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SCALING INNOVATIONS

for Plastic Circularity with Investment in ASEAN

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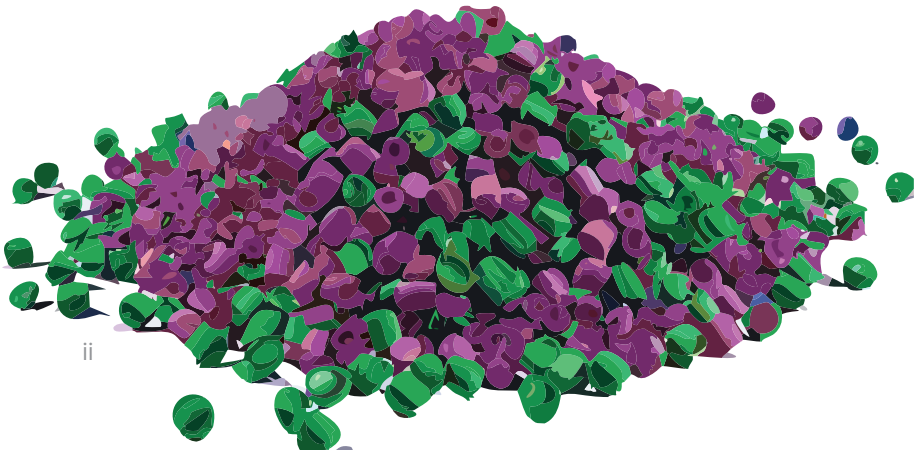

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Acknowledgements

This publication is prepared to enable ASEAN countries in assessing the current innovations supporting plastic circularity and the investment landscape in the region. The analysis identifies key barriers and offers recommendations for stakeholders to address plastic pollution by enhancing innovations through targeted investment, capacity building and cooperation along the plastic value chain.

The development of this publication was coordinated by the World Bank's Environment, Natural Resources, and Blue Economy Global Practice, with funding support from the World Bank Group Korea office.

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The research, preliminary analysis and stakeholder consultations on the innovations were conducted by the non-profit The Circulate Initiative.

The team is grateful for the valuable advice provided by the peer reviewers, Delphine Arri (Senior Environmental Engineer), Etienne Raffi Kenchichian (Senior Financial Sector Economist), and Karin Shepardson (Lead Environmental Specialist).

The study team would like to especially thank the private and public sector stakeholders in Cambodia, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam who generously provided their insights for this study. The team is grateful to the Korean agencies and private entities who contributed their valuable time and knowledge in preparation of the Supplementary Note on Korean innovations in plastic circularity.

Executive Summary

The member states of the Association of Southeast Asian Nations (ASEAN) recognize the serious problem of plastic waste leaking into the environment at every stage of the plastic value chain, from poor collection and sorting to inadequate recycling and disposal facilities. Rapid urbanization and the burgeoning middle class in the ASEAN Region have resulted in an exponential rise in the volume of plastic waste, and particularly waste from single-use plastics (SUPs). In 2021, a selection of six ASEAN member states (AMS) generated approximately 8.4 million metric tons of mismanaged plastic waste.[1] By 2040, the annual flow of waste into the ocean, worldwide, is expected to rise from 11 to 29 million metric tons per year under a business-as-usual scenario.[2] It is alarming to note that of the world's top 10 rivers conveying the highest amount of plastic waste into the ocean, eight are in Southeast Asia.[3] In the ASEAN Region, 75 percent of marine plastic pollution comes from uncollected, land-based waste, and about 25 percent from municipal solid waste system leakage.[4]

Mismanaged plastic waste has significant negative impacts on biodiversity and human health. It exacerbates the inefficient use of raw materials and misses opportunities to create jobs in manufacturing sustainable alternatives to plastics, as well as in reusing and recycling plastics. The environmental, health, and economic cost of mismanaged plastic waste is estimated to be worth more than $100 billion per year,[5] which underscores the urgency of finding solutions.[6] The potential value from plastic recycling is considerable in the ASEAN Region. An estimated $8.9 billion is lost by four

1 Cambodia, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam
2 The Pew Charitable Trusts and Systemiq. 2020. "Breaking the Plastic Wave."
3 Meijer et al. 2019. "Over 1000 rivers accountable for 80% of global riverine plastic emissions into the ocean."
4 UN-ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2020. *Closing the Loop*.
5 All dollars ($) in this paper are US dollars.
6 Minderoo Foundation. 2022. "The price of plastic pollution: social costs and corporate liabilities."

Photo: Plastic pellets are sorted into bins at a plastic recycling facility. *Shutterstock/ImagineStock.*

This paper is intended to enable ASEAN countries to take stock of the current innovations that are supporting plastic circularity and the steps needed to encourage additional capital investment by improving policies and building innovators' capacity.

AMS each year due to their failure to recover and reuse 80 percent of their plastic waste.[7] This demonstrates that solid waste management (SWM) systems are not effectively collecting, sorting, and recycling plastics, and, as noted above, the low recycling rate is failing to exploit the economic potential of plastic waste.

In 2021, in response to the growing plastic waste emergency, the AMS developed the "ASEAN Regional Action Plan (RAP) for Combating Marine Debris in the AMS (2021–2025)." This ambitious commitment by the AMS is reflected in a subsequent document, the "Regional Declaration on Combating Marine Debris," which details actions to reduce plastic waste, enhance waste management practices, and foster innovations to tackle plastic leaking into the environment. Some AMS have developed national plans and strategies to improve SWM, promote the circular economy,[8] and initiate innovations to reduce, recycle, and reuse plastic waste. Through their collective commitment, the AMS are endeavoring to address plastic pollution and capitalize on the benefit of increasing recycling, while also strengthening environmental stewardship and sustainability in the ASEAN Region.

Given that plastic and SWM are interlinked, strategies targeting plastic waste management can only be impactful if they also address the gaps in SWM. These gaps include: (i) the low rate of solid waste segregation at source; (ii) inadequate collection systems; (iii) the limited number and capacity of sorting and recycling facilities, and heavy reliance on the informal sector; (iv) a weak regulatory framework and enforcement of regulations; and (v) limited plastic and solid waste-related data. All these gaps hinder private sector participation and investment, which results in underdeveloped markets for recycled products and packaging, despite the AMS generating a large volume of plastic waste. Given the gaps in SWM, plastic waste management is neither adequate nor efficient, leading to substantial plastic waste leakage into the environment, and limited recycling.

This paper presents a study that was conducted in six AMS and based on an initial assessment of their SWM systems, these were grouped into two sets of three countries. Three countries (Cambodia, Indonesia, and the Philippines) have a nascent solid waste ecosystem that is characterized by some dedicated waste policies and regulations, which are poorly enforced, with no support and incentives for plastic circularity; limited or no waste segregation at source; poor collection systems with a low collection ratio; a strong autonomous informal sector that prioritizes the collection, sorting, and recycling of high-value plastic; and significant gaps in the infrastructure for waste recovery and recycling. A second group of three countries (Malaysia, Thailand, and Vietnam) have an emerging solid waste ecosystem, with a SWM regulatory framework; incentives for plastics' reuse; SUPs' restriction, collection systems, and recycling facilities in place in major urban centers; and consumers are educated to segregate their waste at its source. In addition, Indonesia and the Philippines are island nations that have unique SWM challenges.

This paper acknowledges that although there are gaps in plastic and SWM in the six AMS, these shortcomings in infrastructure and services should not deter them from supporting plastic waste innovations, which can enhance plastic and SWM. This paper is intended to enable ASEAN countries to take stock of the current innovations that

7 World Bank. 2021b. "Market Study for the Philippines, Malaysia and Vietnam: Plastics Circularity Opportunities and Barriers."

8 "The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible…This is a departure from the traditional, linear economic model, which is based on a take-make-consume-throw away pattern." (European Parliament. Website accessed on February 25, 2024)

are supporting plastic circularity and the steps needed to encourage additional capital investment by improving policies and building innovators' capacity. Thus, this paper should assist stakeholders in tackling plastic pollution and improving plastic circularity by focusing on innovations in plastic circularity and supporting entrepreneurs and small and medium enterprises (SMEs).

The World Economic Forum's UpLink Platform, the Living Landscape of Reuse Solutions database, and the Incubator Network were the sources of innovations analyzed in the study. In developing this paper for the AMS, stakeholders who are engaged in driving innovation and investing in plastic circularity were consulted. These comprised investors, government officials, and representatives from non-governmental organizations, associations, corporations, incubators, accelerators, and other enterprise support organizations. Initially 262 innovations were selected from the three databases, and their readiness to scale was assessed. The latter was based on three key factors: (i) robustness of the business model, (ii) current scale, and (iii) potential for scalability. The innovations reviewed and evaluated were mostly from the ASEAN Region (67 percent) and supplemented by some from other developing countries (24 percent), and some developed countries (9 percent). The latter were in the upstream stage of the plastic value chain (alternative materials) and in the cross-cutting stage (digital platforms). These innovations are of relevance to AMS but not as common in the region. The selection of some innovations from outside the ASEAN Region was necessary due to the small number of innovations within the region that were ready to scale. This paper discusses various innovations and includes a Supplementary Note detailing the Republic of Korea's efforts to create a supportive environment for innovations in plastic waste management.[9] The innovations reviewed span the entire plastic value chain, from the upstream stage, to the midstream stage, to the downstream stage, which is before plastic waste either leaks into the environment or it is properly disposed of.

9 World Bank. 2024. "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions: Supplementary Note for Scaling Innovations for Plastic Circularity with Investment in ASEAN."

The upstream, midstream, downstream, and cross-cutting stages in the plastic value chain are as follows:

- **The upstream stage** includes the production of plastic materials. Innovations at this stage contribute to *source reduction* by reducing the production and use of difficult-to-recycle plastic products, such as SUPs. These innovations can be divided into (i) *Alternative materials and substitutions*, which are bio-based feedstocks that substitute plastic with less harmful plant-derived materials, such as bamboo, coconut, and seaweed; and (ii) *Eco-design solutions*, which enhance recyclability to optimize materials by improving the yield and value of reclaimed plastics. The upstream stage of the plastic value chain drives the economic and material efficiency of plastic production, and it also fosters the development of advanced materials and sustainable practices that drive plastic circularity.

