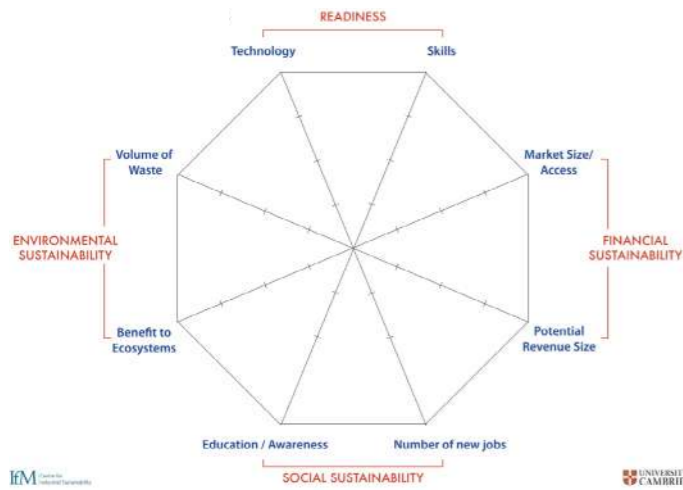


Figure 51
Sustainable Innovation Assessment Spiderweb designed by Curie Park

- **Purpose:** Provides structured evaluation framework across critical sustainability dimensions
- **Key Components:**
 - Environmental Sustainability assessment - Evaluation of ecological impact and resource efficiency
 - Social Sustainability evaluation - Analysis of social benefits and community impact
 - Financial Sustainability analysis - Assessment of economic viability and long-term profitability
 - Readiness Assessment criteria - Evaluation of implementation feasibility and market readiness
- **Impact:** Enables teams to converge on solutions demonstrating comprehensive viability across all sustainability criteria

2.3.5 Running P2G MAKEathons

The P2G MAKEathon programme was implemented in two rounds to integrate international expertise with local Nepalese participation. The first MAKEathon, held in April 2022, operated at an international level through a hybrid format, while the second, delivered in November 2022, focused exclusively on national participants. Both rounds shared a unified theme of plastic remanufacturing for durable housing products and each produced three winning teams.

Innovation Ecosystem Development

The MAKEathon programme successfully laid the first milestone for a comprehensive plastic waste innovation ecosystem that bridges international expertise with local implementation needs. By inviting individuals with an ambition but not necessarily with concrete ideas, we started the innovation process from TRLO.

Through structured mentorship, educational components, and competitive innovation challenges, the

program provided the momentum for the participants to start generating practical solutions to solve their own challenges.

This is a critical step to plant the seed of support culture and support system for innovation in Nepal. From onwards, the follow-on incubation process help the teams further develop the innovation for concrete and viable sustainable housing solutions while building local capacity for local plastic waste management and upcycling technologies.

P2G Process Insight 3

Creating a safe and inviting space for MAKEathon participants, the aspiring individuals, to freely experiment with appropriate technology is key to lowering their guard. This allows them to open up and bring out their best creative potential and collaborative spirit.

Figure 52
Idea development mentoring session involving recycled product samples, pen and paper, and lots of sticky notes





Figure 53
Abhishek Tamang from Paramendo team ideation, MAKEathon2

2.3.6 Running MAKEathons

The P2G MAKEathon programme was implemented in two rounds to integrate international expertise with local Nepalese participation. The first MAKEathon, held in April 2022, operated at an international level through a hybrid format, while the second, delivered in November 2022, focused exclusively on national participants. Both rounds shared a unified theme of plastic remanufacturing for durable housing products and each produced three winning teams.

Evaluation Framework

The judging process was structured around three main focus areas [Table 2](#) and five comprehensive evaluation criteria [Table 3](#), ensuring both technical feasibility and market viability.

Table 1
P2G MAKEathons overview

Event	1st MAKEathon	2nd MAKEathon
Dates	April 1st - 3rd, 10th, 2022	November 10th - 12th, 2022
Scope	International (Online & Offline Hybrid)	National (On-site)
Venue	FabLab Nepal & Zoom	FabLab Nepal
Participants	26 participants from 4 countries	44 participants across Nepal

Table 2
P2G MAKEathon 3 focus areas

Logistics	Plastic waste source, production and market
Durability	Long-lasting housing products
Key Local Challenge	Most critical local needs

Table 3
P2G MAKEathon evaluation criteria

Innovation & Integrity	<ul style="list-style-type: none"> Addressing the challenge Creativity Originality
Prototype	<ul style="list-style-type: none"> Effective demonstration Technical feasibility
Sustainability	<ul style="list-style-type: none"> Substantial social Environmental impact
Business Potential	<ul style="list-style-type: none"> Viability Real-world Scalability
Team & Pitch	<ul style="list-style-type: none"> Enthusiasm to continue Compelling pitch



Figure 54
Prototyping at FabLab Nepal to realise the initial ideas from MAKEathons into reality

Table 4
P2G MAKEathon1 Agenda

Time (NPT)	Day 1 1st April	Day 2 2nd April	Day3 3rd April	4th - 9th April	Day 4 10th April
09:00 - 10:00	Welcome & Registration	Welcome Back	Welcome Back		Welcome Back
10:00 - 11:00	Kick-Off: MAKEathon & Background	Team Exercise: Idea Exploration			Intro to Judges
11:00 - 12:00	Ice-Breaking & Team Building	Team Exercise: Challenge prioritisation	Team Exercise: Idea Refinement		Final Pitch & Feedback
12:00 - 13:00	How Days Work Q&A	Teamwork: Business Canvas	Intro to Final Submission		Winner Announcement & Award Ceremony
13:00 - 14:00		Lunch Break		Team Prototyping	Lunch Break & Networking
14:00 - 15:00	Webinar 1 Challenge Briefing Q&A	Webinar 4 Green Road Solutions	Teamwork: Pitch preparation		
15:00 - 16:00	Webinar 2 Intro to Business Model	Webinar 6 Latest Plastic trend: Reco Solution			
16:00 - 17:00	Webinar 3 Disaster Relief Innovation: Field Ready				
17:00 - 18:00	Networking	Mentoring	Mentoring		

P2G MAKEathon1 Results (March-April 2022)

- **Total participants:** 26 local and global participants from 4 countries
- **Venue:** Hybrid delivery combining FabLab Nepal, Seoul Innovation Hub & Zoom
- **International scope:** Cross-border collaboration between Nepal, South Korea, UK and Bangladesh
- **Participants background:**
 - Participants included individuals, teams, and registered companies with expertise in technology, business development, and social innovation
 - Various entrepreneurs and established organisations focused on sustainability and innovation participated to develop scalable solutions

Programme Implementation:

- **Educational Component:** 6 webinars covering plastic upcycling technology and business model development
- **Mentorship Support:** 11 specialised mentors and 2 on/offline facilitators
- **Team Formation:** Multiple teams developed and pitched innovative solutions
- **Innovation Output:** 7 open-source innovations with 3 winning teams



Figure 55
Ensuring healthy, seasonal food helps the MAKEathon participants stay energised and feel welcomed

Table 5
P2G MAKEathon2 Agenda

Time (NPT)	Day 1 10th Nov	Day 2 11th Nov	Day3 12th Nov
08:30 - 09:00	Breakfast & Registration		
09:00 - 10:00	Kick-Off: MAKEathon Intro & How it works	Team Exercise: Idea Exploration	Intro to final pitch
10:00 - 11:00	Ice-breaking & Team building	Teamwork 3 IDEA Refinement	Teamwork 7 Pitch preparation
11:00 - 12:00	Talk 1 Village Housing 1	Teamwork 4 Prototyping	
	Talk 2 Village Housing 2		
12:00 - 13:00	Talk 3 Village Housing 3	Lunch Break	
13:00 - 14:00	Teamwork 1 Problem scoping	Talk 6 Business model Canvas	Final Pitch & Feedback
14:00 - 15:00	Talk 4 PLASTICpeople	Teamwork 5 Business model building	Winner Announcement Award ceremony
15:00 - 16:00	Talk 5 PolyFloss	Teamwork 6 Idea Refinement & Prototyping	Wrap-up
	Teamwork 2 Idea Brainstorming		
16:00 - 17:00	Mentoring		
17:00 - 18:00	Mentoring		
18:00 - 19:00	Teamwork may continue...		
19:00 - 20:00	Teamwork may continue...		

P2G MAKEathon2 Results (November 10-12, 2022)

- **Total participants:** 48 applications and 44 active participants
 - Ree Gaun village (Province 4): 13 participants
 - Dhipayal, Doti region (Province 7): 4 participants
 - Ilam region (Province 1): 1 participant
 - Pokhara: 1 participant
 - Kathmandu valley area: 25 participants
- **Venue:** FabLab Nepal
- **International scope:** Cross-border collaboration between Nepal, South Korea, and other participating nations
- **Participants background:**
 - Diverse occupations including students, farmers, businessmen, researchers, accountants, project coordinators, and communication officers
 - Plastic upcycling start-ups: 2 companies (Green Road, Plastic Solution)
 - Waste management business: 1 company (Doko Recyclers)

Programme Implementation:

- **Educational Component:** 6 webinars on plastic upcycling technology and business models
- **Mentorship Support:** Comprehensive guidance throughout the development process
- **Team Formation:** 5 teams with 4-8 members each pitched their solutions
- **Innovation Output:** 6 open-source innovations with 3 winning teams

2.3.7 P2G MAKEathon Outcomes

P2G MAKEathon1 Winners

1st: Scavengers

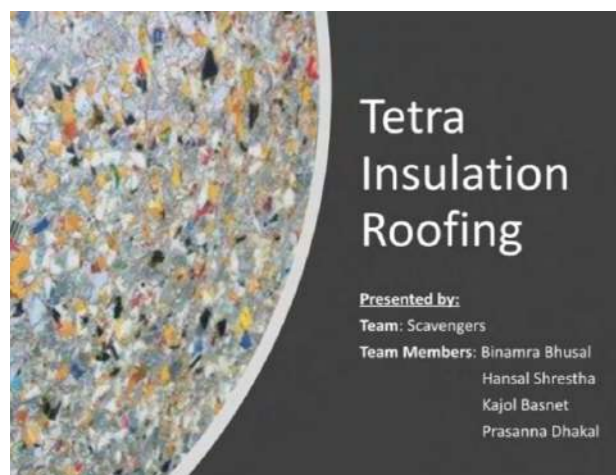


Figure 56
Scavengers' innovation concept

Innovation: Tetra Insulation Roofing

Scavengers, in collaboration with PLASTICPeople Vietnam, tackled the challenge of recycling multi-layer plastic packaging such as crisp packets. Using a high-pressure hot press, they melt and combine these difficult-to-recycle materials to create roofing sheets with greater thickness than commonly used CGI sheets.

Technical Specifications:

- utilises approximately 0.625 kg of plastic per square foot of sheet (8mm thickness)
- For an average roof size of 1700 square feet, about 1 tonne of plastic waste is utilised

Post-MAKEathon Status: The team persevered until 2024, but faced challenges when most members went abroad for studies, leaving only one person. Despite this setback, they provided valuable learning experiences and even participated in an Everest project.

2nd: LUCHOHA (Green Decision Labs)



Figure 57
LUCHOHA's innovation concept

Innovation: PipeWrap Insulations

Using discarded polypropylene plastic (PP), Green Decision Labs developed under-roof insulation wool that improves thermal insulation temperature by up to 5 degrees. Their process involves pelletizing raw materials and converting them into plastic wool using a PolyFloss machine. The wool is then felted and compressed in a cold press machine. To enhance fire resistance, a mud-soaked cotton fabric is added on top, inspired by traditional Nepali wall-finishing methods.

Post-MAKEathon Status: This international team included members from Cambridge and Korea, but international members eventually departed. Green Decision Labs was a pre-existing company that survived the transition but has not significantly advanced the project since.

3rd: Doko



Figure 58
Doko's innovation concept

Innovation: Mattress for emergency shelter filled with PolyFloss materials

PolyFloss Fold mattresses are specifically designed to incorporate the insulation property of plastic into a warm bedding system for disaster-affected areas, especially for the people living in mountainous regions. The use of PolyFloss technology in between layers of foam encapsulated by a soft fabric will provide warmth to those who need it. Furthermore, the mattress can be used for multiple purposes, a flatbed or sofa, or a pillow. The easy folding design will allow for easier transportation and storage.

Post-MAKEathon Status: Ceased due to brain drain. Everyone left to study abroad.

Extra Winner: Geo Dome

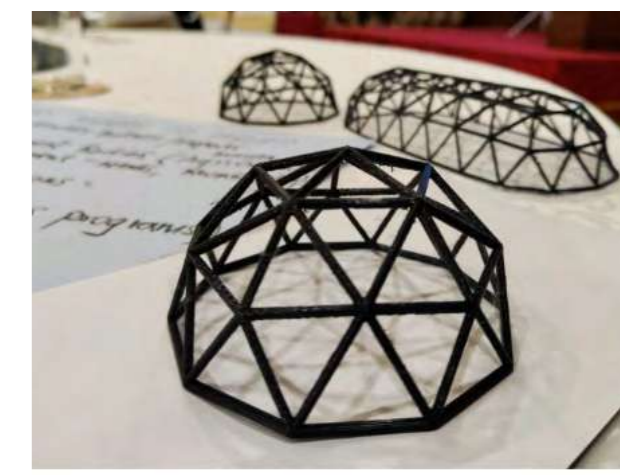


Figure 59
Geo Dome's innovation concept

Innovation: Disaster Shelter Units

Geo Dome produce easy-to-assemble disaster shelter units comprising a skeleton of interlocking plastic tubes and plastic sheet covering using recycled plastic. These shelters serve as safe temporary lodging during major earthquakes or floods when people are advised to vacate their houses.

Post-MAKEathon Status: Although Geodome didn't initially win, their business enthusiasm and existing concept earned them inclusion in the P2G Cohort. The Geodome was an existing registered company even before the MAKEathon. During the MAKEathon, the team members were dispersed to be part of other teams, mainly to support the nascent teams with their technical know-hows and knowledge and develop new ideas. After the MAKEathon the team were specially invited to continue joining the incubation process with their existing idea of the disaster shelter. They continued as a P2G cohort for the following one year, developing and prototyping their ideas further into greenhouse and glamping units. After a while, they decided to leave to pursue their ideas without a tie with P2G.

P2G MAKEathon2 Winners

1st: Paramendo



Figure 60
Paramendo's innovation concept

Innovation: Sajilo Parda (Multi-Purpose Plastic Solutions)
Paramendo focused on utilising different types of polyethylene for various applications:

- MLP Roof Tiles: Multi-layer plastic converted into roof tiles for thermal and acoustic insulation
- LDPE Sheets: Low-density polyethylene sheets for roof sealing and repairs
- LDPE Curtains: Sheets converted into curtains and blinds
- LDPE Frame Covering: Sheets used for covering doors and window frames

Post-MAKEathon Status: Initially 11 people from a village formed the team, but they split into two teams. One of them was from Paramendo and won the first place. Additional members from Kathmandu were later brought in to provide urban market expertise. After a while, the team faced "brain drain" as two founding members relocated to study or work abroad. But it didn't affect the team cohesion, and gave them an opportunity to become even stronger than before. Now Paramendo continues to operate both in Ree and Kathmandu as the homegrown start-up of P2G.

2nd: Khaptad



Figure 61
Khaptad's innovation concept

Innovation: PolyFloss Roofblind

Blind-type removable sun shade over the roof using the insulation materials from PolyFloss. This is specifically designed for Doti area where the sunlight is quite strong in the summer.

Post-MAKEathon Status: The team members from Doti lost the contact after the competition. All the Kathmandu team members experiences brain drain to study abroad. So they ceased after a recycling business feasibility study in Doti.

3rd: Ragunath (later Plastic Heart)



Figure 62
Ragunath's innovation concept

Innovation: Natural AC & Plastic Beams

Non-electricity powered air conditioning system inspired by traditional Newar house techniques. The unit uses unique conical shapes to allow natural airflow into the house. Initially focused on conical ventilation units for regulating heat flow in mountain housing, the team later pivoted to specialize in producing durable plastic beams for interior and furniture applications through extrusion processes.

Post-MAKEathon Status: Team Ragunath soon changed their name to Plastic Heart and pivoted their direction to furniture using the beams from extrusion. Later, when one member left to study, the remaining two members were invited to merge with Paramendo to fill the missing gap of design engineer and marketing. They became a strong team after the merge.

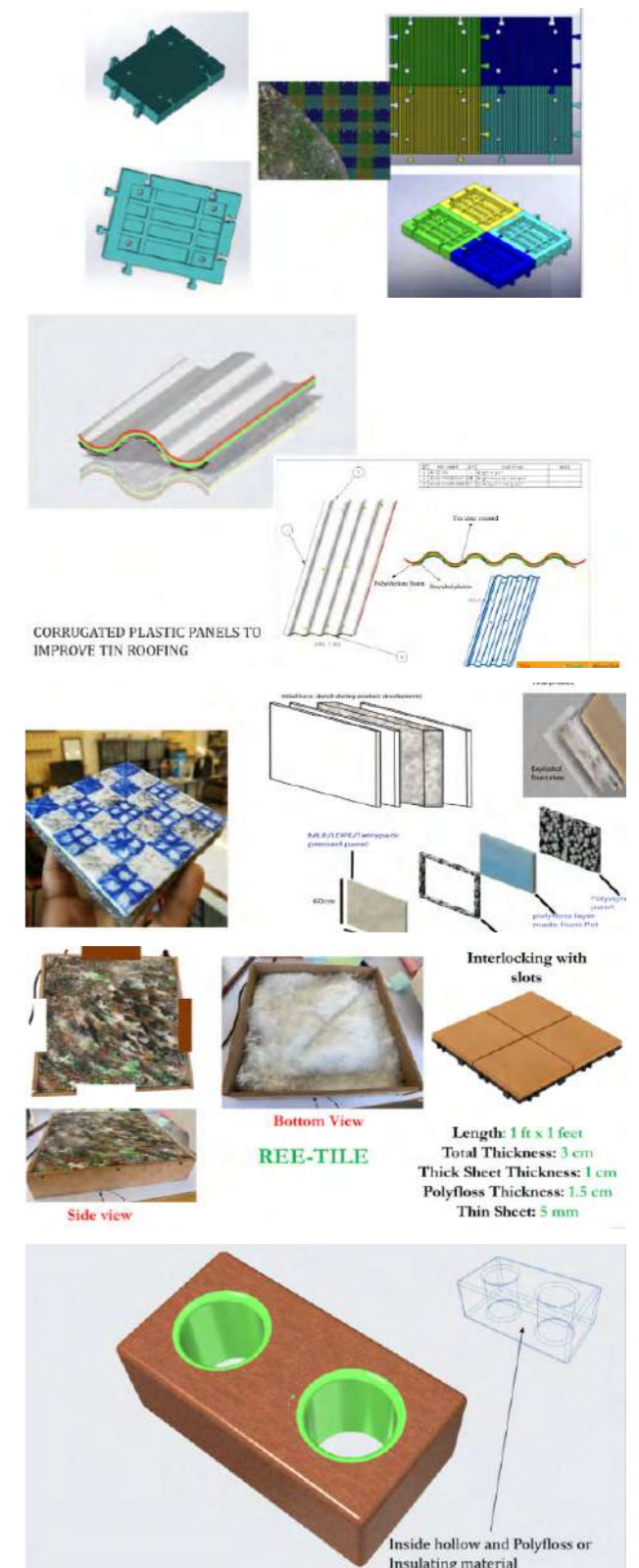


Figure 63
Innovation concepts of other MAKEathon teams

By inviting individuals with an ambition but not necessarily with concrete ideas, we started the innovation process from TRL 0.

This is a critical step to plant the seed of support culture and support system for innovation in Nepal. From onwards, the follow-on incubation process help the teams further develop the innovation for concrete and viable sustainable housing solutions while building local capacity for local plastic waste management and upcycling technologies.



Figure 64
Happy greetings of the Ree Gaun participants arriving at the Kathmandu venue for the final day of P2G MAKEathon 2, 12th November 2022

2.4 Stage 4.

Business Incubation_TRL 5-8

Stage 4 initiates the transition from nascent MAKEathon ideas toward TRL 5–8 through structured business incubation. This stage equips emerging teams with the essential business skills, technical knowledge and market understanding needed to progress toward sustainable, market ready solutions.

P2G Process Insight 4

Follow-up business incubation is critical for the early-stage innovators who have freshly won the MAKEathon. Structured guidance helps them maintain momentum, strengthen initial ideas and prevent the enthusiasm from fading. Without continued support, early innovations can easily lose direction before reaching market-ready maturity.

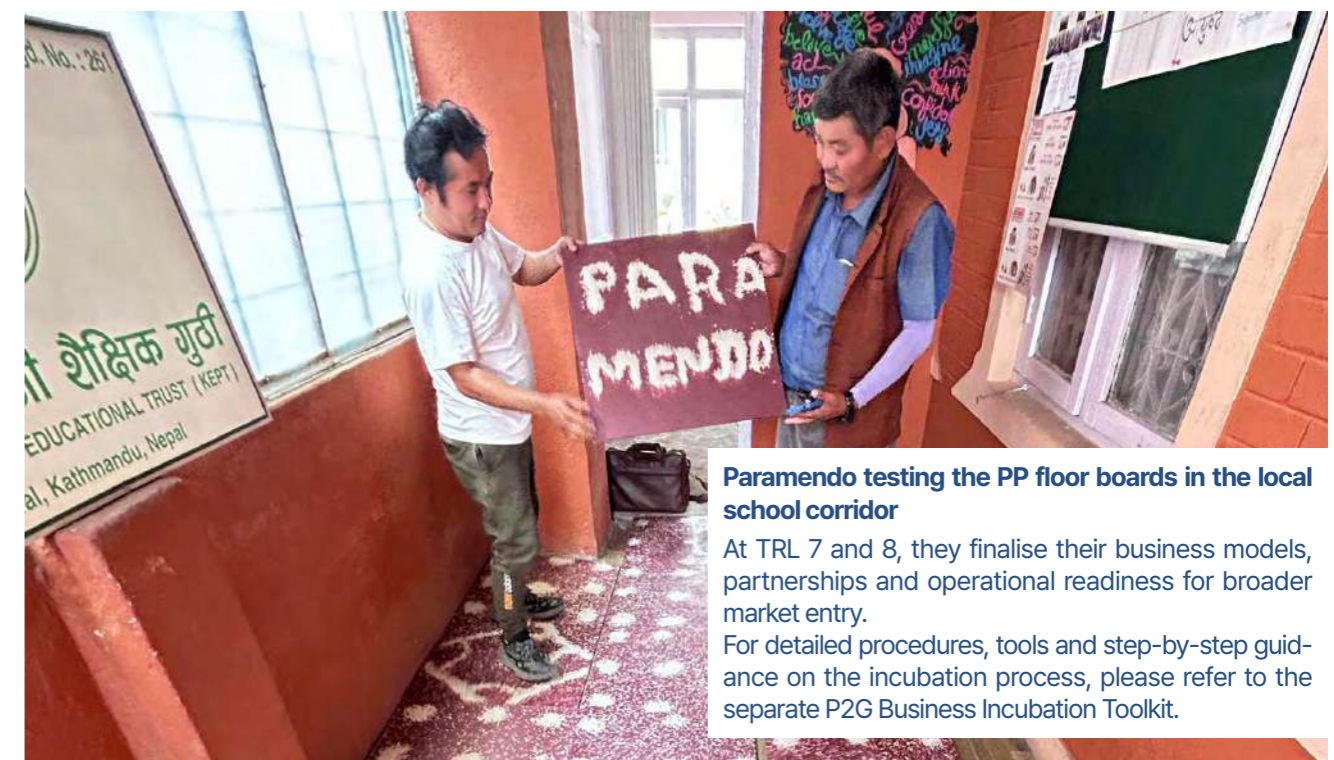




Figure 65
Paramendo celebrating company registration and opening of the office at Impact Hub Kathmandu

2.5 Stage 5.

Business Launch_TRL 9

As the project enters the business launch phase, our observations remain ongoing and evolving. While earlier stages reflect our lived experience, this stage is still unfolding for our start-ups. The below requirements relate to formal registration, operational readiness, and the start-ups' first client engagements.

Official Government Registration as Business

The formal registration of a start-up with the Office of Company Registrar(OCR) is a critical step toward becoming a legally recognised entity in Nepal. This legal process not only formalises the company's existence but also establishes the foundation for lawful operation, enabling the enterprise to enter into contracts, open bank accounts, and access formal channels. Registration thus involves both administrative procedures and strategic decisions about the company's structure and governance.

Key Considerations for Registration

1) Type of Business

At the outset, start-ups must decide whether they will operate as a for-profit company, a social enterprise with blended value goals, or a not-for-profit organisation focused on mission-driven activities. Nepal's legal framework allows registration as:

- Private Limited Company
- Public Limited Company
- Profit Non-Distributing Company (for social/welfare purposes)

2) Company Membership

The identification of founding members is a prerequisite, including the CEO, co-founders, and any advisory or board members. Citizenship certificates or valid IDs are required for all shareholders and directors.

3) Organisational Hierarchy

The internal structure should be clarified—whether the company will follow a vertical hierarchy with defined leadership roles or adopt a horizontal, collaborative model. These details are typically outlined in the Articles of Association (AOA).

4) Financial Arrangements

Founders must agree on the initial capital contributions, co-investment terms, and funding sources. This includes decisions about equity distribution, profit-sharing, and financial responsibilities, all of which must be documented in the Memorandum of Association (MOA).

5) Company Location

The legal and physical location of the company affects taxation, regulatory compliance, and access to local resources. A rental agreement or ownership document is required to verify the company's address.

Registration Process in Nepal

- 1) **Name Reservation:** Reserve a unique company name via the OCR portal.
- 2) **Document Submission:** Upload MOA, AOA, ID proofs, capital details, and address verification.
- 3) **Verification:** Present original signed documents at the OCR office.
- 4) **Certificate Issuance:** Receive the company registration certificate upon approval.

Post-Registration Compliance

- 1) Annual General Meetings (AGMs)
- 2) Tax Registration (PAN/VAT)
- 3) Business Renewal
- 4) Audit and Financial Reporting
- 5) Labor Law Compliance



Figure 66
Professor Steve Evans visiting Kleanit Upcyclers' Nargajun Hub site in construction

1st client project

A start-up becomes a real business the moment it completes its first paid project, often landing through unexpected channels like personal referrals or an Instagram DM. The excitement is warranted, but so is the urgency to establish professional standards and legal safeguards from the outset.

Essentials for a Professional Engagement

To ensure the project is handled professionally and legally, the following items should be prepared:

1) Invoice: A formal invoice should include the company name, registration number, client details, service description, payment terms, and bank information. This document is essential for accounting and tax purposes.

2) Contract: A written agreement outlining the scope of work, deliverables, timeline, payment terms, intellectual property rights, and dispute resolution mechanisms. Even for small projects, a contract protects both parties and sets clear expectations.

3) Branding Materials: Consistent branding—such as a logo, colour scheme, and tone of voice—helps build trust and recognition. This includes branded templates for proposals, invoices, and presentations.

4) Letterhead: A professional letterhead with the company's name, logo, registration number, and contact details adds legitimacy to all official communications.

Additional Considerations

To further strengthen the foundation for future client work, consider:

1) Client Onboarding Process: Create a simple checklist or welcome packet that outlines how you work, what clients can expect, and how communication will be handled.

2) Payment Gateway Setup: Ensure you have a reliable method for receiving payments—whether through bank transfer, mobile wallets, or online platforms like Khalti or eSewa (in Nepal).

3) Record Keeping: Maintain organised records of contracts, invoices, receipts, and communications for future reference and compliance.

4) Tax Registration: If not already done, register for a Permanent Account Number (PAN) and consider VAT registration if your revenue exceeds the threshold. This is crucial for issuing tax-compliant invoices.

Surviving Teams: Navigating Uncertainty and Growth

The six start-ups incubated through the P2G project each embarked on their own unique journey going through moments of excitement, hope, confusion, and frustration. While none of the teams initially imagined discontinuing their ventures, the reality of entrepreneurship is shaped by unpredictable challenges. 10% is known success rate of start-ups (Kalyanasundaram, 2018, Argaw and Liu, 2024), and when incubated the rate increased from 50% (Awonuga et al., 2024) up to 71% (Garcia et al., 2024).

Market shifts, team dynamics, personal circumstances, and resource constraints can all influence whether a start-up continues or pivots. By the midpoint of the final phase of the P2G project (as of September 2025), three start-ups have not only survived but are actively thriving: **Paramendo, Kleanit Upcyclers, and GD Labs.**

Paramendo stands out as a purely homegrown initiative, developed organically through the incubation process. Its resilience reflects strong internal alignment and a clear value proposition.

GD Labs, already a registered company prior to incubation, brought a research and consulting focus to the cohort. Its survival suggests that prior institutional experience and clarity of mission can be stabilizing factors.

Kleanit Upcyclers joined the programme after the first incubation period had ended, yet quickly adapted and integrated into the ecosystem. Their success highlights the potential of late entrants who bring fresh energy and external experience.

P2G Process Insight 5

As exciting as it is to develop innovations that will make the world a better place, the legal and administrative aspects are also part of the entrepreneurial journey and cannot be ignored. They require sufficient time, attention and knowledge. Seeking support from experienced professionals can save you considerable difficulty and help you stay focused on what matters most.



Figure 67
Opening of P2G Plastic Room at FabLab Nepal, Impact Hub Kathmandu

2.6 Stage 6. Ecosystem Propagation

This final stage focuses on ecosystem level propagation beyond business-level growth. This propagation was driven by emerging local orchestrators who catalysed new hubs suited for context specific conditions. These developments unfolded in path dependent and unpredictable ways that were never centrally planned.

Scaling Out

In P2G, more than growing in volume (scaling up), a number of local hubs appeared (scaling out) across Nepal. This scaling out phenomenon was initiated by local orchestrators who emerged organically within each community and start up.

Their initiative shaped where and how each hub took form, rather than project level direction or planned expansion strategy. These orchestrators include local entrepreneurs, staff members and community volunteers who mobilised local enthusiasm and recognised opportunities for mutual value creation. As earlier stages progressed, the basic knowledge base, organisational networks and operational know how are gradually accumulated, forming a backbone that enabled scaling out even as local conditions varied.