Photo: iStock/Studio Fennel

- **The midstream stage** focuses on innovations that minimize the use of plastic products in the product-delivery and consumer-use phases. Midstream innovations act on the critical elements, *Collection and Segregation*, in plastic circularity, and these are divided into (i) *Separation and sorting*, which supports segregation at source, increases collection and separation efficiency, and opens up opportunities for businesses in recycling; and (ii) *Refill and reuse*, which comprises diverse business models that limit SUPs and other plastic products by leveraging business models that target reuse, refilling, or product-as-a-service.[10] Examples of this include package-free shops, refill systems that integrate reverse logistics' operations, capturing and reprocessing containers, and reusable packaging. The midstream stage contributes to environmental sustainability and plastic circularity.

- **The downstream stage** focuses on managing plastics at the end of their usefulness, including reintegrating post-consumer plastic back into the economy. This stage supports all forms of *Cycling*,[11] and especially recycling. These innovations improve the recovery of recyclables through (i) *Recovery*, which refers to the preparation of plastic waste for recycling, aims to increase the quantity, quality, and economic viability of recovered plastics; and (ii) *Recycling*, which focuses on converting recovered plastic waste into usable raw materials to close the loop in the plastic value chain. Business models and technologies that enhance the value of plastic through processes such as separation, shredding/flaking, or pelletizing improve the recycling process, and result in higher-quality recyclable materials, reduce contamination risks, and elevate the overall quality of the recycled output.

- **The cross-cutting stage** comprises *digitalization and smart systems* and *data analytics* across the plastic value chain.[12] Innovations cutting across the plastic value chain provide digital solutions and services that improve plastic waste management; make this more accurate and transparent; streamline operations; optimize resources; enable better decision-making with evidence-based data; and increase efficiency and performance. This stage can also assess citizens' engagement to measure their compliance with regulations and their impact. Examples of digitalization include digital mapping to track plastic waste and products. Digitalization, in line with waste regulations on extended producer responsibility (EPR), also helps stakeholders to account for their plastic usage; audit and provide accurate data on plastic waste flows; and quantify collected waste.

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10 The model shifts the traditional focus from selling plastic products to offering a service that encompasses the lifecycle management of products, including their recycling and eventual disposal.

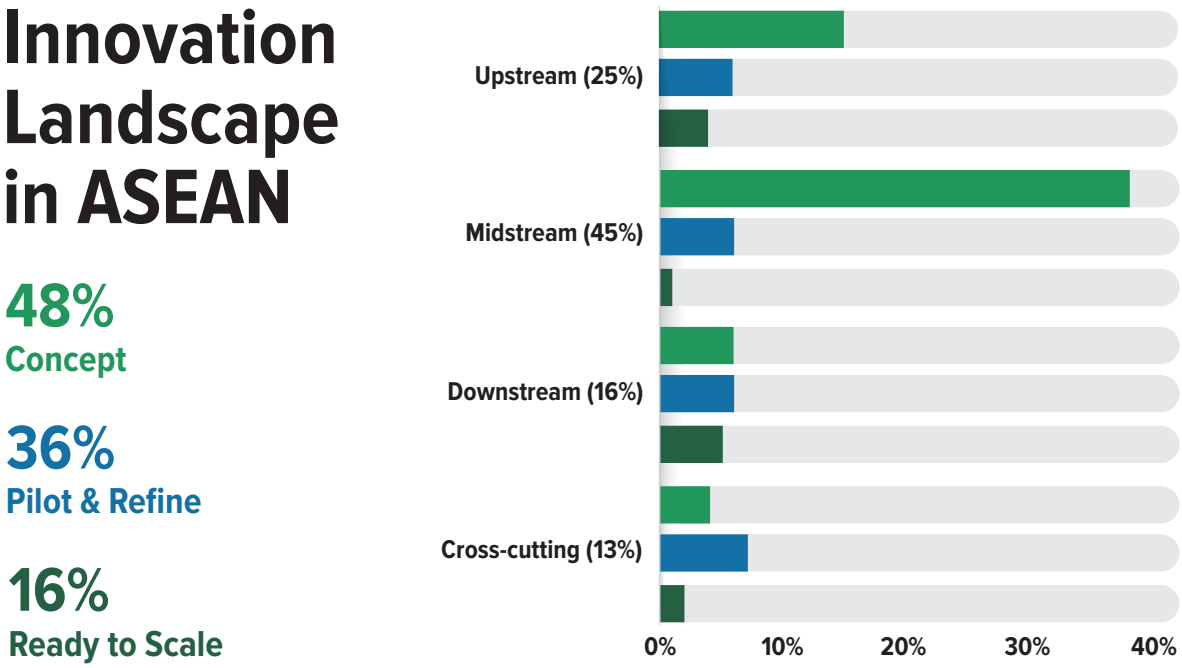
11 Recycling processes post-consumer plastics to make new materials. *Upcycling* transforms plastic waste into products of higher quality or value than the original. *Downcycling* is recycling that degrades the quality of materials and leads to their use in lower-value applications. *Closed loop* is the optimum recycling process as end-of-life plastic is processed to make the same product again, which maintains its economic and material value. *Precycling* involves the strategic reduction of waste by preventing the generation of unnecessary plastics.

12 "The Fourth Industrial Revolution is characterized by the convergence and complementarity of emerging technology domains, including nanotechnology, biotechnology, new materials and advanced digital production technologies." (Lavopa and Delera. 2021. "What is the Fourth Industrial Revolution?")

Of the 262 early-stage innovations reviewed in this study, 48 percent were at "concept stage," 36 percent were at the "piloting and refinement stage," and 16 percent demonstrated "readiness to scale." About half of the innovations focused on the midstream stage (especially in *refill and reuse*). The other innovations that lagged at the upstream, downstream, and cross-cutting stages numbered 25, 16, and 13 percent, respectively. This reflects the ASEAN Region's lack of market support for source reduction, lack of infrastructure for recovery (material recovery facilities), lack of recycling (recycling facilities), and the novelty of digitalization. This study focused on "readiness-to-scale" innovations that were beyond the proof-of-concept stage. The innovations that were ready to scale (16 percent) were further subdivided between the upstream stage (34 percent), the midstream stage (8 percent), the downstream stage (40 percent), and the cross-cutting stage (19 percent). Most of the innovations were at the "concept stage" of their development and, therefore, will require strong policy and financial support to reach the "readiness-to-scale stage." The innovation landscape in the ASEAN Region is presented in Figure ES.1.

Public sector support is critical for plastic waste management and advancing plastic circularity, and many supportive SWM policies have already been developed and adopted in the six AMS at the national, regional, and local levels. However, significant policy gaps remain because some policies are not implemented and enforced. Accelerating the adoption of policies could significantly strengthen opportunities for innovation to play a role in tackling plastic waste management, recycling, and circularity, as well as supporting SWM. To transition from a nascent to an emerging SWM and plastic waste ecosystem (see Table ES.1), countries need to strengthen their policies and regulations by establishing and implementing basic regulatory frameworks and progressing towards complex policies, such as EPR. This transition fosters a culture of innovation that results when technology and practices in SWM improve from basic waste collection and disposal facilities to advanced processing and recycling ones. This transition also means expanding stakeholder engagement by evolving from engaging with local communities to broader collaboration at a national level that harmonizes regulations and investments, country wide.

Figure ES.1. Plastic Waste Management Innovation Landscape in the ASEAN Region



Note: The total does not add up to 100 percent due to rounding of some of the percentages.

Source: The World Bank Group

Table ES.1. Transitioning SWM from a Nascent to an Emerging Ecosystem in the six AMS

INNOVATIONS BY STAGES	NASCENT ECOSYSTEM	EMERGING ECOSYSTEM
UPSTREAM (Policies & Regulations for Source Reduction)	Basic policies and regulations to incentivize the reduction of plastic use and the development of alternative materials: • Implement tax breaks or targeted subsidies for companies that invest in developing environmentally friendly alternatives to materials with virgin plastics. • Drive innovations in alternative packaging by enforcing the restriction of SUPs.	Advanced policies for reducing plastic use and promoting sustainable alternatives: • Implement regulations that mandate the eco-friendly design of products and packaging, and reduce plastic use from the design stage. • Adopt green public procurement policies (GPPP) that prioritize products with less virgin plastic, as well as sustainable packaging.
MIDSTREAM (Collection & Segregation)	Focus on enhancing the efficiency of the collection and segregation of plastic waste: • Initiate government-supported community programs for waste segregation and collection, and provide resources and training to encourage local innovations. • Integrate the informal sector into government SWM systems.	Support sophisticated systems for collection and segregation: • Invest in fully automated waste sorting facilities that use advanced technologies such as robotics and artificial intelligence (AI). • Implement incentive schemes for households and businesses that effectively segregate their waste.
DOWNSTREAM (Recovery & Recycling)	Encourage the development of low-cost recycling and recovery processes: • Provide grants or subsidies to finance communities or the informal sector in operating "low-tech" sorting and recycling facilities, and particularly facilities that can handle low-value and hard-to-recycle plastic. • Provide financial and technical support for establishing local recycling facilities.	Focus on advanced recycling technologies and the development of markets for recycled products: • Support advanced sorting and mechanical and chemical recycling facilities. • Create policies that promote the market for recycled materials such as mandatory recycled content in certain products.
CROSS-CUTTING (Transparency & Accountability)	• Implement digital systems for tracking waste flows and improving data collection to support evidence-based policymaking. • Mandate public reporting on waste management by businesses that generate waste.	• Implement blockchain technology for tracking and verifying nascent SWM practices. • Foster international partnerships and adopting regional and global SWM best practices and standards.

Source: The World Bank Group

The ecosystem for plastic circularity innovations is still at an early stage of development in the ASEAN Region. Innovations must overcome three main hurdles to attract investment and scale:

- **Lack of policy and financial incentives:** The lack of supportive policies and the inconsistency in the enforcement of existing policies all work against innovations for businesses that are trying to reduce plastic waste. They also can disincentivize investors from committing capital to finance innovations.
- **Lack of organizational capacity:** Early-stage innovations are vulnerable to market and policy pressures across the plastic value chain. They may suffer from a weak business model, an unclear product-market fit, lack of access to partnerships/networks, inexperienced leadership, and more.
- **Limited access to capital:** The investment ecosystem is immature. This means that innovations lack access to investors or businesses with innovations are not ready to seek funding. In some of the AMS, investment

capital is also lacking. Technology-driven solutions are the most likely to attract private investors while other types of innovations have less financing opportunities.

Scaling up plastic circularity in the ASEAN Region requires identifying and supporting innovations that address critical gaps in plastic waste management infrastructure and technology. Innovations in the ASEAN Region have had limited ability to scale across the four development stages of the plastic value chain. Given the extensive leakage of plastic waste in the region, the urgent focus should be on midstream innovations, with complementary and progressive focus on other stages of the plastic value chain. Based on the current stage of SWM and plastic waste management in the six AMS, the following policy levers are needed to stimulate the growth of innovation.

Scaling Innovations by Stage

According to the typology for the six AMS and the status of their SWM development and capacity, they should focus on leveraging additional sources of financing to support the scaling of plastic circularity innovations to improve plastic and SWM. Each country's approach will be unique as it evolves with the development of its SWM capabilities and adapts to the challenges in its environment (see Table ES.2).

Developing Policies and Financial Incentives for Plastic Circularity Innovations

This requires analyzing the causes of institutional failures and policy gaps in solid and plastic waste management, and identifying which regulations and financial incentives are needed across the plastic value chain to support creating markets for plastic circularity innovations. The following policy recommendations are based on this study's preliminary analysis; however, further analysis should be carried out at the country level to assess the efficiency and effectiveness of these policies.

Policy and Institutional Gaps to Address Market Failures: Based on the stages of SWM development in the six AMS, policies and practices concerning solid and plastic waste management need to progress from a nascent ecosystem to an emerging one (see Table ES.2.). Tailored innovation-related policies are crucial for both nascent and emerging SWM ecosystems so that they address the challenges to circularity along the plastic value chain. These policies should focus strategically on the different stages of the plastic value chain.

Financial Incentives to Address Market Failures: As plastic products have traditionally been overused and underpriced, and they have negative impacts, financial incentives are needed to encourage the development of plastic circularity-related innovations.

Table ES.2. Prioritization of innovation across the plastic value chain in the six AMS

STAGES	NASCENT ECOSYSTEM	SMALL ISLANDS	EMERGING ECOSYSTEM
Upstream: Source Reduction	++	+++	++
Midstream: Collection & Segregation	+++	+++	++
Downstream: Recovery & Recycling	+++	+++	+++
Cross-cutting: Transparency & Accountability	++	++	+++

Note: + designates the level of importance: ++ important; +++ critical.

Source: The World Bank Group

Creating Market Demand: Shifting from a linear to a circular plastic products' economy in the six AMS will require the harmonization of their regulatory frameworks, and strategically directing them toward creating a market for plastic circularity. This comprises formulating policies to reduce SUPs, incentivizing the adoption of recycled materials, implementing GPPP that will boost demand from the public sector, and developing and enforcing legislation that extends producers' responsibility across their products' entire lifespan. There are two fundamental approaches for accelerating market demand: (i) enforcing regulations; and (ii) advocacy from prominent stakeholders.

Developing Public Awareness: In all six AMS, this study found that consumers' awareness was relatively low. Thus, effective public awareness campaigns are needed to address a number of plastic waste-related issues, including reducing the demand for virgin plastic, encouraging the demand for alternatives to plastic, and encouraging the segregation of waste at its source. Part of building the market for plastic circularity innovations requires accelerating demand for recycled plastic products and alternatives to plastic products. Stimulating demand from large-scale consumers such as governments, universities, corporations, hotels, and so on, could rapidly increase demand for upstream plastic alternatives and downstream source segregation.

Direct Support to Plastic Circularity Innovators

This could be achieved by addressing two of the three major hurdles across the plastic value chain: lack of organizational capacity and limited access to capital to support innovations in plastic circularity.

Building Organizational Capacity: Enterprise support organizations (ESOs) could provide direct support for plastic circularity start-ups and be instrumental in addressing the rapidly growing challenge of plastic waste management in the six AMS. The ESO innovation ecosystem is more robust in Indonesia, the Philippines, Thailand, and Vietnam than in Malaysia and Cambodia, where little support is available for entrepreneurs. ESOs can catalyze and sustain innovations in plastic circularity because their comprehensive approach, which encompasses technical support, funding, policy advocacy, and stakeholder collaboration, contributes to transforming the plastic value chain into one that is more circular and sustainable.

Accessing Finance: If the six AMS are to encourage investment, innovative financial mechanisms and borrowing terms must be developed to bridge the financing gaps in the innovation ecosystem. Across the lifetime of innovations, different financing pools are needed, which range from small grants at the concept development stage of innovations to more complex types of government and commercial funding. Impact funds and venture capital firms specializing in debt financing could offer viable solutions for growth-stage innovative plastic circularity businesses in the ASEAN Region.

Strengthening Regional Cooperation

Cooperation at the ASEAN regional level could provide larger and stable markets for innovations. This study's recommendations for the regional level comprise: (i) pooling knowledge and best practices to speed up the adoption and replication of plastic circularity innovations; (ii) standardizing practices, requirements, and regulations across the region so that businesses can operate more easily in multiple countries; (iii) collecting and harmonizing publicly available data; and (iv) providing financing.

Since 2022, the Intergovernmental Negotiating Committee on Plastic Pollution has been developing an international, legally binding document on plastic pollution that will be completed by the end of 2024. Regionally, financing incentives could be strengthened and leveraged through a platform that is managed by a qualified financial intermediary. This platform could offer both specialized technical assistance and financial resources to start-up/early-stage companies, as well as to later-stage ones.

By championing a full suite of policies, from strict waste management protocols to incentives for green entrepreneurship, to consumer education campaigns, the six AMS could set new benchmarks in plastic waste management. Also, these important actions in the six ASM could provide successful, replicable models for how to address plastic pollution, globally.

Conclusion

The severity of the plastic waste challenge within the ASEAN Region has escalated to a critical point that requires a comprehensive and strategic set of responses, including leveraging innovations. The complexity of plastic pollution and leakage into the environment, and its negative impacts on health and biodiversity, require that all stakeholders work together—from the policymakers developing and enacting legislation, to the entrepreneurs who are driving innovation, to the consumers whose choices are shaping market demand. Pending further development of SWM infrastructure and improving SWM services, midstream innovations could assist in filling the current critical gaps in plastic waste management related to collection and recovery, and catalyze the transition toward plastic circularity.

By championing a full suite of policies, from strict waste management protocols to incentives for green entrepreneurship, to consumer education campaigns, the six AMS could set new benchmarks in plastic waste management. Also, these important actions in the six ASM could provide successful, replicable models for how to address plastic pollution, globally.

To build on the insights provided in this paper, the study team recommends that a more in-depth examination of innovations be undertaken for each country in the ASEAN region. This could be carried out through country-specific innovation mapping, which would involve examining innovation-related policies, industry-specific initiatives, financial and other incentives, and the support structures that foster innovation. By examining these aspects, a more complete and nuanced view of the ASEAN innovation ecosystem could be obtained, which would inform the development of strategies and recommendations that are tailored to each country's innovation landscape.

Furthermore, in a future study, the transfer of technologies and the adoption of innovations from other countries could be explored, including innovative business models that are both viable and scalable. In this regard, valuable insights and experiences could be gained from countries with established track records, and this should include both developed countries (North-South transfer) and developing countries (South-South collaboration). Cross-border knowledge exchange and technology transfer also have the potential to significantly enhance innovations and their sustainability across the ASEAN Region.

CHAPTER 1.
Introduction

1.1. Background and Objectives

The Association of Southeast Asian Nations (ASEAN) Member States (AMS) face serious plastic waste management challenges. As solid waste management (SWM) infrastructure, services, and plastic waste management are interlinked, poor SWM has resulted in the limited recovery of plastic waste, with an estimated 80 percent of it leaking into the environment. Of the world's top 10 rivers that are known to convey the largest amount of plastic waste to the ocean, eight are in the AMS.[13] In 2021, approximately 8.4 million metric tons of mismanaged plastic waste were generated by just six AMS,[14] and if the current level of plastic waste mismanagement continues, the volume of plastic waste flowing into the ocean will rise from 11 to 29 million metric tons per year by 2040.[15] The negative impacts of plastic waste mismanagement are far-reaching as they increase air and water pollution, reduce biodiversity, and affect human health and wellbeing.

For the period from 2022 to 2030, the estimated environmental, health, and economic costs of mismanaging plastic waste are over $100 billion per year,[16] which underscores the urgency of solving the plastic waste problem. Also, the failure to properly treat a high percentage of plastic waste is the significant loss of a resource that could be recovered and reused. In most of the six AMS, plastic recycling is a budding industry that could conserve resources and reduce reliance on

13 Meijer et al. 2019. "Over 1000 rivers accountable for 80% of global riverine plastic emissions into the ocean."
14 Cambodia, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam.
15 The Pew Charitable Trusts and Systemiq. 2020. "Breaking the Plastic Wave."
16 Minderoo Foundation. 2022. "The price of plastic pollution: social costs and corporate liabilities."