Small scale hubs

Nepal's geography produces small, fragmented waste streams, especially in remote mountain settlements where transportation is limited and waste volumes remain low. Under such conditions, decentralised small scale hubs provide a practical and context appropriate approach for handling local waste. In P2G, two types of hubs emerged:

- **Rural hubs** consolidate waste from neighbouring villages for locally situated, small scale processing.
- **Urban hubs** operate larger facilities suited to higher waste volumes and more advanced processes.

Small scale hubs became the physical expression of ecosystem propagation in P2G: they allowed multiple, distributed pockets of circular activity to take root, each shaped by local conditions.

Key enablers of scaling out include

- Serendipitous opportunities through local networking
- Partnerships with cooperatives, schools, women's

groups and local governments (including PPPs)

- Mentor-mentee systems connecting experienced hubs with new units

Going forward, structured aids may further support orchestrators:

- Toolkits and manuals (e.g. P2G Knowledge Suite, FlipiFlopi Toolkit)
- Digital tools for tracking, logistics and reporting
- Simple impact metrics such as volume processed, jobs created and community participation

Sustainability & Risk Management

Long term ecosystem sustainability depends less on project led structures than on the continued agency of local orchestrators who carry the system forward beyond the formal project timeline.

To support ongoing resilience:

- Conduct scalability assessments
- Implement continuous feedback loops
- Mentor-mentee support system
- Prepare contingency plans for supply chain or policy disruptions

* Firm level scaling up remains a potential future trajectory but is beyond the scope of the ecosystem level propagation observed to date.

P2G Process Insight 6

Orchestrators often emerge quietly rather than through formal leadership. A motivated staff member, technician, or community volunteer may step forward when conditions align. Create a safe space where these informal orchestrators feel comfortable to speak up and keep your eyes open! They can prove far more powerful and effective than any predefined scaling plan.

Chapter 3

P2G Achievements & Beyond

Chapter 3 presents the outcomes and impact of the P2G journey, highlighting the enterprises, hubs, products, and knowledge created along the way. It distils the key lessons that emerged and outlines future directions and opportunities for scaling circular empowerment within and beyond Nepal.

3.1 Theory Of Change

3.2 P2G Outcomes

3.3 P2G Impact

3.4 The Eleven Lessons from P2G

3.5 Future Recommendations

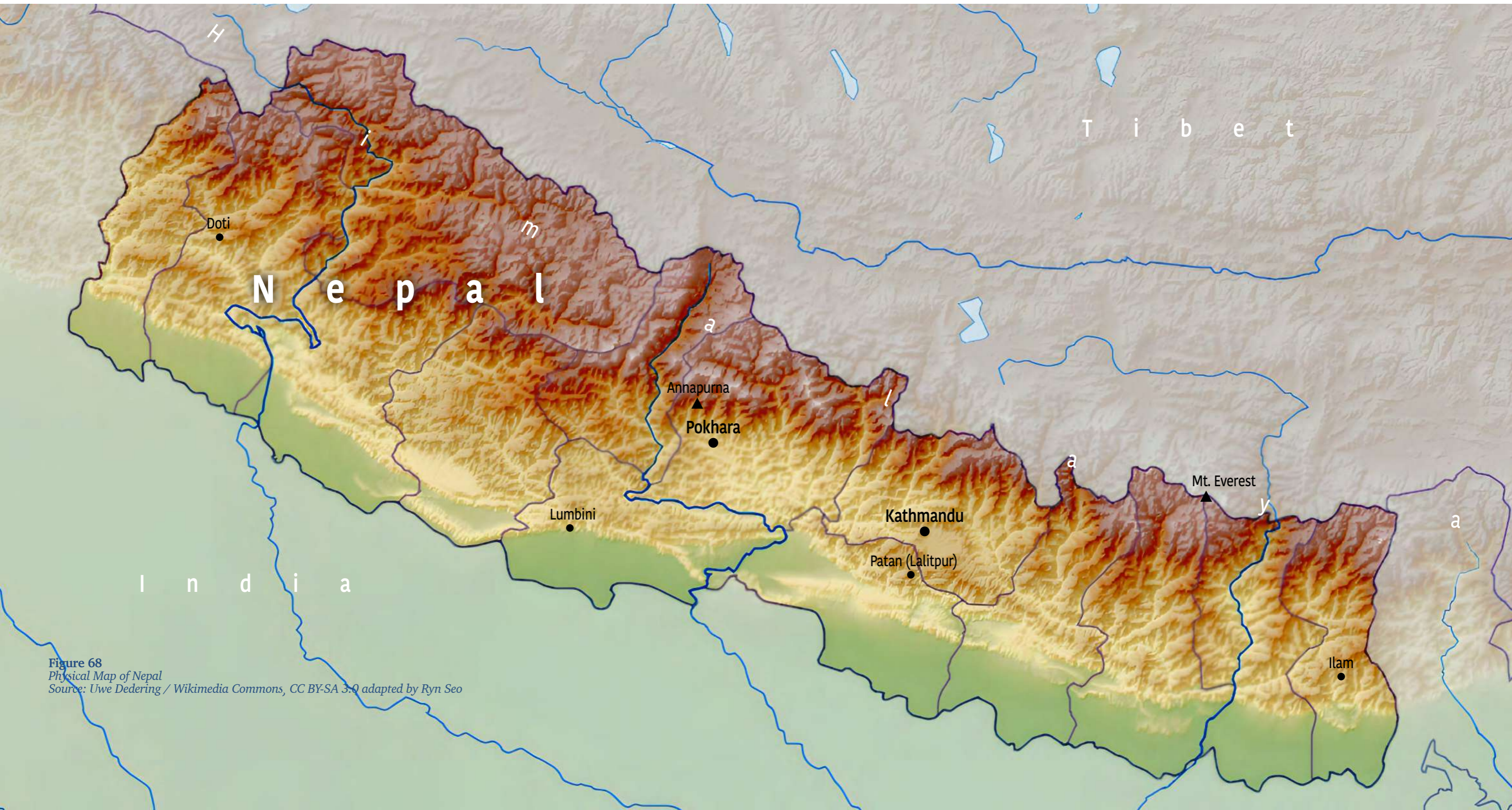


Figure 68
Physical Map of Nepal
Source: Uwe Dederig / Wikimedia Commons, CC BY-SA 3.0 adapted by Ryn Seo

3.1

Theory Of Change

Theory of Change exercise is useful to check the project progress against the project aims and anticipated impact.

What is Theory of change

A theory of change (ToC) is a strategic framework and roadmap that explains how and why a desired change is expected to occur, linking specific activities and interventions to intended long-term goals. It serves as a detailed description or visual diagram of the causal pathways, underlying assumptions, and conditions necessary to achieve a program's impact. Used for planning, monitoring, and evaluation, a ToC provides a common understanding among stakeholders and helps identify the specific actions needed to reach the desired future state.

A well-constructed Theory of Change typically includes several key components:

- **Inputs** represent all the resources required to implement the project, including human resources (staff, volunteers, beneficiaries), financial resources (funding, investments), material resources (equipment, facilities), and intangible resources (knowledge, networks, partnerships), forming the foundation upon which all project activities are built.
- **Processes** describe the specific actions and interventions the project will undertake using available inputs, directly linked to intended outputs based on evidence or reasonable assumptions about what actions will lead to desired changes.
- **Outputs** are the direct, tangible products or services that result from project activities, typically under the direct control of project implementers and measurable with relative ease. Outputs represent what the project produces rather than the changes it creates.
- **Outcomes** represent the changes that occur as a result of the project's outputs, observed in individuals, organisations, communities, or systems, typically categorised by timeframe: short-term (0–6 months), medium-term (6–18 months), and long-term (18 months and beyond).

- **Impact** refers to the ultimate, long-term changes that the project aims to achieve. Impact represents the broader, systemic transformation that extends beyond the immediate beneficiaries and may continue long after the project ends. Impact is often the most challenging to measure and attribute directly to project activities.

P2G Project Theory of Change Application

For the P2G project analysis, we utilised the Theory of Change Model Template provided by Planet B, which offers a structured approach to mapping project logic across six interconnected dimensions. This template is specifically designed to capture both the narrative elements and quantitative measures of change, making it particularly suitable for projects that aim to demonstrate measurable social and environmental impact.

The template follows a reverse chronological approach, starting with the identification of the problem to be solved and working backwards through the logical chain:

- **Step 1 Problem Definition** begins by clearly articulating “the business and/or social problem we are solving.” This ensures that all subsequent elements are aligned with addressing a specific, well-defined challenge. For sustainability and circular economy projects like P2G, this typically involves identifying gaps in current systems, unsustainable practices, or unmet needs in waste management and resource utilisation.
- **Step 2 Impact** defines the highest level of ambition for the project, bold and visionary while remaining realistic. The impact statement should capture the long-term transformation the project seeks to contribute to, often extending beyond the project's direct sphere of influence.

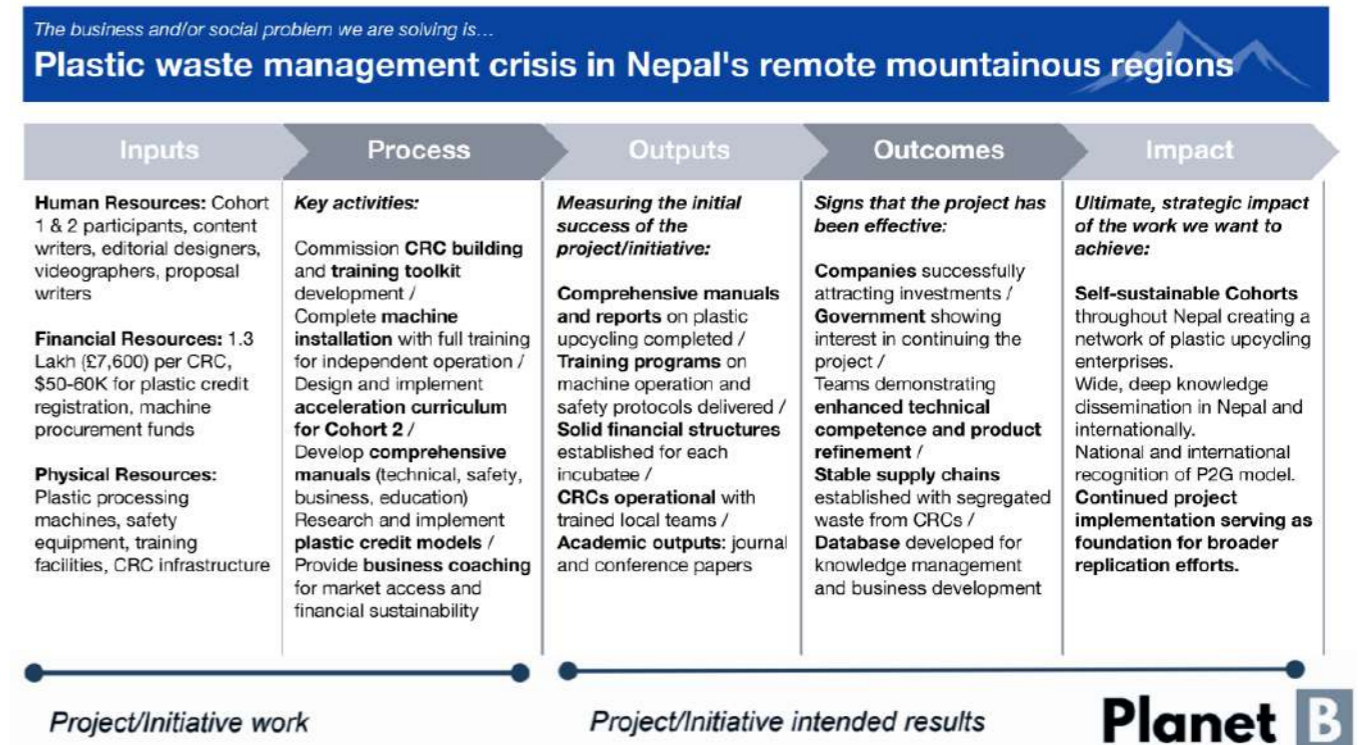


Figure 69

Theory of Change exercise as of December 2024. Inevitably the contents keep on evolving!

- **Step 3 Outcomes** describes “how we will see signs that the project has been effective post initial launch.” These are observable changes that indicate the project is on track to achieve its intended impact. Outcomes bridge the gap between immediate outputs and long-term impact, providing crucial feedback on project effectiveness.
- **Step 4 Outputs** specifies “how we will measure the initial success of the project/initiative.” These are concrete, measurable deliverables that result directly from project activities. Outputs should be specific, measurable, achievable, relevant, and time-bound (SMART).
- **Step 5 Processes** outlines “what are the key activities you will conduct to reach the goal.” This section details the specific interventions, methodologies, and approaches that will be employed to transform inputs into outputs. The processes should be evidence-based and aligned with best practices in the relevant field.

- **Step 6 Inputs** enumerates “all the resources you need to complete the task (people, places, funding etc).” This comprehensive inventory includes both quantified resources (budgets, staff numbers, equipment) and qualitative resources (expertise, partnerships, access to networks).

The Theory of Change framework was particularly valuable for complex, multi-stakeholder initiatives like the P2G project, where success depends on various interconnected factors including capacity building, business development, knowledge transfer, and systemic change. By mapping out the causal relationships between inputs, activities, and outcomes, ToC exercise helped P2G revisit the initial aim and the trajectory. We could also share assumptions, and external factors that may influence project success.