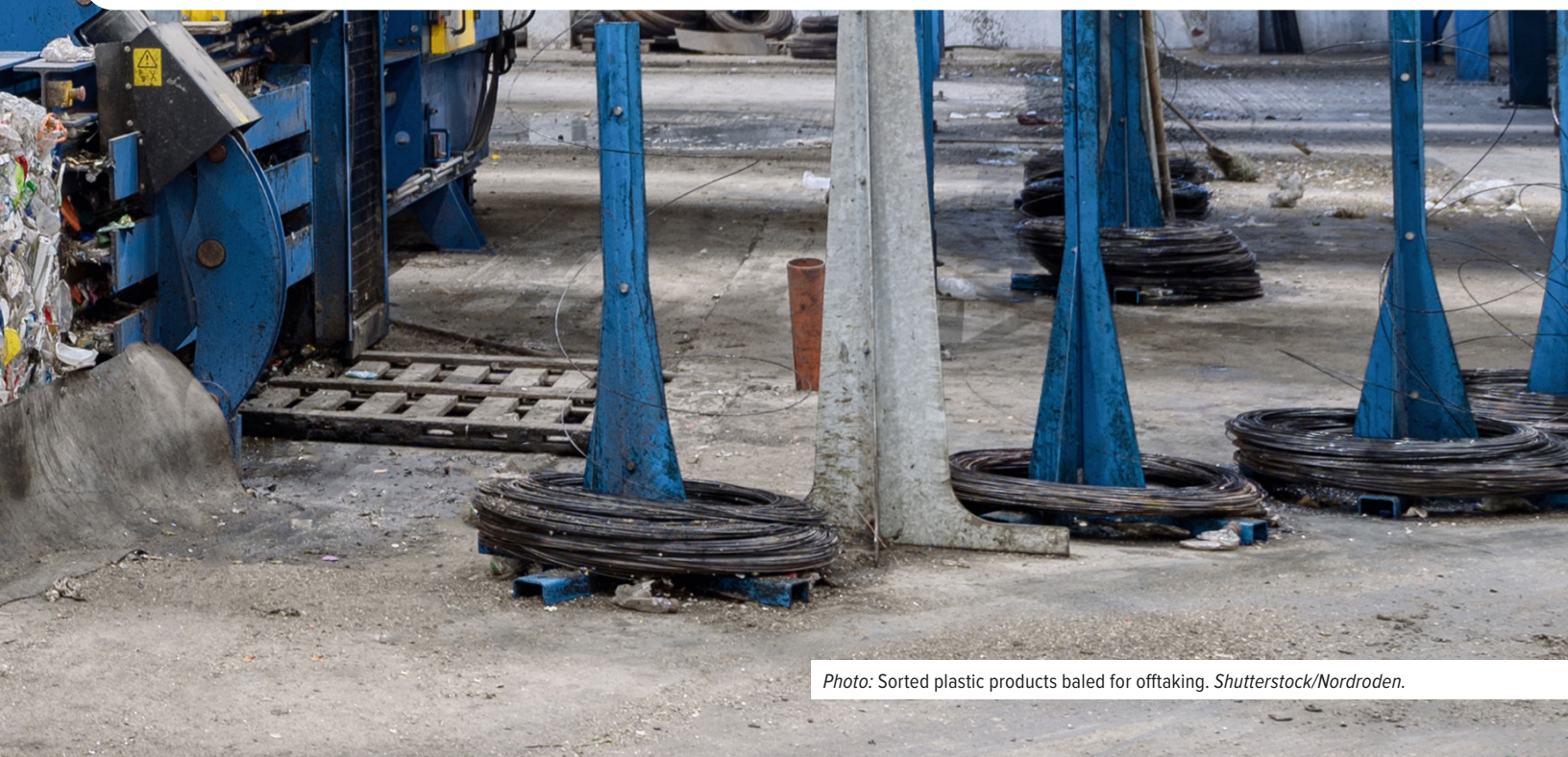
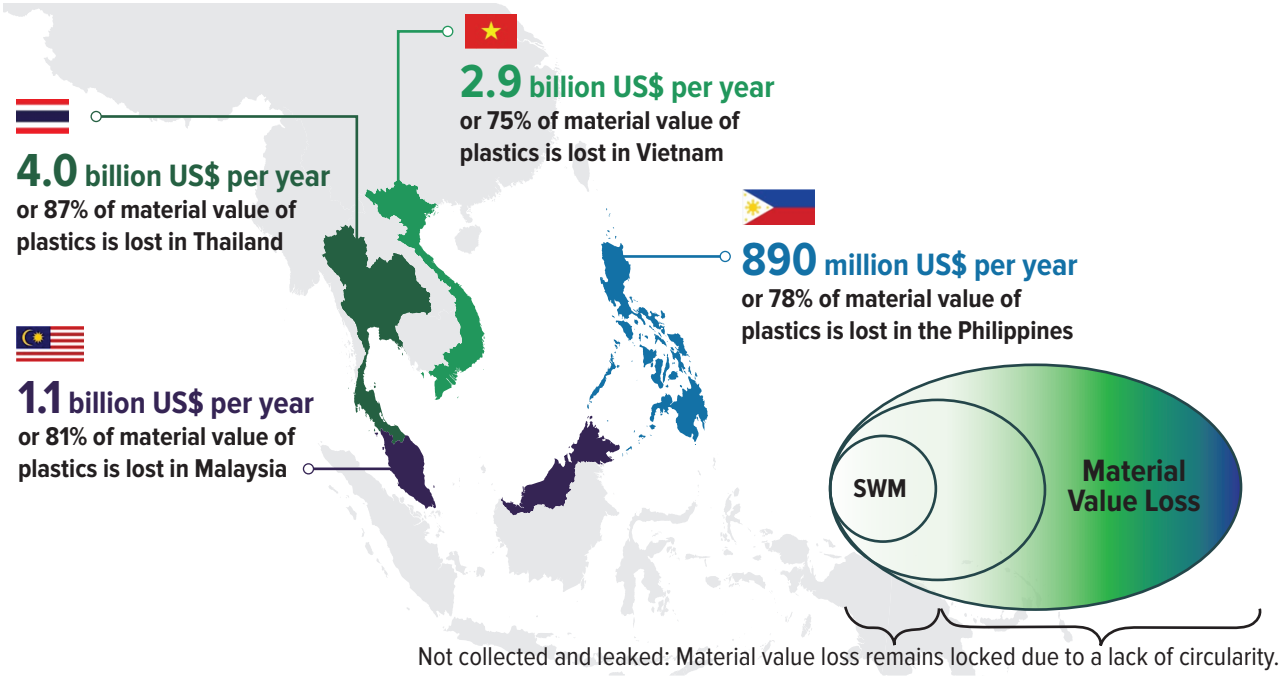


Photo: Sorted plastic products baled for offtaking. *Shutterstock/Nordroden.*

Figure 1. Losses of Recyclable Material Value in Four ASEAN Member States



Source: The World Bank Group

virgin plastic, while also creating a circular economy that fosters economic green growth and creates green jobs.[17] The potential value of plastic recycling in the ASEAN Region is considerable—an estimated $8.9 billion is lost by four AMS each year due to their failure to recover an estimated 80 percent of the material value of their plastic waste (Figure 1).[18] This failure demonstrates that these countries face considerable challenges in collecting, sorting, and recycling plastic waste.

Since SWM challenges in the AMS are significant, innovation could be catalytic to fast-track solutions to addressing plastic pollution. Innovative approaches are crucial for addressing the solid and plastic waste management problems that are due to the significant lack of infrastructure and services, inadequate regulations, and poor enforcement of the regulations that are already in place. However, it will take substantial funding, time, and effort to solve these problems. Financially supporting innovative new businesses that prevent plastic waste, recycle it, or use new materials to create useful products, could be instrumental in turning the tide on plastic pollution in the AMS.

This study presents best practices for developing innovations, providing policy support, providing innovations targeting plastic circularity with investment capital, and highlighting innovative enterprises from Korea and a selection of other countries that have focused on reducing plastic pollution.[19] This paper acknowledges that although there are deficiencies in solid and plastic waste management in the six AMS, innovations have a role to play in overcoming such shortcomings and helping address the ASEAN Region's solid and plastic waste problem.

17 Green growth refers to a sustainable development strategy to foster economic growth while minimizing environmental degradation and enhancing social inclusiveness. It involves policies and initiatives that promote resource efficiency, reduce greenhouse gas emissions, and encourage the adoption of clean technologies and renewable energy sources.

18 World Bank. 2021b. "Market Study for the Philippines, Malaysia and Vietnam: Plastics Circularity Opportunities and Barriers."

19 World Bank. 2024. "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions: Supplementary Note for Scaling Innovations for Plastic Circularity with Investment in ASEAN."

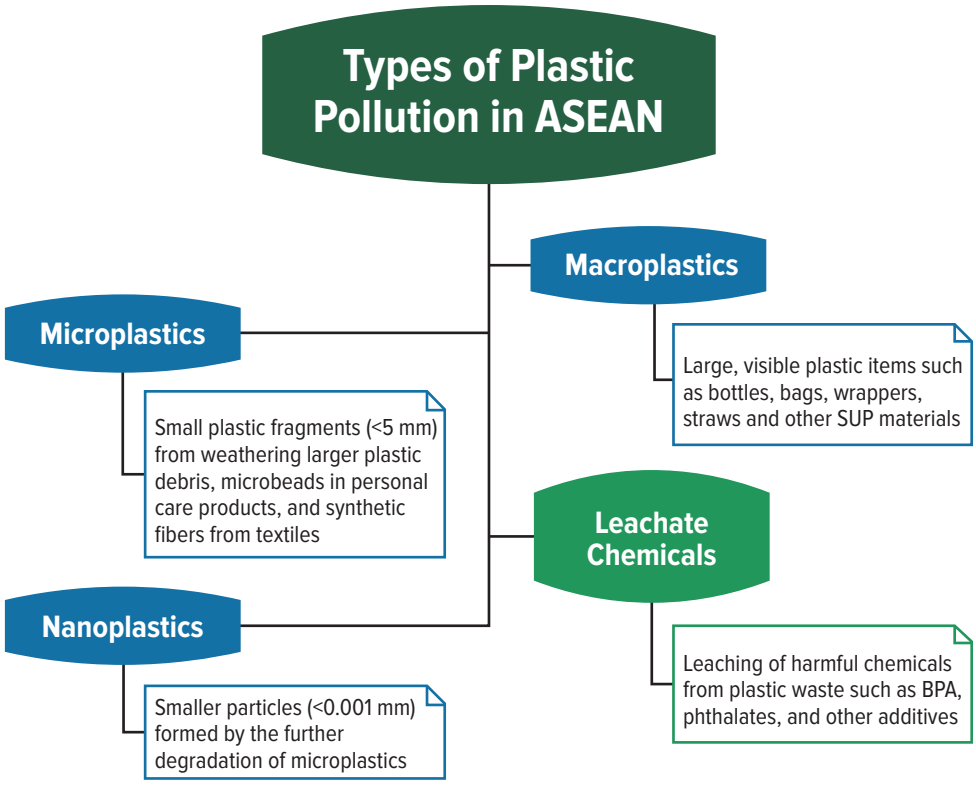
1.2. Plastic Pollution in the ASEAN Region

The rapid rise in the consumption of plastic products across the world has resulted in plastic waste becoming one of the most pervasive and pressing global ecological challenges. In countries in the ASEAN Region, the plastic pollution problem is enormous and it is growing rapidly from the sources that are presented in Figure 2

In the ASEAN Region, 75 percent of marine plastic pollution comes from uncollected, land-based waste, and about 25 percent leaks from municipal solid waste systems.[20] Cities generate as much as 60 percent of the plastic waste that leaks into an AMS environment.[21] The lack of efficient solid waste infrastructure, rapid urbanization, and growing consumption of plastic products, especially SUPs, all contribute to the problem of plastic waste pollution in the AMS.[22] Not only does this plastic pollution significantly threaten human health and the natural environment, it has economic consequences, such as the adverse impact on fisheries and tourism, and strain on the government's budget to pay for pollution-related cleanups, remediation, and healthcare, which all divert funding from other crucial development initiatives.

Addressing plastic pollution in the six AMS requires a comprehensive and multi-pronged approach. This study, which focuses on the role of innovations in addressing the plastic waste issue, defines innovation and investment, as follows:

Figure 2. Types of Plastic Pollution in the ASEAN Region



BPA = bisphenol A; SUP = single-use plastic.

Source: The World Bank Group

20 UN-ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2020. *Closing the Loop.*

21 Ibid.

22 Van Trotsenburg and Hoi. 2022. "Turning the tide on plastic pollution through regional collaboration in Southeast Asia."

- Innovations comprise technologies, materials, or business approaches that are novel in the six AMS, and address pollution-related challenges along the plastic value chain. However, it is important to note that the innovations in plastic waste management that are discussed in this paper have not been tested nor vetted. Thus, the innovations that are presented here are for information only, and this paper does not constitute an endorsement of their effectiveness.
- Investment refers to the allocation of financial resources with the expectation of generating a financial return. Financial instruments include grants; equity/quasi-equity; debt; and guarantees provided through different approaches such as blended finance, public-private partnerships (PPPs), and so on.

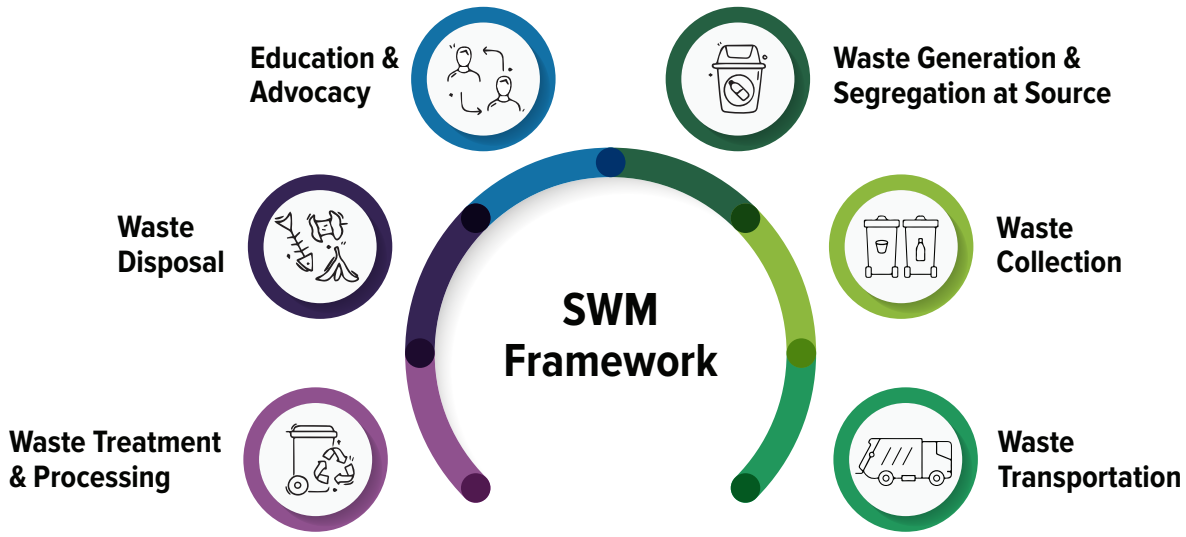
1.3. Innovation and Plastic Waste Management

Each of the six AMS offers a unique context for adopting plastic waste innovations, which can only be successfully integrated if solid waste management, overall, is taken into consideration. Also, innovations should be carefully selected and comprehensively evaluated to ensure that their technology is appropriate and reliable, and that their workers have safe and fair working conditions. Thus, introducing innovations requires a multi-pronged approach that necessitates the cooperation of multiple stakeholders who are committed to carrying out strategic interventions to improve plastic waste management and, therefore, solid waste management, overall. The SWM framework typically comprises the key elements presented in Figure 3, which shows where innovations could be introduced to support improving plastic waste management.

As noted previously, improving plastic waste management must be an integral part of improving SWM. Effective plastic waste management requires a solid policy framework, robust infrastructure, and the active participation of all stakeholders. Lastly, plastic waste management requires a similar framework to SWM that focuses on:

- **Source Reduction:** Practices and strategies to reduce the volume of plastic waste that consumers generate.
- **Collection and Segregation:** An efficient system of plastic waste collection, with the segregation of plastic waste at its source into recyclables, non-recyclables, and biodegradables for easier processing downstream.

Figure 3. Solid Waste Management Framework to Support Innovation



Source: The World Bank Group

- **Recycling:** Conversion of plastic waste into reusable materials through various technologies and processes.

With effective plastic waste management, advances can be made toward plastic circularity, which is an approach that minimizes waste and extends the life of plastic products and packaging. This approach contrasts with the traditional linear one of "take, make, and dispose," and it requires a shift in thinking about the plastic value chain, as well as the collaboration of all the key stakeholders—consumers, manufacturers, waste management services, and policymakers. Critical aspects of plastic circularity comprise:

- Design: Plastic products and packing are designed for durability, reuse, and recyclability.
- Use and Reuse: Plastic products and packaging are used and reused to extend their lifespan.
- Recycling: At their end-of-use stage, plastic products and packaging are collected and recycled.
- Infrastructure Development: Robust infrastructure is developed to facilitate plastic waste collection, sorting, and recycling.
- Policy and Regulation: Strong policies and regulatory frameworks are developed and enforced to support plastic circularity.
- Consumer Education and Engagement: Consumers are educated about the importance of plastic circularity and their role in plastic waste management.

The key success factors for plastic waste management are appropriate policies; effective waste collection systems; segregation of waste at source; advanced recycling and processing technologies; developing the market for recycled materials; and raising consumers' awareness and their participation in recycling programs. In addition, to advance toward circularity, a shift toward the use of plastic alternatives and an overall reduction in the use of plastic products are both needed. In all these areas, innovations can provide catalytic support.

The AMS have been carrying out important measures to stop the leakage of plastic waste into the ocean. In 2021, the AMS developed its ambitious "ASEAN Regional Action Plan (RAP) for Combating Marine Debris in the AMS (2021–2025),"[23] which recommends policy reforms, research, innovation, raising public awareness, building capacity, and engaging the private sector in promoting the circular economy. One of the key components of the RAP is Research, Innovation, and Capacity-building, which prioritizes the "establishment of Regional Platforms to Promote Innovations, Knowledge, and Partnerships for Plastics Circularity."

Target Audience: The target audience for this paper is the AMS. It is intended to help these countries take stock of the current innovation ecosystem supporting plastic circularity; the gaps preventing the ecosystem from scaling up, especially those related to policy and investment; and the steps necessary to encourage the provision of additional investment capital through improving policies, building innovators' capacity, and developing the knowledge of consumers, investors, policymakers, and entrepreneurs. The activities summarized in this paper could support implementation of the RAP, and more specifically, the design of a platform for the six AMS that supports alternatives to plastics, as well as innovations and investments in plastic waste management.

1.4. Methodology

The methodology for this study comprised three interlinked steps: (i) a review of published information, (ii) an assessment of innovations, and (iii) stakeholder consultations.

A desk review of more than 150 published sources, including some from the World Bank Group, was carried out for this study, which focused on:

- **Waste and Plastic Waste Management in the Six AMS:** Published information on waste and plastic waste management systems in the six AMS that provided baseline data on the critical waste types and materials that are most mismanaged (see Figure 2.). This review also offered insights into the country-level context for

23 ASEAN. 2021a. "ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States."

innovation, including SWM collection and recycling infrastructure, local end markets for plastics, national and sub-national policies, and the ASEAN Region's entrepreneurial support ecosystem.

- **Innovations – Collation, Categorization, and Mapping:** Innovations related to plastics and plastic waste were sourced from the multiple innovation challenges that have been run by the World Economic Forum's UpLink Platform; the Living Landscape of Reuse Solutions database; the Incubator Network; and innovations that were recommended by participants in the stakeholder consultations (see Section 1.5). Selecting from the three databases offered a practical approach for identifying innovations in the ASEAN Region. By registering to participate in an innovation challenge, innovators indicated their desire to attract more capital and scale.[24] Of 302 innovations related to plastic waste, 262 were assessed based on the adequacy of the data and information provided on them. These were grouped according to the four stages of development along the plastic value chain (see Chapter 3 and Figure 6), and this was determined by the nature of the innovation. This analysis used data provided in the three databases discussed above, and it was supplemented, wherever possible, with a review of relevant resources that were available online or published. This information commonly identifies the type of business, its country of origin, or where it is operating, and details about funders and partners. Although almost two-thirds (62 percent) of the innovations reviewed in this study were operating in the AMS, to provide a broader spectrum of plastic innovations, it was important to include innovations from outside the ASEAN Region, especially from South Asia (21 percent), other developing countries (3 percent) with similar types of plastic and SWM issues, and Western countries (9 percent) that have innovations in alternative materials and in digitalization—both of which are lagging in the six AMS.
- **Policies that Support Innovations and Investments in Plastic Circularity:** Policies that currently influence innovations, and potentially encourage or support investments in innovations in plastic circularity were part of this study's desk review (see Chapter 4). This included a broad, non-exhaustive review of policies related to SMEs and early-stage start-ups in the six AMS, as well as policies from other countries to see if they could provide lessons learned for the six AMS.
- **Investments in Plastic Waste Management, Recycling, and Circularity:** As the focus of this study was on identifying investments and potential investors in plastic circularity innovations, a comprehensive review of the investment ecosystem was undertaken (see Chapter 5). This part of the desk review focused on trends in investment, identification of key investor groups, key investors' previous and current investments in plastic circularity in the six AMS, and the financing tools available for supporting plastic circularity innovations.
- **Identification of Key Stakeholders:** The desk review identified potential stakeholders to participate in this study's consultations. These comprised consumers, innovators, investors, policymakers, and other relevant ecosystem participants (see Section 1.4).