3.2

P2G Outcomes

The quantitative outcomes of P2G in four categories; incubated businesses, plastic innovation hubs across Nepal, new jobs and plastic waste converted from landfills

20 Products

3 Base Products

Lumbers
Boards
Sheets

6 Housing Products

Decking Tiles
Floor Tiles
Pavement Blocks
Insulation Sheets
Roofing Repair Kits
Signboards

4 Furniture

Benches
Desks & Chairs
Coffee Tables
Sofas

7 Souvenirs

Keyrings
Plush Toys
Flower Pots
Phone Stands
Combs
Coasters
Photo Frames

3 Start-ups

From 2 MAKEathons,
7 winnings teams incubated
into 3 start-ups (as of March 2026)

Paramendo
GD Labs
Kleanit Upcyclers

Original P2G members have
taken part in the P2G business
incubation programme

Plastic Heart
(merged with Paramendo)

Geodome
(operating interdependently)

Scavengers
(ceased to operated)

Khaptad
(ceased to operated)

5 Hubs

2 Village Hubs

Ree
Ruby Valley

3 Urban Hubs

Nagarjung (Kathmandu)
Pokhara
Dang

104 Jobs

	Full Time	Part Time
P2G Cohort	4	
GD Labs	7	4
Paramendo	5	3
Ree Hub		3
Kleanit Upcyclers		
Nagarjun Hub	7	3
Pokhara Hub	6	
Dang Hub	22	
Pellet suppliers (Indirect jobs)	34	6

5.37t Waste Converted

Paramendo 1.27 t
GD Labs 0.05 t
Kleanit Upcyclers 4.05 t

Knowledge Creation +

Knowledge Suite

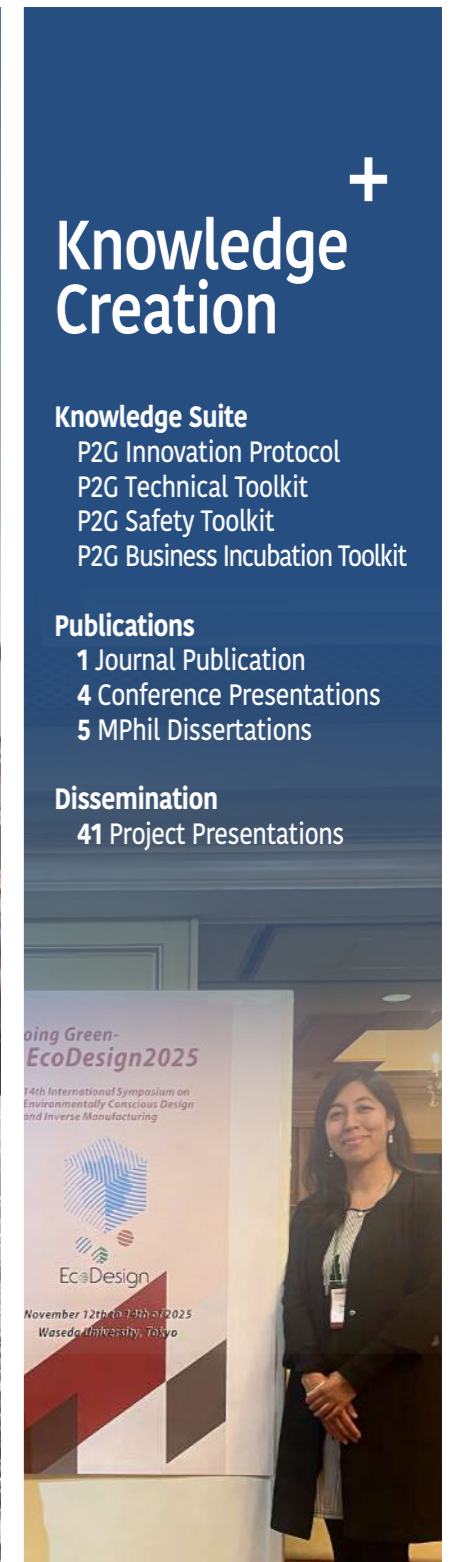
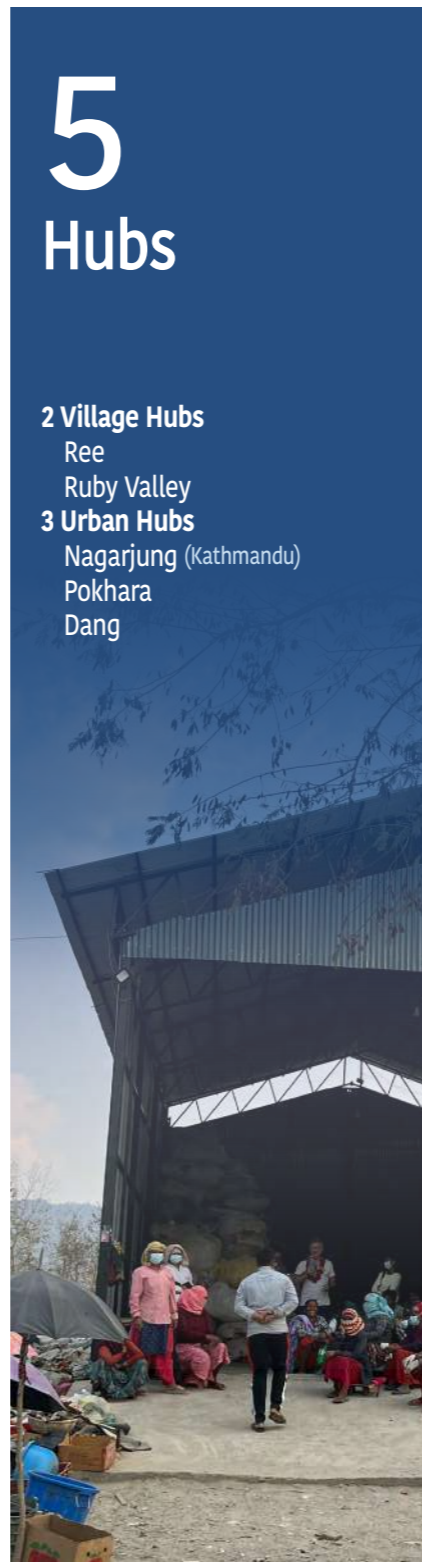
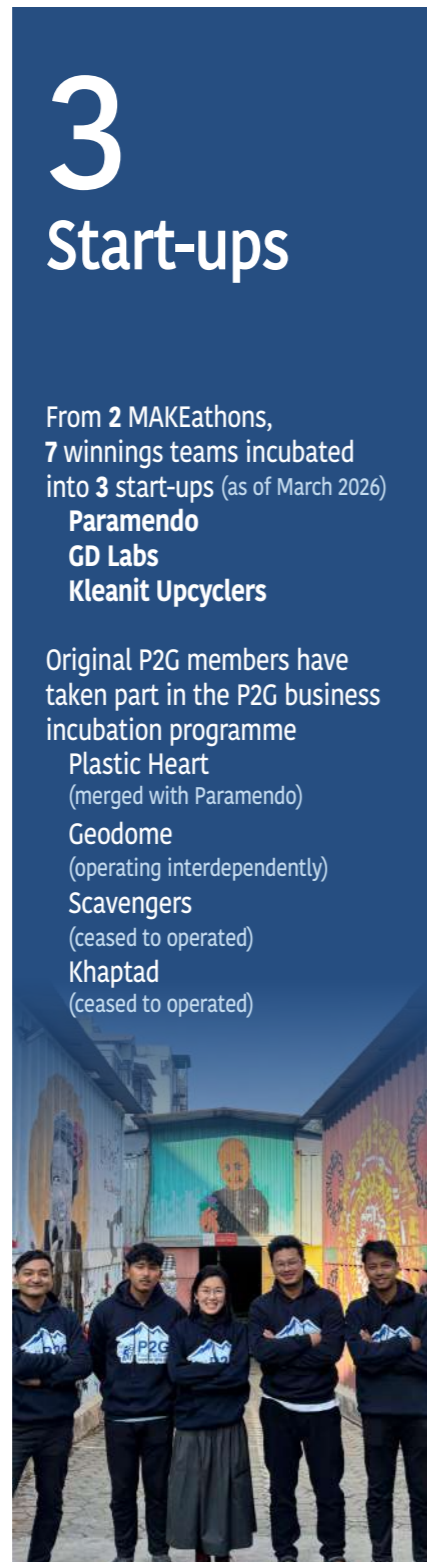
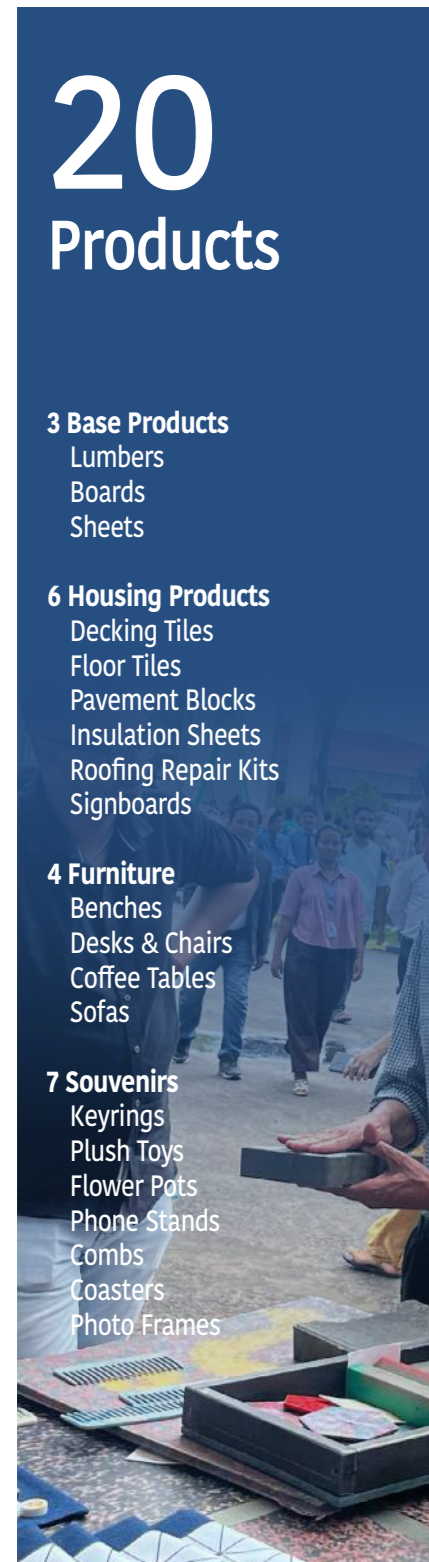
P2G Innovation Protocol
P2G Technical Toolkit
P2G Safety Toolkit
P2G Business Incubation Toolkit

Publications

1 Journal Publication
4 Conference Presentations
5 MPhil Dissertations

Dissemination

41 Project Presentations



3.2.1

Raw Materials & Products

Our approach is to focus on the most abundant type of plastic waste generated in the locality, rather than choosing the easiest materials to process such as PP or the most profitable ones such as PET. We incorporated PP, however ruled out PET from the beginning as it is being collected and recycled very well.

MLP (Multi Layer Plastic)

Based on our internal research and surveys, MLP, or multi-layer plastic is most common. MLPs are composite soft plastics with a thin aluminium layer sandwiched between one or more different types of thin plastic films that provide different functional properties. MLPs are widely used for food packaging such as instant noodles and crisps. However, because the composite materials melt at different temperatures, they are tricky

to process. Combined with the fact that they are very light, MLPs are often considered non-recyclable.

However KIU and Paramendo persistently tried to tackle the MLP, and successfully managed to create MLP lumbers and boards respectively. They are now applied to create various end-products.



Figure 70
Pavement block & floor tile by Kleanit Upcyclers



Figure 71
MLP boards by Paramendo



Figure 72
Everest bench by Kleanit Upcyclers



Figure 73
School desk & chairs by Kleanit Upcyclers

Table 6
MLP Processing Methods & Outcomes

Process	Product	End-products	Lead company
1 Extrusion	Lumber Due to its versatility and scalability, lumber is the most common type of recycled plastic application. Recycled plastic lumber replaces wooden lumber in light construction and furniture structure. Despite the trickiness of MLP, KIU has been successfully producing MLP lumbers using extrusion moulds of different thicknesses. One piece of lumber can consume 1.5kg of waste plastic at a maximum length of 1.5 metres. The pieces can be cut and processed into required lengths and profiles	<ul style="list-style-type: none"> • Benches Figure 72 • Sofas • School desks & chairs Figure 73 • Photo frames 	Kleanit Upcyclers (KIU)
	Decking tile The melted plastic paste from the extrusion process is directly fed into the decking tile press, which creates a surface texture similar to wooden decking tiles. With a capacity of up to 2 tonnes per day at the Nagarjun Hub, KIU aims to convert the floors of many households in Nepal.		
2 Extrusion + Press	Composite Extrusion mixed with sand + Press Similar to the decking tiles process, the pavement block and tiles are extruded and pressed in their respective moulds to shape. The pavement block is a composite mixed with sand for reinforcement. These products are made at P2G Dang Hub in collaboration with EcoFamily. Thanks to the PPP (public-private-partnership) model with the local government, the municipal waste is collected and delivered to the Dang Hub, and the produced pavement blocks are procured to the government roadwork.		Kleanit Upcyclers (KIU) + EcoFamily
	Board Despite the innate challenge of MLP, Paramendo at P2G Ree Hub managed to produce a beautiful board using the locally-sourced MLP. Households in the village consume at least 10 instant noodles per day, which makes MLP the greatest source of local plastic waste.		<ul style="list-style-type: none"> • Flooring Figure 70 • Wall cladding • Furniture (table top)
3 Composite Extrusion mixed with sand + Press			
4 Hot Press			

PP (Polypropylene)

PP is considered one of the easiest thermoplastics to recycle thanks to its lower melting temperature at 160-166 Celsius, good mouldability for injection and extrusion, chemical stability and low toxicity. Hence the most of the Precious Plastic machines focus on PP processing. At P2G, PP is also one of the top two most commonly used types due to its usability. The main uses of PP are hard food containers, household items,

automobile parts and pipes, thanks to its strength, durability and chemical resistance. However its recycling rate remains relatively low due to contamination challenges. We usually source PP in the pellet form from local suppliers which provides the more even quality which often result in better end-results compared to the shredded version.



Figure 74
Phone stand by Paramendo



Figure 75
Keyrings by Kleanit Upcyclers



Figure 76
Plush toys by GD Labs



Figure 77
Poly+Roll by GD Labs

Table 7
PP Processing Methods & Outcomes

Process	Outcomes	End-products	Lead company
1 Hot Press	<p>Board</p> <p>A mix of coloured pellets can be fed into the press mould to create multi-coloured, decorative patterns e.g. marbling effect. The colours disperse as the pellets melt and blend. The material can be used as it is or can be further processed into consumer products.</p>	<ul style="list-style-type: none"> • Flooring • Wall cladding • Furniture (table top) • Phone stand <p>Figure 74</p>	Paramendo
2 Injection	<p>Figurines, key rings, combs, flower pots, coasters</p> <p>Figure 75</p> <p>Relatively small amounts of plastic can produce high-value products through injection moulding. Although the main focus of P2G is housing materials which is more essential and consume a large amount of plastic as a resource, the injection moulded tourist souvenir items are also produced to support the cash flow in the early stage of the start-ups.</p> <p>Requires higher investment for mould design and production.</p>		Kleanit Upcyclers (KIU)
3 Flossing	<p>Floss</p> <p>Using the innovative PolyFloss Machine, GD Labs continues to invest significant time and resources to experiment and develop insulation materials in various formats including boards, tiles and rolls. Believing in the environmental and health benefits of insulation, GD Labs is ambitious to ignite insulation culture in Nepal to help people in both cold and hot regions. The latest Poly+Rolls include a layer of muddy cloth to provide light fire resistance.</p>	<ul style="list-style-type: none"> • Insulation rolls <p>Figure 77</p>	GD Labs
4	<p>Recently, small plush animal charms have been developed in collaboration with a young female artist, filled with recycled floss, designed for the tourist souvenir market.</p>	<ul style="list-style-type: none"> • Plush toys <p>Figure 76</p>	GD Labs

LDPE

LDPE is another common flexible plastic waste type, often found in the form of grocery bags and packaging wraps. However, due to its high contamination rate and its light weight, it is one of the least recycled plastic items, with only about nine percent recycled globally. Its thin and flexible structure can also jam machinery if its suitability is not assessed carefully. When cleaned with care, however, LDPE can be remelted and reprocessed

very quickly because its thinness allows rapid heating and reshaping using simple thermal processing. A small scale and controlled facility like Ree Hub makes LDPE recycling more plausible, as the material can be collected directly from households.

Table 8
LDPE Processing Methods & Outcomes

Process	Outcomes	End-products	Lead company
1 T-shirt press	<p>Thin film sheet</p> <p>Thin LDPE film sheet is the MAKEathon idea that led Paramendo team to win the competition. It addresses the local challenges very well: LDPE as the common waste in the Ree Village and can help fixing the holes in the CGI (corrugated galvanised iron) sheet roofs. Its versatility makes it also suitable for many other uses where waterproofing is needed. By playing with colours and shapes, artistic impressions and decorative patterns are also possible.</p>	<ul style="list-style-type: none"> • Roof repair kit • Notepad cover 	Paramendo



Figure 78, 79
LDPE sheets by Paramendo



Figure 80
Roofing repairing kit pilot using the LDPE sheets in Ree village with the local youth



3.2.2 P2G Start-ups

Out of seven winning MAKEathon teams, three start-ups are thriving through the incubation programme and managed to become registered business. Each evolved from conception (TRL 0) to commercialisation (TRL 9). Teams merged, expanded, and reformed organically along the way.