1.4.1. Limitations of the Methodology

The results presented in this paper were affected by the following limitations:

- *Selection of innovations:* The selection of innovations from the three databases provided a practical approach for identifying innovations in the ASEAN Region. By registering to participate in a relevant innovation challenge, an accelerator, and/or an incubation program, these innovations indicated their desire to attract more capital and scale.[25] However, engaging with these AMS entrepreneurs face-to-face, in their country, was not possible, as this would have required more funding than what was available for this study.
- *Evaluation of innovations:* The evaluation of innovations was constrained by the scarcity of data. For example,

24 Note—innovations that were entirely financed by the owner were excluded from this study.

25 Innovation challenges, accelerators, and incubation programs typically offer mentoring by experts; and access to training, networking opportunities, and, sometimes, grants, or prize money (usually below $100,000).

evaluating a business model's level of robustness required accessing its financial information or other disclosures, which were not always available. Also, the status of innovations may have changed since they were evaluated in 2022. In addition, as quantitative data were not always available or adequate, sometimes evaluations were based on the authors' judgment.

- *Qualitative nature of the evaluation:* A detailed quantitative or formula-driven approach to reviewing innovations was not always possible, given the limited available data. Thus, assessing innovations required an extensive literature review and multiple stakeholder consultations.
- *Stakeholder consultations:* This study's stakeholder consultations took place during the 7th International Marine Debris Conference (7IMDC), which was held in Busan, Korea, in September 2022. Because the stakeholder consultations were limited to this conference, plus some follow-up phone interviews, some key stakeholders who could have contributed information on innovations or investments in plastic circularity may have been missed as they did not attend the 7IMDC. Also, consumers, the informal sector, and other key non-waste actors who were not consulted in this study due to funding constraints, should be consulted in future studies on plastic circularity.
- *Policy environment:* The policy environment and the ensuing recommendations in this study were sorted and categorized according to their country profile and typology, as well as the stage of innovation along the plastic value chain. This study was a first attempt to define the policy and regulatory ecosystems for plastic circularity innovations in the ASEAN Region, and, ideally, its policy recommendations and suggestions about various incentives to scale plastic circularity innovations with investment will provide a foundation for conducting future analytical work.

1.5. Stakeholder Consultations

Interviewees from 37 stakeholder groups involved in the plastic waste ecosystem were consulted for this study. These interviewees were drawn from incubators, accelerators, ESOs, investors, philanthropists, corporations, ministries, civil society organizations, consumers, and other entities that are currently contributing to tackling the plastic pollution challenge in the six AMS. The topics discussed in the interviews included the current range, and the state of the innovations tackling the plastic waste challenge; innovations' stage of development; trends in investments in plastic circularity solutions; barriers to the growth of innovations and attracting investment; and how to overcome these barriers.

Several one-on-one interviews were conducted during 7IMDC as well as later over the phone. The conference participants who were interviewed, as well as the other interviewees, are listed in Appendix 3.

Box 1.

Stakeholder Consultations during the 7th International Marine Debris Conference (7IMDC)

A panel discussion for this study was held during the 7IMDC on September 20, 2022, with representatives from the Commonwealth Scientific and Industrial Research Organisation, Australia; Ministry of Natural Resources and Environment, Thailand; Center for Southeast Asian Studies; University of Kyonggi, Korea; Philippine Alliance for Recycling and Material Sustainability; and Alliance to End Plastic Waste. The panel members discussed challenges, existing practices, and regional plastic innovation ecosystem opportunities. These discussions shed light on business models and the level of investment needed to scale innovations, and they also highlighted enabling policies that could further catalyze investments in plastic innovations in the AMS.

CHAPTER 2.

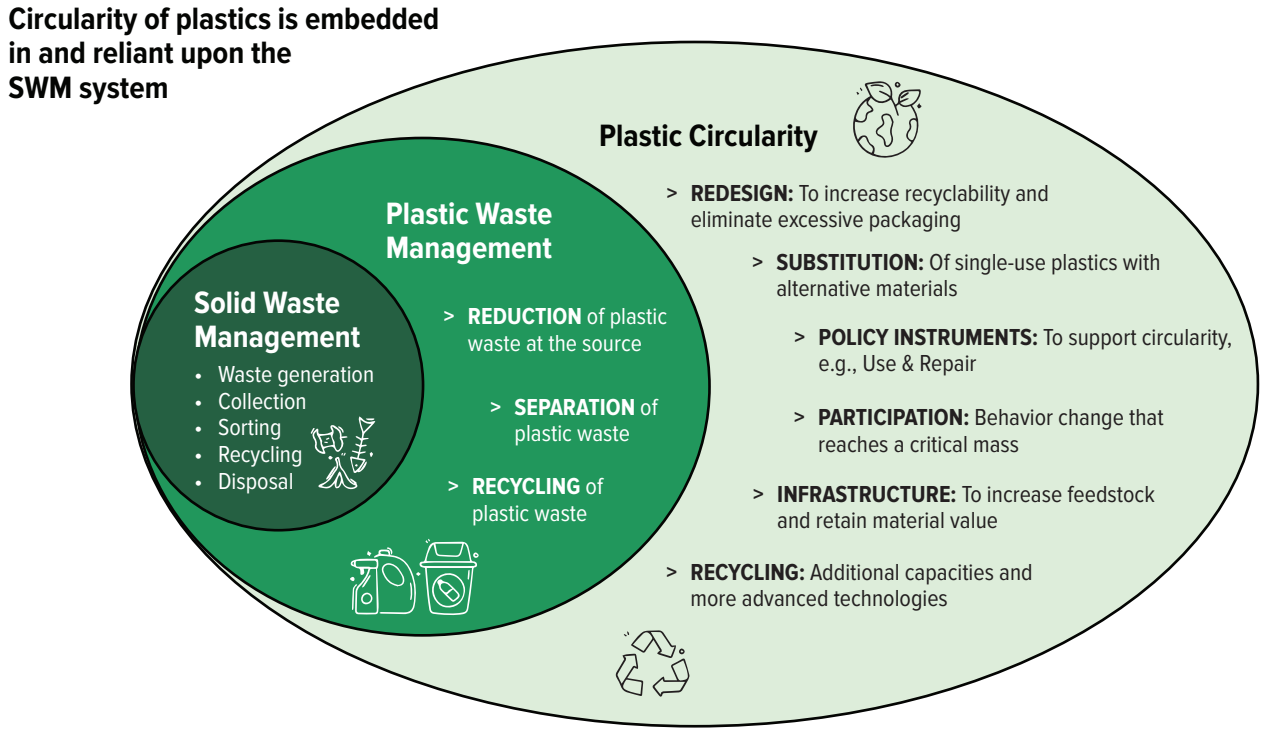
Overview of the Waste Management Ecosystem and the Key Plastic Waste Types in the Six AMS

2.1. Evaluation Parameters for Waste Management, Recycling, and Plastic Circularity in the Six AMS

As indicated in Figure 4, SWM is an integral part of plastic waste management, and the key elements of SWM such as collection, sorting, recycling, and final disposal can be geared toward managing plastic waste to improve recycling and optimizing disposal. This, in turn, creates an opportunity for innovations in plastic circularity through (i) source reduction, (ii) collection and segregation at source, and (iii) recycling.

Photo: A man recycles a plastic bottle using a reverse vending machine. *iStock/ LordHenriVoton.*

Figure 4. Elements of Plastic Circularity (Plastic Waste Management within Solid Waste Management)



Source: The World Bank Group

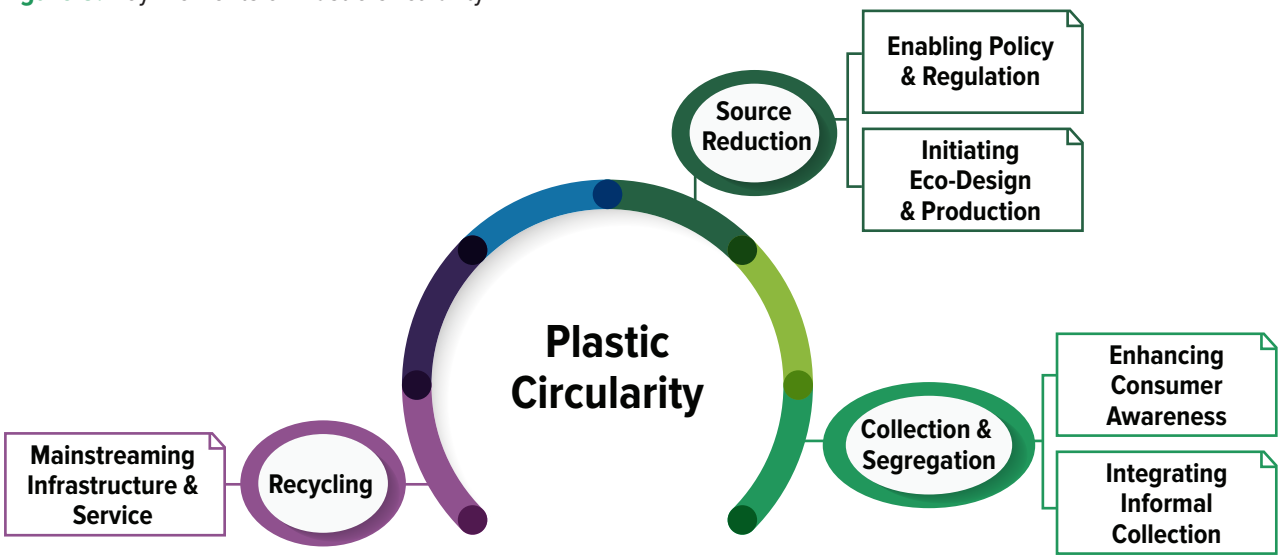
Fully integrating SWM in the six AMS would initiate and mainstream the key elements needed to support: improving and enhancing source reduction, waste collection and segregation, and recycling; preventing plastic waste leakage; and enabling plastic circularity innovations to take hold and scale. By identifying their country's relative strengths and weaknesses, the six AMS should be able to identify gaps and continuously improve and integrate innovations that are appropriate for the local context and culture.