Figure 81
Team Paramendo doing the technology transfer in Ree hub



Figure 82
MLP & HDPE boards produced at Ree hub



Figure 83
Coffee table made with MLP boards

Paramendo

Paramendo is the purely home-grown initiative formed during the P2G MAKEathon. Although they did not have any prior experience with plastics or business, the team, selected for its promising solutions to the challenge in the village, subsequently participated in the P2G business incubation programme, developing a range of business models.

Teams are based in Kathmandu and the mountain village called Ree Gaun (gaun means village in Nepali) positioned itself as a waste management company dedicated to transforming plastic into usable recycled products in collaboration with local communities and governments. In Ree Gaun the operation revolves around the Community Recycling Centre (CRC) which evolved into P2G Ree Hub once the extension was built, and the plastic recycling machines are procured. , where plastics are collected, sorted, and upcycled into useful goods. A French NGO, Namaste Avignon sponsored building the CRC, and P2G supported equipping the CRC with the plastic machines. Its current focus is on producing LDPE wraps and MLP boards as roofing and flooring alternatives.

Paramendo Nepal embodies the ideation and values of the P2G programme to cultivate, establishing a localised circular economy. Aiming to address the challenge of haphazard plastic disposal, it has benefitted from extensive technical, business, and financial mentorship through the P2G programme, alongside direct support in building The Ree Hub. As CEO Rahul Bisunkhe reflected: "We can feel the change and our vision coming to life."

Vision

Empowering rural communities to actively solve their plastic problems and create a localised circular economy.

Mission

Manage waste by recycling, upcycling, and converting plastic waste into useful housing products.

Values

- Empowerment the community to create waste management systems
- Revalorisation of local plastic waste

Customers

- Local Villagers
- Villages around Ree
- Dhading Besi

Value Proposition

1) Social

- Train, educate, and empower village community members the village to manage and solve their own problems of plastic waste.
- Skill development of the youth and people of Ree village.

2) Environmental

- Convert plastic waste into housing material, creating a new value chain.
- Protect agricultural lands, water sources, and clean air from pollution.
- Replace the open-air burning culture of plastic waste with upcycling.

3) Economic

- Save the waste disposal cost, time and resources.
- Generates employment in the village to operate P2G Ree Hub and P2GRuby Valley Hub.



Figure 84
Team GD Labs after poly+roll piloting



Figure 85
PolyFloss made from recycled PP pellets



Figure 86
Plush toys filled with PolyFloss, crocheted by a local artisan

GD Labs

Green Decision Labs and Research (GD Labs) is a Kathmandu-based research and innovation thinktank, dedicated to advancing urban sustainability in Nepal. As a registered environmental research and consulting business, GD Labs focuses on air pollution, waste, mobility, and many ways to promote greener cities.

In 2022, GD Labs joined the P2G MAKEathon and won second prize with its idea to convert waste into a means of insulation. Through the process, the team incubated Shital Chhana, which further developed into Poly+ Roll, an affordable insulation designed to regulate indoor temperatures in Nepal's extreme climate while reducing energy use.

The company has also developed a school-based insulation program in collaboration with the Annapurna Conservation Programme. By installing a mobile PolyFloss machine in government schools, children can collect household plastic waste, see the process of the waste being converted into insulation, and actively experience the environmental and educational benefits.

Combining product innovation with education and community engagement, GD Labs builds both environmental resilience and social impact across the country by turning plastic waste into sustainable housing solutions.

Lately, GD Labs has developed a range of plush toys hand-crocheted by a local female artisan. Featuring Nepal's iconic native wildlife such as tigers, snow leopards, turtles, elephants, rhinos, red pandas and pigeons as well as legendary yetis, these high-value added products are made using PolyFloss, designed for the tourist market.

Vision

Contributing to the circular economy by providing sustainable solutions for plastic waste.

Mission

Extending the life cycle of discarded PP plastic through upcycling it into insulation material.

Values

- Waste management through upcycling locally generated plastic waste
- Livelihood creation and quality assurance
- Improved indoor living conditions and climate resilience

Core products

- Poly+ Roll: Insulation roll with decorative wallpaper (recycled plastic wool)
- Hand-crochet plush animal toys

Value proposition

1) Social

- Prevent open burning
- Create local jobs
- Raise waste management awareness

2) Environmental

- Reduce fuel use and deforestation
- Enable plastic recycling and circular economy
- Build climate resilience

3) Economic

- Lower fuel costs
- Create skill-based jobs
- Cost-efficient longevity



Figure 87
Team Kleanit Upcyclers at FabLab Nepal



Figure 88
MLP lumbers



Figure 89
MLP benches installed in Kathmandu

Kleanit Upcyclers

Kleanit Upcyclers (KIU) is a plastic upcycling company, providing innovative solutions to Nepal's growing plastic crisis. KIU converts multiple kinds of plastics, such as HDPE, PP and MLP into durable, high-value products with advanced upcycling technologies. Their projects range from urban installations to waste management initiatives along the Mount Everest Base Camp route, supporting sustainable urban/rural development.

In the past three years, KIU has scaled from a 2-person partnership to a mid-sized company and is continuing to expand its projects : three urban hubs in Nagarjun, Dang, and Pokhara. Recognising the challenges posed by relying on imported recycling machinery, the company works with the National Innovation Centre to strengthen Nepal's domestic machine building capabilities while marking a critical step toward localised innovation for circularity.

Through both public and private partnerships, KIU is now a trusted collaborator in the sustainability manufacturing sector. It aims to deliver practical, long-term solutions to Nepal's waste challenges. By demonstrating that plastic is more than waste, it positions it as a valuable resource for building a sustainable future.

Vision

Reimagine waste through innovation, reclaiming discarded resources and repurposing them into valuable products for a sustainable future.

Mission

Shape a sustainable future by upcycling discarded materials, reducing waste and promoting sustainable consumption.

Values

- Advanced waste processing and innovative upcycling techniques
- High-quality products from waste materials
- Closed-loop recycling and sustainable manufacturing

Core Products

- Furniture (benches, tables, stools)
- Construction materials (lumpers, sheets, pavement blocks, decking)
- Household items and accessories (pots, combs, key rings)

Value Proposition

1) Social

- 60% women-owned franchises
- Youth entrepreneurship
- Community skill development
- Marginalized group empowerment

2) Environmental

- 2 tonnes plastic diverted monthly
- 45,000+ kg CO2 saved, zero toxic emissions
- Landfill reduction

3) Economic

- 3-10 jobs per franchise
- 40% income increase for waste collectors
- 18-24 month ROI
- Local wealth retention

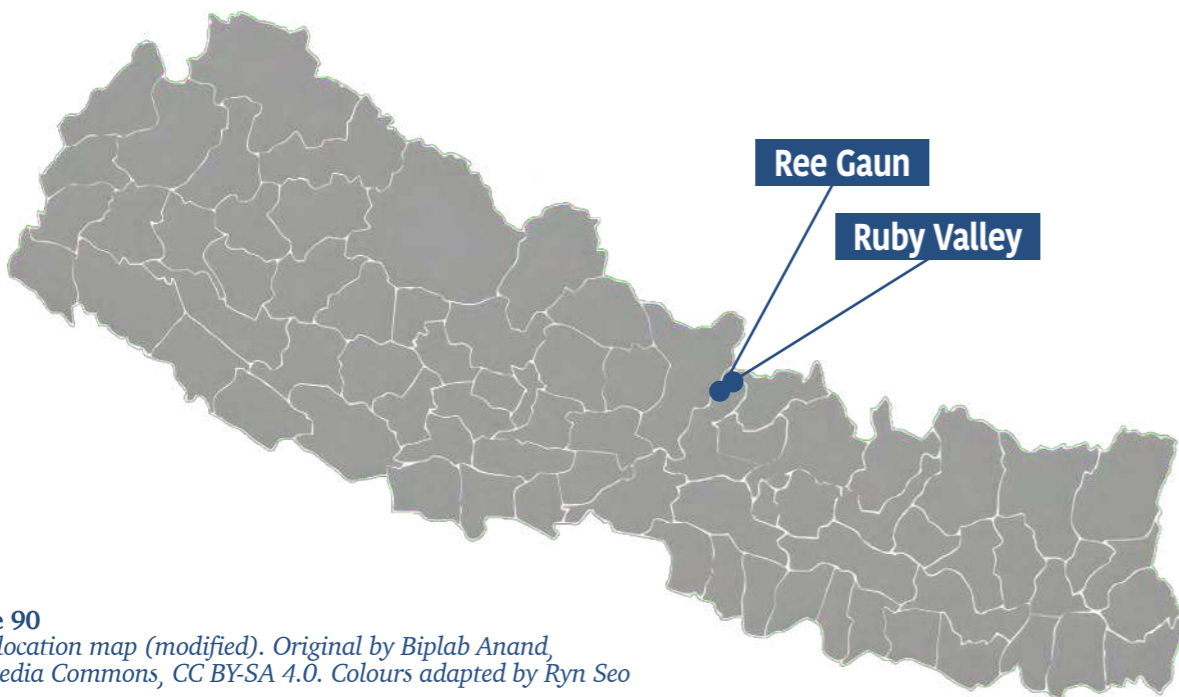


Figure 90
Nepal location map (modified). Original by Biplab Anand, Wikimedia Commons, CC BY-SA 4.0. Colours adapted by Ryn Seo



Figure 91
Kaisarki, Ree Hub manager, with MLP board produced in Ree



Figure 92
Collection, segregation section in Ree Hub



Figure 93
Satellite collection centre in Tawal nearby Ree Hub



Figure 94
Weekly waste collection & training in Ruby Valley

3.2.3

P2G Plastic Hubs

Acknowledging the differences in plastic waste management conditions across Nepal, P2G determined that different plastic hub models were required for rural and urban contexts. Each hub serves as a centre for collecting, sorting and reprocessing plastic waste, and as a space where companies can create new products using recyclates such as shredded plastic flakes and pellets.

P2G Village Hubs

Two P2G Village Hubs have been established in Ree and Ruby Valley in the hilly region of Himalaya (as of June 2025). Paramendo is leading the development of these two village hubs. Although the waste volume handled by the Village Hubs is relatively limited, the qualitative impact on village sanitation and local empowerment is unparalleled.

P2G Ree Hub

The first P2G Village Hub, was created in the remote village of Ree in early 2025. It was established on public land in an existing community recycling centre (CRC) funded by the French NGO Namaste Avignon, with two dedicated collectors bringing in plastic waste from the 115 village households.

Paramendo is responsible for its operation using a set of small-scale machines P2G installed in the hub including a grinder, hot press, cold press, T-shirt press, table saw, and hand tools.

Paramendo focuses on producing boards for roofing, flooring, wall cladding, and furniture using the hot/ cold press with three plastic waste types: MLP, PP and PE. MLP (Multi-layer plastic) is the most abundant plastic waste type from instant noodle packaging, with each household consuming an average of 5-6 packs per day.

A satellite collection centre in the nearby village of Tawal was subsequently established with a plan to also send its plastic waste to the hub. Ree Hub is currently seeking a collaboration opportunity with the local municipal government for support in waste collection and procurement of the end-products.



P2G Ruby Valley Hub

A second village hub is being established in Ruby Valley in collaboration with Paramendo. The local government official from this village attended the opening of the Ree Hub and aspired to open one of their own. Similar to the Ree Hub, a local NGO, Shechen Karuna, has planted the seed of waste management and successfully enhanced village hygiene and sanitation by conducting weekly door-to-door collection of recyclable waste. Since four enthusiastic local volunteers ensure segregation at the household level, the village has experienced significant improvement. The NGO and the local municipal government are both enthusiastic and willing to provide the financial support and the land.

Paramendo is providing knowledge support for the waste audit, machine selection, installation, local training and management. The recent waste audit suggests that focusing on collection and segregation, and subsequently transporting the pre-processed plastic waste to the Ree Hub, is more efficient than installing a full set of machines in Ruby due to its limited plastic collection volume.

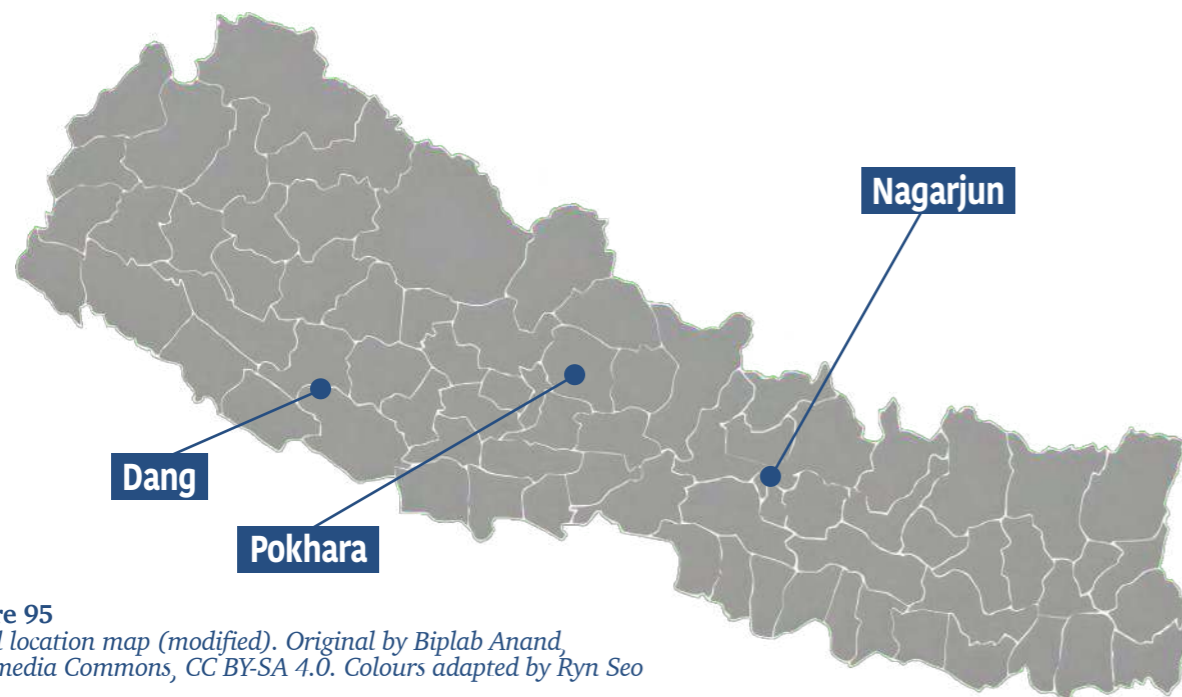


Figure 95
Nepal location map (modified). Original by Biplab Anand, Wikimedia Commons, CC BY-SA 4.0. Colours adapted by Ryn Seo



Figure 96
Kleanit Upcyclers headquarter Nagarjun Hub



Figure 97
Decking machine in operation at Nagarjun Hub



Figure 98
Dang Hub with 20+ segregation employees



Figure 99
Pokhara Hub with Kleanit Upcyclers, P2G Summer interns and EcoFamily

P2G Urban Hubs

Three P2G Urban Hubs have been established in the cities of Dang, Kathmandu, and Pokhara (as of June 2025). Kleanit Upcyclers (KIU) is leading the development of these three urban hubs. Urban Hubs are each built with semi- to fully industrial-level facilities, with capacities ranging from over 100 to 1,000 tonnes per year.

P2G Nagarjun Hub

Nagarjun Hub is the headquarters of KIU, launched in autumn 2025. KIU has relocated from its original site at the Nepal Innovation Centre to expand its operational capacity and product range, moving from small-scale extrusion to medium-scale extrusion and decking tile production. This hub has the semi-industrial level facilities of >300 tonne/year capacity. KIU also aims to use this space for public education and awareness building on plastic upcycling.

As Nagarjun is a municipality within Kathmandu District, it is strategically located for strong connectivity to the central government departments, potential customers including INGOs and local businesses, the wider waste-management supply chain, and the P2G Plastic Room within Impact Hub Kathmandu for continuing experiment.

At this hub, the two main areas of focus are plastic lumber production using extrusion, which is versatile for creating furniture such as benches, desks, and chairs, and decking tile production, which utilises extruded MLP, PP, and PE as feedstock for the decking-tile moulding press.

P2G Dang Hub

At the Dang Hub, KIU established its first public-private partnership (PPP) model in 2024 with Eco-Family, a local private company, and the local municipality in Bhalubang, Ward No. 1, Deukhuri. The PPP includes a 15-year contract with the government to process two tonnes per day of municipal solid waste (MSW) generated by approximately 11,000 households (a population of fewer than 50,000) in the region. This progressive collaboration represents the leading PPP model for circular economy implementation in Nepal. Support from the local government has been crucial,

particularly in securing land and buildings, and covering the costs of daily door-to-door collection and waste segregation.

In addition, local government procurement is stimulating the production of paving blocks and floor tiles made from plastic waste. Eco-Family is responsible for overall municipal solid waste (MSW) management and employs 20–25 female waste workers to segregate plastics and other waste types. In this partnership, KIU oversees production and sales activities.

For plastic-waste preprocessing, the facility has installed a baler, a crusher, an extruder, a tile press, and a pavement-block press capable of upcycling 2–4 tonnes per day of multilayer plastic waste and construction aggregate waste in ratios ranging from 100:0 to 30:70.

The Dang facility was severely damaged by an arson attack in December 2025, resulting in the loss of all installed machinery. Reconstruction is currently under way with support from the local municipal authorities.

P2G Pokhara Hub

The Pokhara Hub focuses on producing small gift items using injection moulding techniques. Given its strategic location in one of Nepal's most popular tourist destinations, with access to Annapurna and the region's beautiful lakes, the hub utilises locally-sourced plastic waste from Pokhara municipalities into souvenirs such as mountain figurines, boat key rings, coasters, flowerpots and incense holders.

To support KIU and its growth of Pokhara Hub, P2G arranged a co-design workshop with the Sustainable Design Studio from the UK to explore locally driven design ideas and develop injection moulds while transferring knowledge to improve the overall quality of the production.

This hub is partly supported by the Green Job Creation through Recycling and Upcycling (GCRU) project, funded by the Korea International Cooperation Agency (KOICA) and executed by UNDP. By focusing on transforming the city's waste management system into a sustainable circular economy, the project positions Pokhara as a potential national model for climate-resilient and economically inclusive urban development in Nepal.




Figure 100
Ree Hub in front of Ganesh Himal, 7,422m above sea level


3.2.4


P2G Knowledge Suite

The P2G Knowledge Suite consolidates the project's key knowledge, experiences and lessons across four dimensions: innovation process implementation, technical practices, safety controls and business incubation.





P2G Innovation Protocol
Implementing Localised Circular Empowerment Platform in Nepal







P2G Technical Toolkit
Plastic Upcycling Processes & Practices






P2G Safety Toolkit
Risk Management & Safety Controls in Plastic Upcycling





P2G Business Incubation Toolkit
Innovation Process for Circular Plastic Entrepreneurship



3.2.5

Academic Publications



Five MPhil dissertations as part of Industrial Systems, Manufacture and Management (ISMM, IfM, University of Cambridge), one journal publication and four conference papers are generated.

ISMM MPhil Dissertations

2022

- I-Chuan Hsia, 2022, *Plastic Remanufacturing Greenhouse Gas Emission Comparison: Plastic Type and Processing Method*, MPhil Dissertation, Industrial Systems, Manufacturing and Management, University of Cambridge
- Haseeb Mohammed Sheikh, 2022, *Exploring the Greenhouse Gas Reduction and Trading Potential from Transforming Plastic Waste into Housing Products in Nepal*, MPhil Dissertation, Industrial Systems, Manufacturing and Management, University of Cambridge

2023

- Manuel A. Regalado, 2023, *Innovation System for SDGs: The Himalayan Plastic Waste Upcycling Case*, MPhil Dissertation, Industrial Systems, Manufacturing and Management, University of Cambridge

2024

- Youssef Sorial, 2024, *Exploring the Requirement for Material Property Testing for Upcycling Plastic Housing Products in Nepal*, MPhil Dissertation, Industrial Systems, Manufacturing and Management, University of Cambridge

2025

- Aisling Day, 2025, *Exploring the Optimal Plastic Credit Potential and Requirement for Nepal's Plastic Upcycling Start-Ups*, MPhil Dissertation, Industrial Systems, Manufacturing and Management, University of Cambridge

Journal & Conference Papers

- Park, C., Hira, A., Rana, P., Pacini, H. and Evans, S., 2024. Dirty, difficult and dangerous: Establishing a plastics waste upcycling system in Nepal. *Cleaner Waste Systems*, 9, p.100190. <https://doi.org/10.1016/j.clwas.2024.100190>
- Park, C., Rana, P. and Evans, S., Against the Odds: Innovation System Dynamics for Circular Economy. *In Sustainable Design and Manufacturing Proceedings of the 11th International Conference on Sustainable Design and Manufacturing (KES-SDM 2024)* (Vol. 112, p. 433). Springer Nature.
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Figure 101
Youssef Sorial receiving the samples at IfM for accelerated weathering test for his MPhil thesis



Figure 102
Palistha presenting at Eco Design Conference 2025, Tokyo

41 P2G International Disseminations

5 in Seoul, South Korea

- Climate Corps Summer School (2025)
- Seoul Climate-Air Expo (2025)
- Synergy Forum (2025)
- Rotary Club Youth Leadership Forum (2023, 2025)

8 in UK

- Here to Hope Sustainability Cohort (2026)
- Cambridge University IfM Buns Talk (2022, 2024, 2025)
- West Cambridge Research Café (2024)
- Impact Hub Inverness (2023)
- Cambridge Institute for Sustainability Leadership Sustainable Technology Forum (2023)
- Open Innovation Forum (2022)

4 in Nepal

- RU Fest (2 presentations, 2025)
- UNEP Carbon Neutral Village Workshop (2024)
- 19th National Technological Fest (2023)

2 in USA

- International Conference on Sustainable Development (2 presentations, 2023)

2 in Japan

- EcoDesign conference (2 presentations, 2024)

5 in Canada

- UBC Humanitarian Engineering Course guest lecture (2024)
- Global Plastic Workshop (2 presentations, 2024)
- International Conference on Cleaner Production (2 presentations, 2023)

2 in Indonesia

- FabFest Bali (2 presentations, 2022)

1 in Bhutan

- FabFest Bhutan (2023)

1 in Portugal

- Sustainable Design and Manufacturing Conference (2024)

2 in Thailand

- Circular System Innovation for Polyurethane Foam Workshop (2022, 2023)

3.3

P2G Impact

The P2G journey has catalysed long-lasting, systemic changes in Nepal through hands-on learning, accessible technologies and locally led innovations. By shifting plastic waste from a burden to an opportunity, new capabilities and practices have emerged across four domains.

Foundation for Plastic waste Upcycling

P2G provided the technical backbone and practical know-how for local upcycling ecosystems

- Establishment of appropriate, affordable and maintainable technologies
- Demonstration of viability for converting low-value plastics into useful products
- Incremental improvements in product quality and production reliability
- Ecosystem structure that can be adapted by other communities



Local Empowerment

The communities gained confidence and internal capacity to lead circular activities interdependently, more than being passive beneficiaries

- Emergence of local orchestrators capable of expanding and sustaining local plastic circularity
- Strengthened self-efficacy to tackle local environmental challenges
- Growth of practical skills for fabrication and machine operation
- Increased ownership of local collection systems and production processes



Knowledge Co-creation & Cross-Pollination

One-directional knowledge transfer intrigued local knowledge creation, and evolved into a shared, evolving asset across actors

- Collaborative development of technical, operational and educational knowledge across community members, entrepreneurs and collaborating NGOs
- Local know-hows feeding back into prototype refinement, finish improvements and operational decisions
- Sharing of P2G learnings through exhibitions, school events, local festivals, international workshops and academic publications

Agent of Change

Individuals became proactive changemakers to drive cultural shifts, influencing collective norms and mobilising others

- A transition from external project participation to locally driven change leadership
- Shifts in local attitudes toward waste, from negligence to problem-seeking
- Community members initiating awareness activities, village sanitation and innovation proposal
- Increased pride and recognition within and beyond the village, reinforcing continued action



3.4

The Eleven Lessons from P2G

The P2G journey has given us tremendous amount of lessons: from philosophical reflections on ways of living to the most practical tips and know how, such as removing bubbles from products. This section presents the BIG Eleven lesson that will help you avoid common mistakes and make your innovation journey less bumpy!

1. Coordination is key

Transition to a circular economy requires a fundamental restructuring of existing value chains and the creation of entirely new ecosystems. Why? Because the current linear economy of take-make-use-discard system has been rigidly entrenched over the past 250 years. Moving towards circularity means bringing together stakeholders who rarely, if ever, interact. Coordination is not just helpful but essential.

Stakeholder coordination starts within close networks and expands outwards to the broader local and global value chains. Key stakeholders include:

- Local government: for their infrastructure, financial support, and procurement of end-product
- Formal and informal waste workers: to collect, transport, aggregate, sort, wash, and crush the plastic waste
- Local village community members: potential trainees, entrepreneurs and customers
- Potential customers: across B2B, B2C and B2G markets
- Local and international NGOs: as both clients and lobby partners
- Internal knowledge partners: P2G Cohort members who collaborate to expand the CE pie sharing knowledge, resources, networks and opportunities to strengthen the collective impact
- External knowledge partners: local and global universities for knowledge transfer, co-creation and diffusion through workshops, webinars, testing, piloting and publications

We maintain constant communications among these stakeholders through knowledge workshops, friendly networking events, interviews, mutual visits and regular meetings.

Mini story: Plastic Magic in Ree!

Our visit to Ree village is one of the memorable examples. The Ree Village had recently set up a village waste collection centre in support of an International NGO, but due to the lack of means to handle the collected waste, they dug a couple of pits to bury them. When we showcased the plastic upcycling technologies and product examples to the local village members and the government officers, they were deeply impressed and enthused. They ended up sending 11 village members to the P2G MAKEathon in Kathmandu, and became the winner. This is the beginning of Paramendo, the P2G Cohort no. 1

Figure 103
First P2G introduction workshop
with the local stakeholders in Ree village



2. Multiple Ecosystems for Scaling out

In Nepal, where the economic units are fragmented due to the geography, a centralised system to realise the economy of scale is not feasible. Instead of scaling up, we opted to scale out by establishing ecosystems in the villages and towns that are remote from each other.

Transportation is challenging due to the mountainous terrain, extreme weather and frequent landslides. As a result, the communication between the locations is sparse, and each area faces unique challenges. Rather than building a single large ecosystem, we developed multiple ecosystems tailored to their specific contexts.

While some of the high-level stakeholders overlap across regions, the localised ecosystems often evolved interdependently over time. On another note, we initially planned the first quarter for ecosystem building, but this deliverable turned out to be ongoing. These ecosystems continued to grow through word of mouth and personal introductions.

Mini story: One size does not fit all

The local conditions in the neighbouring village were very different from Ilam town about an hour's drive away. In Ilam, many youths actively participated in the focus group discussion showing great interest in opening a plastic upcycling business, whereas in the village only young female students remained because most of the male youth left to work abroad.

Similarly, the waste management conditions in Ruby Valley differed from those in Ree village, even if they were considered neighbouring regions, about a day's walk apart. Ruby had a different sanitation programme run by a national NGO, and the attitude of the local politicians were also distinct. After conducting a waste audit, we concluded that it is not suitable to replicate the P2G upcycling units in Ruby. Despite having a much greater population than Ree, the amount of plastic was limited to support efficient upcycling production.

These village by village contrasts illustrate why a centralised ecosystem is not feasible.

3. Pivot Means You are Doing Well

In a long-term project like this, uncertainty is inevitable. Even if we had planned with utmost care to every detail, we had expected the unexpected. We didn't know what would come, only that some surprises and new learning would come up and upturn the plans. While we could stick to the principal goal and objectives of the project, unexpected disruptions forced us to pivot. While such shifts may initially feel like a failure. They are not. Don't despair. In fact, sticking rigidly to the plans that no longer work is the real failure, when done to move closer to the goals is a sign of progress.

We faced many setbacks:

- The plastic machines import delays over six months each time, triggering a domino effect across our timeline.
- Local staff failed to meet basic expectations.
- Our international tech transfer partner repeatedly changed terms and deflected responsibility.
- Commissioned testing from a local university poorly conducted.
- Landslides, holidays, custom delays stalled the project progress, yet few shared a sense of urgency.

These disruptions taught us to revisit our definition of success, not just project goals or deliverables but our personal and common sense of achievement. For some, success means seeing the happy faces of the villagers. For others, it means cleaner hills, rivers and air. Assessing the current progress in the scale of gold, silver and bronze scale is helpful. This relative framework, the gold-silver-bronze medal analysis helped us remain motivated and calm to pull through the difficult times. relieve tension by putting the progress in the relative terms against the total failure. The gold medal does not mean flawless execution. It means we did well against our own criteria.

Success is not static. It evolves. Revisit your goals, assess your progress, and pivot when needed. That's how you stay resilient and realistic.

Mini story: Break Free From Our Own Boundaries!

Our project goal is to establish self-sustaining plastic upcycling businesses in the Himalayan villages, and replicate them across the region. We originally focused on the hilly and high mountain part of Nepal only, and excluded the Terai region. The international spotlight was on the increasing amount of plastic waste in Himalaya, hence supporting waste management in this the extremely harsh geographical conditions seem more urgent than Terai. But by the second year, we pivoted to include Terai. This shift allowed us to achieve greater quantitative impact while pursuing qualitative impact in the local villages. The higher population density and better road access in Terai meant more plastic waste could be processed, complementing the community-driven efforts in the mountains.

1. Align Definitions of Success: Yours and Local Partners' Own

The local partners' definition may not necessarily align with yours. Actively check for discrepancies, discuss them openly, and see how the project can help them achieve their goals. Running a regular session where local partners share their understanding of the project goals as well as their personal goals through the project is extremely helpful. It ensures that the project is not only progressing according to the plan, but also creating a sense of shared ownership and mutual growth.