2.2. The Country-specific Status of SWM, Recycling, and Plastic Circularity in the Six AMS

The following section presents a qualitative assessment of current conditions in the six AMS regarding the key elements of plastic circularity (see Figure 5). This analysis assumes that the capacity to design, build, and maintain innovations to tackle plastic waste pollution varies in each of the six AMS. Detailed country profiles on the level of development of SWM, and the key elements of plastic circularity, are summarized in Tables 1 and 2, with additional information provided in Appendix 1.

- **Nascent Ecosystem** (see Table 1): In Cambodia, Indonesia, and the Philippines, the nascent plastic waste ecosystem is characterized by: a poorly developed SWM policy framework; lack of enforcement of SWM regulations; limited or no waste segregation at source; poor collection systems, which results in a low collection ratio; major gaps in sorting, recovery, recycling, and disposal infrastructure; a strong autonomous informal sector; and no ecosystem support or economic incentives for plastic circularity. Cambodia's policies prioritize basic waste collection and segregation at source, better SWM, and developing infrastructure that will carry out more effective recycling. Policies that restrict the use of SUPs such as plastic bags and straws are being planned, and policies are being considered for a deposit-return systems (DRS) for bottles and implementing fines for improper SWM practices. In Indonesia, 57 percent of

Figure 5. Key Elements of Plastic Circularity



Source: The World Bank Group

all the solid waste is plastic packaging; more than 60 percent is not collected; and there is no end market for recycled plastics. Plastic packaging is also a major issue in the Philippines, where about 70 percent of packaging waste in not properly disposed of and leaks into the environment. An important characteristic of SWM in the Philippines is that awareness about plastic pollution is relatively high, and although efforts to innovate are still at an early stage, they are actively underway. In all countries leakage plastic waste is significant and informal workers form a key part of waste management.

- **Emerging Ecosystem** (see Table 2): In Malaysia, Thailand, and Vietnam, which have an emerging plastic waste ecosystem, improving management is a priority; there is an emerging regulatory framework that provides incentives for plastics reuse and SUPs' restriction; collection systems and recycling facilities are in place in major urban centers; and behavior change campaigns have educated consumers to segregate waste at its source, as well as reuse plastic products and packaging.

  To some extent, as a result of some innovation ecosystem support, innovations in recycling and recovery are available in these three countries. However, these countries continue to experience high rates of plastic packaging mismanagement, which is the most common type of plastic leaking into the environment. In Malaysia, despite strong local need, eco-designs and production are scarce, so efforts are required to promote these in line with planned policies. Thailand is conducting early-stage attempts to develop eco-designs and production, and the government is supporting alternative plastic technologies that use natural materials. In Vietnam, the government-driven plastic circulation hub (see Table 2) benefits from well-organized international support. Given the involvement of Vietnamese SMEs in global supply chains, enhancing eco-design and production efforts to navigate future trade barriers is essential. In Thailand, outside the capital, innovations that increase the rates of segregation, collection, and recycling should be prioritized due to the limited infrastructure. Given the large informal sector, which is primarily focused on PET bottles, options such as promoting the use of plastic bottles without labels would make recycling PET easier and support innovations in recycling. As in other countries, the low rates of segregation, collection, and recycling impede the development of midstream and downstream innovations.

- **The island nations of Indonesia and the Philippines** have unique SWM challenges and, consequently, require smaller-scale SWM solutions as island communities have limited funding, resources, and SWM expertise. Given the islands' high levels of mismanaged waste

and plastic leakage, innovations such as distributed recovery models are suited to their low waste volumes, mix of materials, and limited SWM capabilities.[26] A World Bank study undertaken in 2022 found that small and remote islands carry out no recycling, and they either deposit their plastic waste in a landfill or burn it.[27] Small islands are particularly vulnerable to plastic waste problems due to their high coastline-to-area ratio and their reliance on the fishing and tourism sectors, which both generate plastic waste.

The Supplementary Note for this paper, which is based on Korea's experience,[28] and the various examples within and outside the ASEAN Region that are presented in boxes in this paper, provide examples for the six AMS to use in addressing their identified gaps.

Table 1. Nascent Ecosystem: Cambodia, Indonesia, and the Philippines

STAGE	CAMBODIA	INDONESIA	THE PHILIPPINES
SOURCE REDUCTION (Policies & Regulations, and Eco-design & Production)	**Context for Plastic Waste Management:** Cambodia generates 4 million tons of waste, annually, and 20 percent leaks into the environment. Plastic packaging—mainly PP, HDPE, LDPE, and PET—could be better managed. Around 10 million plastic bags are used daily, in the capital, Phnom Penh. **Policies and Regulations Initiated:** Phnom Penh has updated its SWM regulations and waste service fees. **Eco-design and Production:** There is none. **Nascent ESO:** The Ministry of Environment, with the support of international agencies, runs innovation challenge competitions for start-ups. Cambodia faces many ecosystem challenges with regard to science; technology; governance; the large number of informal businesses; and the need for a more scientific and entrepreneurial culture, and more professional skills.	**Context for Plastic Waste Management:** Indonesia generates 7.8 million tons of plastic waste, annually, and 57 percent is plastic packaging. Over 60 percent of plastic waste is not collected, and rural areas lack SWM infrastructure and regulatory enforcement. Plastic bags, sachets, and SUPs are the primary plastic waste, but these have low value if they are recycled. PE, PP, and PS could be better managed since they are higher value materials for recycling. **Weak Implementation of Policies:** Targets and ambitious plans to improve SWM have been set, but these have weak implementation and enforcement. There are some voluntary EPR initiatives, and no tipping fees are charged for depositing waste in a SLF. Indonesia aims to divert 70 percent of its waste from landfills by 2025. **Eco-design and Production:** Indonesia has some alternatives to plastic and solutions to recycle sachets. It also has a plastic innovation hub that supports early-stage businesses that reduce, substitute, or redesign plastic products. **An Actively Engaged ESO:** NPAP, the Innovation Taskforce, OPPA, and ESOs support innovators and create market demand.	**Context for Plastic Waste Management:** Plastic packaging (LDPE, MLP, PET, PP, and HDPE) is the main pollution source. About 33 percent of plastic is disposed of, 35 percent leaks into the environment, 9 percent is recycled, 2 percent is recovered for RDF, and 5 percent is exported. **Policies and Regulations have Expanded:** SWM regulations have increased, including the new EPR Law for packaging, but regulations need better implementation and enforcement at the LGU level. **High Potential for Eco-design and Production:** DOST has developed technologies for plastic alternatives. Alternatives to plastics and the recycling of multilayered packaging and sachets better match the country's needs. **A well-organized ESO:** The government provides loans to innovators. Although the country has a strong plastic circularity network, a strong microfinance sector, and an established banking system, SMEs find it difficult to get commercial financing, and there is little investment in plastic waste-related businesses.

26 Distributed recovery models for plastic circularity typically involve decentralized systems that integrate various recovery methods. These models optimize resource utilization, minimize transportation costs, and enhance the resilience of communities, while also fostering a circular approach.

27 World Bank. 2022b. "Technologies and Solutions to Manage Plastic Waste in Small and Remote Islands."

28 World Bank. 2024. "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions: Supplementary Note for Scaling Innovations for Plastic Circularity with Investment in ASEAN."

Fully integrating SWM in the six AMS would initiate and mainstream the key elements needed to support: improving and enhancing source reduction, waste collection and segregation, and recycling; preventing plastic waste leakage; and enabling plastic circularity innovations to take hold and scale.

STAGE	CAMBODIA	INDONESIA	THE PHILIPPINES
COLLECTION & SEGREGATION (Consumer Awareness, Informal Collectors)	**Good Collection Ratio:** Waste collection is 86 percent in cities, and 72 percent nationally. Large cities have formal private SWM collection businesses, but municipalities lack a proper SWM system. **Segregation of Waste at Source is Not Enforced:** Since 2021, residents of Phnom Penh must segregate their wet and dry waste, however, this regulation is not enforced. **Consumers' Awareness is Limited:** In 2018, the government implemented a tax of $0.10 per plastic bag that is provided to consumers, however, due to lack of enforcement, consumers are largely unaware of the bag tax, and are not paying it. **Large Informal Sector:** An estimated 3,000 waste pickers collect and sell waste to buyers and recyclers.	**Improved Collection Ratio:** 60 percent of urban residents have access to collection; 55 percent of MSW is managed at a transfer facility; 85 percent of plastic waste in rural areas is collected; 11,330 regulated community-based waste banks operate and feed waste into recycling systems with PSP. The plastic waste collection rate is 39 percent. **Segregation of Waste at Source is not Enforced:** Most households segregate little solid waste, and instead burn it. **Consumer Awareness is Poor:** Given the low rate of plastic collection/ recycling, it is likely consumers are largely unaware of the plastic waste problem. **Large Informal Sector:** Indonesia has about 2 million informal waste collectors and recyclers, who focus on higher value materials such as PET bottles, as these have a market.	**Low Collection Ratio:** The SWM system is underdeveloped (about 40 percent of collection). The highest collection rates are in Metro Manila, and businesses have raised consumers' awareness about the importance of waste collection. **Segregation of Waste at Source is Not Enforced:** RA 9003 requires waste segregation at its source, but there is little enforcement across the LGUs. The 1996 Anti-littering Law needs to be better enforced. **Consumer Awareness is Driven by Businesses:** Various businesses are raising consumers' awareness about plastic pollution, driving behavior change, and reducing SUPs. **Large Informal Sector:** Informal collectors collect rigid PET and HDPE/ PP, and 84 percent of waste collectors sell post-consumer PET and HDPE/PP.
RECYCLING (Infrastructure & Services)	**Underdeveloped Infrastructure & Immature Recycling:** Cambodia has high rates of mismanaged waste, and a plastic recycling rate that is below 1 percent. According to stakeholder consultations, plastic recycling must be formalized as it is carried out with unregulated processes, outdated equipment, lack of knowledge, and poor environmental practices.	**Low Recycling Rate with Some Infrastructure:** The plastic recycling rate is about 10 percent, but this varies by region (Greater Jakarta = 17 percent; Bali = 7 percent). There is a relatively robust plastic recycling industry that processes PET, HDPE, PP, and LDPE. A combination of domestic and imported plastic waste provides the feedstock for this recycling.	**Low Recycling Rate with Limited Infrastructure:** The plastic recycling rate is 9 percent and focuses on high-value materials (rigid PET, PP, and HDPE). About 28 percent of PET, PP, HDPE, and LDPE/LLDPE was recycled in 2019. As hard-to-recycle plastic materials do not have a market, they end up in landfills or leak into the environment. The local recycling industry imports good quality plastic waste.