This not only helps prevent unnecessary frustration, but also demonstrates a genuine leadership for long-lasting impact for everyone involved.

If the project appears successful on the surface but leaves local partners feeling unhappy or stressed, it's a failure in the long run. Without their genuine engagement, there will be no continuity beyond the project period.

Make the project everyone's success.

Mini story: A Different Dream, Still a Success

When we hired a new staff, our ambition was to help her become a plastic upcycling specialist. But as a mother of a small child, her ultimate goal was to open a kindergarten and we respected her aspiration by offering her flexible working hours and supporting her attendance in an evening certification course. After a year of working with us, she left to realise her dream. And we are happy for her new departure. Her journey reminded us that success looks different for everyone. Supporting personal goals alongside project goals is not a detour, it's leadership.

Figure 104

Abhishek Tamang, Paramendo, welcoming the P2G team to Ree village



2. Uncertainty vs. Agility: Adapt as You Go

The GenZ protest that toppled the government in September 2025 was a vivid reminder of the political volatility that has marked Nepal throughout the project. Frequent government changes often brought shifts in government processes causing delays and interruptions.

The high level of political volatility creates uncertainty which can be stressful. However, on the bright side, such conditions also cultivate agility and adaptability. Locals have learned to navigate these disruptions: sometimes waiting with patience and grace, some other times by finding the way through. Smiles persist even in the face of setbacks, and people often find creative ways to bypass obstacles. This resilience is a quiet superpower. Celebrate the bright side!

Mini story1: Afno manche: There will always be someone to help you.

Afno manche, my people in Nepali, is a powerful cultural trait in Nepal. Once a personal connection—be it friends, family or colleagues— is formed, it becomes a deep social support system. Without it, progress can be slow or even impossible. But with it, doors open wide.

People are genuinely willing to help you make things happen, often literally dropping whatever they were doing to be of service. When we asked to visit the new factory site, nearly the entire staff at Klean It Upcyclers gave us a ride in their car, and motorbikes, eager to spend the time together. When we asked for a place to try a local drink, the hotel manager personally took us to a nearby tavern and stayed with us throughout the evening.

To outsiders, the level of friendliness can sometimes feel like it encroaches on the boundaries. But when we asked “where do you draw the line?” The answer was simple: “Why do you draw a line?” Then they added “In Nepal, we all believe that there will always be somebody, somewhere, to help you, even if you lose everything: money, family or friends.”

Mini story 2: Protest, Pause, and a Landfill Tour

On the evening we arrived in Ilam for focus group discussions and meetings with government officers, a political protest was suddenly announced for the next day. That meant a full stop: offices closed, shops shuttered, transportation halted. We unexpectedly found ourselves handcuffed in a foreign town.

But none of our Nepali colleagues panicked. They simply comforted me, saying, “It happens all the time. There’s nothing we can do. Let’s wait and see.” And so we did.

Soon, we turned the pause into a chance to meet the locals more freely—because they also had nothing to do. They took us to the local landfill, and we ended up conducting more interviews than we had planned. A day that began with disruption ended with unexpected progress. That’s Nepal ho chalcha (=Nepal moves in their own way).

3. Respect the Culture of Contentment

Happiness comes in many forms. For some pursuing excellence brings happiness. For others, being content with the status quo means happiness. There is no right or wrong way to feel happy. In other words, excellence, contentment and happiness may not necessarily come together.

In Nepal, the culture of contentment is deeply rooted. People often find joy in what they have, rather than striving to gain what they lack. This mindset instantly disarms anxious minds, questioning why we stress over every detail, every moment. To outsiders, their relaxed sense of punctuality and attention to details can seem chaotic, and have room for improvement. But they can hardly answer why bother, if they are happy just as they are.

If both local clients and suppliers are happy with the quality, then why not? Do not push your own standard of excellence. Let them be happy.

Mini story: Content in a Chaos

After spending months in Nepal, I returned to Cambridge and saw a poster for ‘Anxiety Week’. It grabbed my attention and made me scoff a bit to myself. It reminded me how long it has been since I’d even thought about such a thing.

Soon, an old colleague came along and started to explain how helpful that week’s event has been. I listened but part of me was still lingering in the Nepali rhythm of life, where contentment is woven into everyday moments.

But let’s be honest: Nepal isn’t necessarily calm. It’s chaotic. Yet people aren’t resisting the chaos; they’re part of it. And somehow, they smile through it all.

Figure 105

Political protest can shut down everything at once such as offices, schools, shops and transportation



4. Cherish the beauty of imperfection

Working with locally-sourced plastic waste often of varying qualities and cleanliness means the final product quality rarely meets the pristine standard of virgin plastic. For many days and nights, we believed that we could make our products as shiny and clean cut as mass-produced ones, if we tried harder. However, despite our best efforts, the upcycled boards and beams came out wobbly in shape, bubbly inside, and murky in colour, far from perfect!

Eventually, we stopped pretending. It took courage to accept that striving for perfection is not only unrealistic, but also toxic for the team. We made a clear declaration: we would no longer compete with the shiny new products off the shelf. Instead, once we chose to embrace imperfection (Korsunova et al. 2022), we could start smiling again.

Better still, we turned this around and began to cherish the beauty of imperfection. Our unique value lies in the story and the meanings behind each item. The products carry the spirit of community effort, belief in ourselves, and the endurance poured into every step of the process. Then the bubbles in the boards? They began to look lovely, like proud marks of resilience and hope for the sustainable future. That's the spirit!

Mini story: Beauty in the Bubbles

Phone stand prototype by Paramendo using recycled PP boards with many bubbles in between. Initially, we tried hard to remove them, but later decided this is a story only recycled product can embody.



Figure 106
Paramendo phone stand prototype and a close-up image of the bubble inside

5. Virtue of Patience

P2G is here to catalyse the local innovation and CE transition. It didn't take long to realise that the innovation will not take place at your pace. Even if locals say they want innovation there are many causes that look like they don't want it! The local partners will come and tell you all sorts of reasons why the jobs couldn't be done on time. Because they were bitten by a dog the night before last, because the road is blocked by a sudden landslide, because the local government asked for the money, because the protest shut down everything, because it's the biggest holiday season, because someone in the family passed away, because of they are down with food poisoning, to name a few.

There is nothing but waiting for them to overcome the constant obstacles with patience. In the end, we are not aiming to impose the changes ourselves. The role of this project is to provide the catalyst to create the momentum for new innovative thinking, where it is not likely to take place voluntarily, or extremely slowly.

P2G only plants the seeds with what we have in our hands, then wait until they bloom in their time. With a firm belief that they will. Then they do.

Mini story: The Blessing in Disguise

Towards the original midpoint of the project, the UK government revised the budget allocation plan and our funder extended our project time. Four years and one quarter is nearly double the original duration with less money. It felt like a major shock. But in Nepal, where dogs bite, roads vanish, and festivals and protests stop the entire country, the new timeline turned out to be exactly what we needed.

The extra time gave space for things to unfold at their own rhythm. Start-ups don't mature in 1-2 years, after all. They need time like a slow-cooked dal bhat, not a ready meal in the microwave. And just like that, the virtue of patience became our theme.

Figure 107
Landslide is a common roadblock during the rainy season in Nepal.



1. Appropriate technology

We thoughtfully selected appropriate technology machines that were best suited to the local context. This meant prioritising simplicity, affordability, durability, reparability, and adaptability over sophistication or scale.

In many development projects, high-end machines are imported with little regard for local realities. These machines often break down quickly, and spare parts or technical expertise are hard to find. We wanted to avoid that trap.

Instead, we chose machines that had been time-tested, could be maintained locally, operated with minimal training, and adapted to the available power supply. This approach not only reduced downtime but also empowered local entrepreneurs to take ownership of the technology.

Mini story: "We don't want that headache"

When we hear complaints like the one from Everest, we smile because it's exactly what we aimed to avoid.

"They don't know how it is here. It's so different up in the mountains! They just dropped this big machine from Europe. Very complex one. And it soon broke down. Nobody knows how to repair it or find the parts. And they don't care! Now it has become rubbish here. We don't want that headache."

This kind of frustration is common when technology is imposed without context. By choosing appropriate technology, we avoided becoming part of that story but helped write a better one.

2. Triangle of plastic upcycling

It didn't take us long to realise that plastic upcycling is not the job for a single company. It takes a coordinated effort across the key actors of what we call the 'triangle' of plastic upcycling.

- Government and municipalities play a critical role in waste collection infrastructure and policy support.
- Suppliers and waste workers handle the preprocessing: segregating, washing, drying, crushing, or pelletising the plastic waste.
- Upcycling entrepreneurs then transform the processed plastic into new products through innovation and craftsmanship.

Each part of the triangle is essential. Without proper collection, there's no feedstock. Without preprocessing, the material is unusable. And without entrepreneurs, there's no transformation. This ecosystem approach ensures that plastic upcycling is not just technically feasible, but socially and economically sustainable.

Mini story: it takes a village to upcycle

We tried the entire process ourselves. First we visited the local waste collection depot and watched how the plastic was sorted. When the sorted plastic arrived at the FabLab, we sat for hours to fish out the contamination by hand. We washed them in an old washing machine, dried them overnight and crushed them multiple times to reach the right size for melting.

It was dusty, slow, and back-breaking. But more than anything, it was eye-opening.

That day made one thing clear: no single actor can do this alone. The process demands coordination, care, and community. It's not just a technical system, it's a human one.

Figure 108
The plastic recycling machines arrival at Ree Hub



Figure 109
P2G innovation triangle diagramme

3. Testing in Three Dimensions: Feasibility, Performance, and Process

Testing is not just about quality assurance—it's about learning. In our project, we found that successful plastic upcycling requires testing across three distinct dimensions:

- **Product Feasibility:** Does the product work as intended? This involves early-stage prototyping and iterative design to refine functionality.
- **Product Performance:** How well does the product hold up in real-world use? This is essential for quality assurance and market readiness.
- **Manufacturing Process:** Can the machines consistently produce the desired product? This includes testing for efficiency, reliability, and adaptability to local conditions.

Each dimension reveals different insights. Together, they ensure that the product is not only viable and desirable, but also manufacturable in a sustainable way.

Mini story

Geodome, one of the original P2G cohorts that now operates interdependently, has been focusing on developing affordable modular building units as emergency shelters using recycled plastic. Their shelter, also called the Geodome, has a unique structure that is easy to assemble and disassemble, making it ideal for transport to remote areas affected by natural disasters. When they installed the first full-scale prototype on their land, they decided to spend a night inside it to test its safety and comfort. Voila, look at their happy faces after a deep sleep the next morning!



Figure 110
Geodome sent us a selfie after a night in their Geodome prototype. Feasibility testing successful!



Figure 111
Kleanit Upcyclers testing the first plastic recycling bin prototype with interns

3.5

Future Recommendations

Drawing on the lessons learned, we propose a set of future actions that outline how to continue the work in Nepal and how the model can be replicated beyond Nepal

Continue P2G Legacy In Nepal

FabLab Nepal serving as Nepal's Plastic Innovation Headquarter

With the P2G Plastic Room and its equipment, FabLab Nepal gradually built a strong base of knowledge and practical know-how, establishing a solid reputation across Kathmandu. Looking ahead, it should position itself as Nepal's headquarter for plastic innovation by continuing to serve the national plastic upcycling ecosystem as a welcoming and reputable R & D space for technology development and hands-on experimentation.

To maintain accessibility for emerging innovators, the existing pay-as-you go model housed within Impact Hub Kathmandu should be strengthened so that the threshold remains low for aspiring plastic innovators who need affordable access to plastic processing machines and the full range of low and high-tech fabrication facilities.

Cross pollinating culture through knowledge sharing

P2G placed strong emphasis on nurturing a culture of knowledge sharing within the P2G start-ups and successfully built a collaborative alliance. The regular and informal meet ups created a space for members to gather, exchange updates, and discuss ongoing challenges, and these conversations often led to practical solutions by the end of each session.

Carrying this culture forward, this uplifting practice of mutual support should continue so that the wider plastic innovation industry in Nepal can grow through shared learning, collective problem solving, and a stronger sense of community, instead of competing.

Quality Education throughout the plastic supply chain

To address one of the most persistent challenges of low quality in end products, greater attention should be

directed toward quality management across the entire plastic supply chain. This includes the collection of raw materials from households, the preprocessing stages of segregating, cleaning, crushing and pelletising, and the manufacturing of the final products. Poor-quality recycled plastic is often seen as a low-value byproduct rather than a reliable raw material for manufacturing.

Raising the currently relaxed standard of quality across society will be a challenging task, yet it will also be one of the most rewarding efforts within the Nepali plastic upcycling scene. A collective pursuit of excellent quality can gradually shift individual mindsets and foster a sense of pride and self-confidence, generating long term positive change.

Intentional Design of Gender Equality Social Inclusion (GESI)

Gender Equality and Social Inclusion (GESI) Principals must be incorporated deliberately from the earliest stages, ensuring that both design and implementation remain consistently inclusive in the future. Looking ahead, a stronger emphasis should be placed on supporting the growth of female led enterprises by identifying potential women innovators, providing targeted mentorship and guidance, and enabling them to take on decision making and leadership roles within incubation pathways. To widen access, the outreach and selection approach for future start-ups should be intentionally structured to engage women and young people, ensuring that emerging talent from underrepresented groups can enter and benefit from the programme.

Empowering in more remote regions of Nepal

Conducting regular MAKEathon events in various regions in Nepal can help sustain the momentum of plastic waste innovation and broaden participation across the wider Nepali society. Reaching out to

remote regions, in particular, will be critical to empower underprivileged individuals who have had little or no exposure to the idea of transforming plastic waste into valuable resources. These outreach activities should include mobile demonstration units, hands-on workshops, and locally adapted training sessions so that communities can engage directly with practical and accessible upcycling methods. Such efforts can also help identify talented future innovators who may not otherwise have access to these opportunities.

To strengthen and sustain this work, Impact Hub Kathmandu and FabLab Nepal should actively collaborate with local governments and schools to embed these activities into regional development plans. This can be complemented by a structured business incubation programme utilising the P2G expertise, providing mentorship, technical support, and entrepreneurial training for promising participants

Creative niche of Public Private Partnership (PPP) model

Mature start-ups equipped with strong technical and

managerial skills should proactively seek partners to develop locally-grounded Public Private Partnership models. Although waste management is formally the responsibility of government, it remains ineffective in Nepal due to geographical, financial and political barriers. Where a centralised approach unviable, small, agile and localised businesses can offer practical circular solutions to municipal authorities with far less burden. Local government often wants solution but does not have the capacity to meet these needs alone. A PPP model driven by circular solutions is the lightweight, win-win approach that fits the Nepali context.

This presents a creative and future-friendly pathway for Nepal, and potentially for other countries, to address the areas where government systems struggle to reach. By positioning themselves as problem solving partners for local government, these start-ups can help shape a new niche of community-centred PPP models that extend services, close gaps and accelerate circular innovation.



Figure 112
Aakash Mali, Paramendo, sharing the lessons captured from Plastic Odyssey workshop in Chennai during the P2G cross pollination session. Learning and sharing must go on!

Policy Reflection

Balanced Incentivisation

As seen in Chapter 1 (P.19-21), Nepal's political context around waste management is marked by a symbolic recognition of its importance, resulting in a fragmented legal framework. This fragmentation not only assigns limited weight to the 3Rs approach but also prevents the emergence of a more integrated and cohesive system. Moreover, policies and laws often lack corresponding guidelines, creating difficulties at the implementation stage where they are either inconsistently applied or ignored altogether due to limited resources and weak political support. In order to address the prominent lack of law enforcement proposed below recommendations for balanced incentivisation across diverse stakeholders.

Public-private partnership (PPP)

The public-private partnership is emphasised in Nepal in the Public Private Partnership and Investment Act (2019) as a means to reduce cost and increase effectiveness. As an alternative to full privatisation in which the government and private businesses share co-ownership and co-responsibility for the provision of specific services, PPPs is an effective means that combines the skills and resources of both the public and private party by sharing risks and responsibilities (Lam, 2024) One of the P2G Urban Hubs in Dang is a notable example of such partnerships that support local plastic upcycling and eventually achieving CE implementation.

Integrated Circular Economy (CE) framework

Integrated approaches that align with the local socio-economic conditions can ensure relevance and implementation (Yaotian et al., 2025). Combining economic, social and environmental perspectives, an integrated CE framework would include further incentives for entrepreneurs as well as municipalities,

private sector and households. For example, the informal waste workers can be simultaneously addressed by establishing a formal channel for segregation, recognising the contributions of and improving their working conditions and safety through Personal Protective Equipment (PPE) or WASH facility not only address health issues but also their dignity.

Financial support mechanism for implementation

These improvements could be financed by a tax on imported plastic as advocated by Bharadwaj et al. (2020): "An additional 1% tax on plastic imports would be sufficient to cover plastic-related waste management when plastic waste recovery and collection efficiency rates are low." Imposing tariffs would: a) promote substitutes, b) reduce the use of plastics, and c) increase the price of recycled plastic while reducing trade deficit. In 2012, Nepal imported 0.4 million tonnes of plastic, estimated plastic waste generated was 0.23 million tonnes. Foreign Trade Statistics FY 2074/75 (2017/18). Monthly Foreign Trade Statistics based on First Month Data of Fiscal Year. Kathmandu; 2017.

Extended Producer Responsibility (EPR) framework

Reflecting on the plastic credit potential study (see p.27, Day, 2025), Nepal lacks an Extended Producer Responsibility (EPR) framework or formalised plastic credit policy. As such, findings are situated in a transitional policy environment and are vulnerable to future regulatory shifts. Any eventual formalisation of compliance frameworks could alter cost structures, market access, and certification incentives substantially. (Day, 2025)

Collection efficiency

Improving collection efficiency could generate income and thus pave the way for a self-sustained waste

management system. Bharadwaj et al. (2020) note that "plastic material recovery could generate revenue, which is equivalent to 1.38 times of the plastic-waste-related management cost when collection efficiency reaches 66.7%", collection efficiency being defined as "the percentage of recyclable waste material collected out of the total waste".

Collection efficiency can be increased through three channels: an increase of the percentage of waste material collected out of the total waste; an increase of the recyclable waste collected; and an increase of the recyclable waste material out of the total waste. The two first solutions require segregating the waste though.

As in Nepal household waste represents a major part of the waste the municipalities must deal with, inducing behavioural change among households could increase the percentage of waste material collected out of the total waste, especially if households segregate waste.

Nepal et al. (2023) showed that information dissemination can have a positive impact on household waste management, while being relatively cheap with a cost of 3USD/households. Similarly, Miafodzyeva et al. (2010) showed that schoolchildren were more prone to accepting separate waste collection systems than adults, while Ekstrom (2007) showed that children can later one change their parents' recycling behaviour. Thus, information campaigns aimed at schoolchildren could help improve households' waste management behaviour and increase the proportion of recyclable collected waste out of the total waste.

In the same manner, providing households with economic incentives to segregate their waste could improve collection efficiency. Dijkgraaf and Gradus (2020), in a comparative study of waste management systems, showed that the two most efficient waste collection systems were either post-segregation, i.e. segregation by the municipality, or households segregation paired with a unit-based price, i.e. households segregate their price and pay for the non-

segregated waste. The latter could be implemented in Nepal as Ghimire et al. (2024) observed that Nepalese were willing to transition to a Pay-As-You-Throw system. For this system to work, it requires the municipality to keep the waste segregated during the transportation from the collection point to the recycling facility. Another manner to improve the part of collected waste out of the total waste would be to increase waste collection frequency and make it at regular times, so that people can both rely on it and not dump or burn their garbage.

Overcoming the geographical difficulties

Instead of rural municipalities invest in formal waste collection in the remote areas, the local government can subsidise the decentralised private collection centres and innovation hubs (e.g. P2G Ree Hub, Ruby Valley Hub) by providing the land, facilities and cover the labour cost of the local businesses. This approach is more cost effective than running the regular collection services which often is not even viable in the mountainous regions. In addition, this allows the remote community to become the agency of change for their own natural environment.

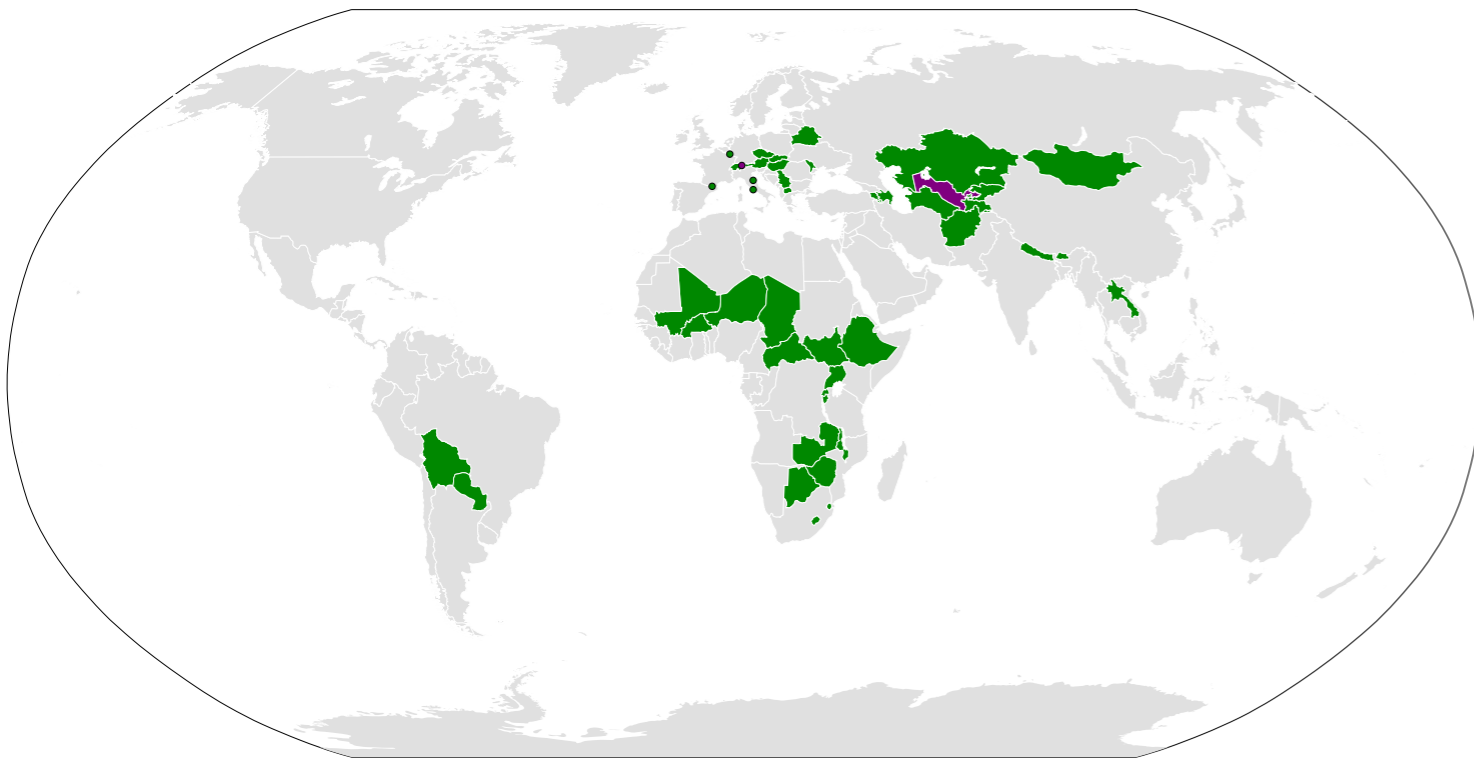


Figure 113 Distribution of 44 Landlocked Countries in the World

Source: NuclearVacuum (2022) Landlocked Countries [map]. Wikimedia Commons. CC BY-SA 3.0. Available at: https://commons.wikimedia.org/wiki/File:Landlocked_countries.svg (Accessed: 10 March 2026).

Table 9 32 Landlocked Least Developed Countries (LLDC) defined by UN (as of 2026)

Region	Country	LDC status	Region	Country	LDC status	Region	Country	LDC status	Region	Country	LDC status
	Botswana	Graduated		Malawi	Yes		Afghanistan	Yes		Turkmenistan	No
	Burkina Faso	Yes		Mali	Yes		Bhutan	Graduated	Africa	Uzbekistan	No
	Burundi	Yes		Niger	Yes		Kazakhstan	No		Armenia	No
Africa	Central African Republic	Yes	Africa	Rwanda	Yes	Asia	Kyrgyzstan	No	Europe	Azerbaijan	No
	Chad	Yes		South Sudan	Yes		Lao PDR	Yes		North Macedonia	No
	Eswatini	No		Uganda	Yes		Mongolia	No		Republic of Moldova	No
	Ethiopia	Yes		Zambia	Yes		Nepal	Yes			
	Lesotho	Yes		Zimbabwe	No		Tajikistan	No	South America	Bolivia	No
										Paraguay	No

Source: United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) (n.d.) List of LLDCs. Available at: <https://www.un.org/ohrrls/content/list-lldc> (Accessed: 10 March 2026)

Beyond Nepal

Replication of Localised Circular Empowerment Platform (LCEP) Beyond Nepal

Localised Circular Empowerment Platform (LCEP) is a community-centred model that enables local communities to manage their own plastic waste ecosystem using appropriate, low-cost and modular technologies. Rather than relying on government-led centralised waste infrastructure, LCEP focuses on building local capability with strong emphasis on collaborative identification of local needs and co creative innovation, followed by iterative problem solving, hands on learning, knowledge sharing and practical ownership of local resources and knowledge. By embedding business knowledge, technical skills, local innovation and small-scale circular economy practices within neighbourhoods, LCEP allows diverse communities in both developing and developed countries to operate resilient, adaptive and financially accessible waste solutions that grow over time.

Replication in Landlocked Developing Countries

Nepal is a great example of LLDCs (Landlocked Developing Countries). LLDC is a subset of low-income countries, characterised by their lack of territorial access to the sea, isolation from world markets and high transit and transportation costs. Just like in Nepal, these characters often lead to severe structural barriers to development.

Currently 32 out of the total 44 landlocked countries is classified as low-income developing countries (based on the 2024 UN data), often recipients of Official Development Assistance (ODA) [Table 9](#).

The listed 32 Landlocked Developing Countries (LLDCs) experience a critical environmental and economic challenge of plastic waste, however often overshadowed by marine-focused initiatives. Despite having no coastlines, these nations contribute

significantly to global plastic leakage into river systems that eventually reach the oceans. The common challenges includes:

- **Prohibitive Transit Costs** forced reliance on transit neighbours, making transport 50% more expensive than for coastal nations
- **Infrastructure Gaps** lacking in technical facilities and financial resources for modern waste collection, sorting, and recycling due to inadequate road and rail networks hinder internal and external commerce
- **High Mismanagement Rates** due to inadequate formal waste systems leading to widespread littering and open burning, releasing toxic gases and microplastics
- **Cost Inequities** often bear a lifetime cost of plastic pollution up to 10 times higher than in wealthy nations due to healthcare impacts and environmental degradation. Some of them are used as dumping grounds for plastic waste exports from richer countries under the guise of “recycling”.
- **Climate & Environmental vulnerability** Plastic pollution further degrades soil quality and clogs vital freshwater systems, which LLDCs rely on more heavily due to lack of ocean resources.

The skills and lessons captured from the four-year P2G journey in Nepal can be applied to LLDCs that face similar geographical constraints in managing plastic waste. The intention is not only to solve existing plastic problems but to turn them into high value opportunities that offer new possibilities for LLDCs.

However, copy and paste of the Nepali experience as it is will not work. Each country requires its own adaptation that reflects its social, cultural and infrastructural context. The strength of the P2G method lies in its learning by doing approach, which encourages local experimentation, continuous adjustment and practical ownership. When this adaptive process is embedded



Figure 114
Plastic toy upcycling workshop at Seoul Upcycling Plaza, South Korea

within communities, it creates a pathway for impact that avoids large-scale failure and builds confidence through early wins. This is how LCEP can grow into a fail-free model of circular empowerment across diverse LLDC settings and address their systematic mismanagement issues.

Replication in Developed Countries

Although LCEP is shaped by lessons from Nepal, the core Principals of the Localised Circular Empowerment Platform (LCEP) are equally beneficial for the plastic waste ecosystem within developed country contexts. Many high income nations struggle with fragmented recycling systems, low community participation, limited transparency in waste flows and a heavy reliance on large, centralised facilities that can overlook opportunities for local circular value creation. Furthermore, integrating advanced technologies such as AI driven sorting robots and digital watermarking can improve sorting accuracy and reduce contamination.

Applying the LCEP model in these settings can help visualise the often disenfranchised plastic waste supply chain that operates behind the scenes. It activates neighbourhood level, transparent circular economies by embedding small scale, low cost and community centred solutions within existing urban infrastructures. Through co creative innovation, iterative problem solving, hands on learning, knowledge sharing and practical ownership, local communities can participate directly in reshaping transparent and locally grounded circular systems.

LCEP aligned approaches offer significant decarbonisation and economic resilience potential such as

- **Culture of circular empowerment** Residents regain control over often complex and malfunctioning recycling systems, enabling them to produce high

value products within their vicinity

- **CO2 reduction** Shifting from incineration can reduce ± 3.75 kg CO₂ eq per household in annual greenhouse gas emissions. Recycling one tonne of plastic saves roughly 130 million kJ of energy compared with producing virgin materials.
- **Job Creation** The transition can create highly labour intensive roles that are not easily replaceable by AI, particularly within repair and remanufacturing tiers of plastic circularity. For example, Sweden estimates that circular policies could create 68,000 jobs by 2030, primarily in remanufacturing.
- **Economic Value** Keeping plastics in a closed loop system prevents the loss of an ± 80 –120 billion US dollars in packaging material value that is currently lost after a single use.
- **High Value Output** Community based systems can produce higher quality post consumer resin suitable for advanced applications instead of downcycling

However, these models face barriers such as high initial costs for smart infrastructure and the continued low price of virgin plastics driven by volatile oil markets. A triple helix approach, more advanced version of PPP involving collaboration between government policy, academic innovation and private sector execution can help address these challenges. In short, LCEP offers a scalable and adaptive framework that can complement advanced technologies and policy gaps, enabling developed countries to foster more resilient, participatory and community centred circular ecosystems. a fail-free model of circular empowerment across diverse LLDC settings and address their systematic mismanagement issues. gaps, enabling developed countries to foster more resilient, participatory and community centred circular ecosystems.



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