Notes: DOST = Department of Sciences and Technology; HDPE = high-density polyethylene; LDPE = low-density polyethylene; LGU = Local Government Unit; MLP = multilayered packaging; MoE = Ministry of Environment; MRF = material recovery facility; MSW = municipal solid waste; NPAP = National Plastic Action Partnership; NSWMC = National Solid Waste Management Commission; OPPA = Ocean Plastic Prevention Accelerator; PET = polyethylene terephthalate; PP = polypropylene; RDF = refuse dry fuel; SLF = sanitary landfill.

Source: The World Bank Group

Table 2. Emerging Ecosystem: Malaysia, Thailand, and Vietnam

STAGE	MALAYSIA	THAILAND	VIETNAM
SOURCE REDUCTION (Policies & Regulations, and Eco-design & Production)	**Context for Plastic Waste Management:** In Malaysia, alternative disposal methods are needed due to unsanitary landfills and waste leaking into the environment. SUP packaging is the main problem: plastic bags, containers, bottles, cups, and film. **Updated and Expanded Policies and Regulations:** Act 672 centralizes SWM under the federal government, and enforcement of the solid waste corporate policy varies: only eight states (out of 16) have adopted Act 672. EPR is a critical part of the *Malaysia Plastics Sustainability Roadmap 2021–2030*. Initially, EPR will be voluntary, but it will become mandatory by 2026. The Roadmap Towards Zero SUP 2018–2030 has been launched. **This is Little Eco-design and Production:** The *Malaysia Plastics Sustainability Roadmap 2021–2030*, has three innovation strategies: (i) phasing out some materials, (ii) reusing packaging, and (iii) improving collection. More support is required to promote plastic circularity. There are only a few examples of innovations for plastic circularity: Government and the private companies, Grab and KLEAN, operate reverse vending machines;[29] and SICA upcycles plastic waste.	**Context for Plastic Waste Management:** About 70 percent of Thailand's plastic waste is uncollected or mismanaged (for example, plastic bags, snack bags, food utensils, food packaging, and bottles). **The Implementation of Policies is Slowing Down:** Many of the agencies involved in SWM have policies that sometimes conflict. The *National Roadmap on Plastic Waste Management 2018–2030* bans some SUPs by 2022, and it requires the recycling of 100 percent of plastic waste by 2027. While government efforts are slow, retail groups are enforcing a partial plastic ban. **Eco-design and Production Have Begun:** The government supports the bioplastic industry. Innovations with alternative materials use cassava and sugarcane starch. The NIA focuses on plastic waste management, the bio-economy, and circular economy. **Active ESOs:** The government focuses on SUPs. The plastic circularity ecosystem includes the Plastics Institute of Thailand and universities. Plastic circularity is not a consistent focus of ESOs.	**Context for Plastic Waste Management:** In 2018, 72 percent of Vietnam's plastic waste was mismanaged and leaked. The key mismanaged plastic waste types are soft and hard plastic fragments, fishing gear, plastic bags, and Styrofoam food containers. Away from large cities, only basic SWM infrastructure is available. Waste-to-energy and incineration are popular municipal waste disposal methods. RDF for cement kilns is an emerging disposal method. **Policies and Regulations are Starting to Achieve Results:** Vietnam's government has introduced EPR for specific products and packaging. Several new regulations are expected to be introduced, including bans of specific SUPs, and in 2025, charges will begin to be applied, country wide, based on households' volume of waste. **Eco-design and Production are not available.** **Well-coordinated ESOs:** MONRE supports the application of technologies across the plastic value chain, and the NPAP connects innovators with potential funders. A circulation hub supports both upstream and downstream innovations. Several ESOs conduct innovation challenge competitions and provide coaching.

29 Reverse vending machines enable users to deposit empty plastic bottles and containers in exchange for incentives such as discounts or vouchers. By incentivizing individuals to recycle their plastic waste, reverse vending machines promote plastic circularity, reduce plastics' environmental impact, and contribute to resource conservation.

STAGE	MALAYSIA	THAILAND	VIETNAM
COLLECTION & SEGREGATION (Consumer Awareness, and Informal Collectors)	**High Collection Ratio:** About 80 percent of urban areas have MSW collection services. Rural and remote areas need more collection and disposal systems. Many rural households dump their waste on open land, bury it in small dumpsites, or put it in communal garbage bins with a high potential for leakage in the environment. **Segregation at Source is not Enforced:** Act 672 requires licensing waste concessionaires and source separation. Segregation at source is largely not enforced. Some states and territories have curbside and drop-off collection programs for solid waste and recyclables. **Consumers' Awareness is Limited:** With regard to segregation at source and recycling, consumers' awareness is low. **Large Informal Sector:** Almost all (99.9 percent) plastic recycling is carried out by the informal sector, which diverts about 28 percent of waste from landfills for recycling. Informal collectors pick up higher-value plastics: PET bottles, rigid HDPE, and rigid PP.	**Collection Ratio to Improve:** In Bangkok, the waste collection rate is 91 percent, and 70 percent goes into landfills. In other provinces, the collection rate varies from 46 to 91 percent. Rural areas have the lowest collection rate, and a high level of waste is dumped on open land and burned. In 2019, about 22 percent of solid waste was mismanaged. Uncollected waste results in plastic leakage into the environment. Of Thailand's 2,691 solid waste disposal sites, only 15 percent are sanitary. Sanitary landfills are primarily operated by LGUs, while 14 percent are privately operated. **Segregation at Source is Only in the Capital, Bangkok:** Thailand has no policy on segregation at source. In 2022, the BMA launched a pilot to separate wet organic waste from dry waste. **Consumers' Awareness is Low:** Given that plastics have a low collection and recycling rate, consumers' awareness of the need for waste segregation and recycling appears to be low. In municipalities, the limited solid waste collection services, and infrastructure hinder consumers from improving how they handle their waste. **Large Informal Sector:** Informal workers buy recyclables from households, and get them from waste bins, transfer stations, and landfills. They prepare materials for recycling by cleaning and removing labels, as this enables them to get a higher price. The informal sector's waste reduction efforts save the BMA $15.8 million, annually, which is more than two years of BMA spending on waste collection.	**The Collection Ratio is Low:** Most solid waste from formal LGU operations goes into landfills. In cities, the government collects waste and manages landfills, and pushcarts and garbage trucks collect solid waste from curbside collection points. Regarding access, 40 percent of people in rural areas, and 85 percent of people in urban areas have access to waste collection systems. In rural areas, a high level of waste is dumped on open land and burned. Most low-value and hard-to-recycle plastics are not recyclable due to the lack of market demand. **Initiation of Segregation at Source:** Starting in 2024, the 2020 Law on Environmental Protection requires households to segregate their waste into solid, recyclable, and food waste. **Consumer Awareness is Low:** Given that plastics have a low collection and recycling rate, consumers' awareness of the need for waste segregation and recycling appears to be low. Limited access to MSW collection services and infrastructure hinder consumers from improving how they handle their waste. **Large Informal Sector:** The informal sector collects recyclable plastics in large cities. Craft villages and family businesses comprise most of the informal, unregulated recyclers. Informal collectors typically target plastics that have a known market value (PET and HDPE).

STAGE	MALAYSIA	THAILAND	VIETNAM
RECYCLING (Infrastructure & Services)	**Limited Infrastructure and Recycling:** Most collected waste goes to landfills and dumpsites, rather than to sanitary landfills. Private operators run curbside collection programs, MRFs, and integrated waste recovery and recycling facilities for plastic bottles, containers, and films from commercial and industrial sources. The plastic recycling rate is 20 percent, and the plastic collected-for-recycling rate is 28 to 45 percent for PET, and 5 to 15 percent for LDPE/LLDPE. The loss of material value is due to: (i) the low local demand for recycled plastics; and (ii) the gap in recycling capacities and recyclers' preference for recycling higher-quality imported feedstock. Some plastic recyclers produce food-grade rPET.	**The Recycling Rate is Modest Due to Limited Infrastructure and Limited Demand:** Away from urban centers, material recovery rates vary due to the lack of basic SWM infrastructure, and the modest domestic recycling system for PET. Only 17.6 percent of key plastic resins are recycled. Hard-to-recycle plastics, such as flexible plastics, are not collected or recycled. Thailand's recycling markets are more developed, with several established recyclers, especially ones that recycle PET. There are 149 recyclers in Bangkok, Chon Buri, and Rayong. Some produce both virgin resin and recycled polymers. There is limited local demand for recycled plastics, and high-value food-contact-grade rPET is exported. In 2022, this changed, with the approval of Thailand's Food and Drug Administration.	A compulsory 10 to 22 percent recycling rate for packaging is expected to be applied in Vietnam in 2024. In 2019, the World Bank Group estimated a 33 percent recycling rate for PET, HDPE, LLDPE/LDPE, and PP, and this collected-for-recycling rate is the highest of the six AMS due to Vietnam's large number of informal recyclers. Due to Vietnam's proximity to China, and the relatively lower cost of operating a recycling business in Vietnam, there is a steady demand in China for Vietnamese pellets and flakes from recycled plastic. The Vietnamese reclaimers that rely on importing plastic waste, rather than using local waste, will be banned from doing so in 2025. Some Vietnamese companies are developing collection networks so that they can access the waste collected by local family businesses. Plastics collected by the informal and formal sectors are purchased by junk shops and aggregators, which resell the materials to craft villages and other recyclers. In 2024, Vietnam had a very tiny domestic market for recycled plastics, which are used, primarily, to produce building materials and small furniture.

Notes: BMA = Bangkok Metropolitan Administration; CFR = collected for recycling; LLDPE = linear low-density polyethylene; MONRE = Ministry of Natural Resources and Environment; MRANTI = Malaysian Research Accelerator for Technology and Innovation; NIA = National Innovation Center; PE = polyethylene; PS = polystyrene; rPET = recycled polyethylene terephthalate; SICA = Social Impact Challenge Accelerator; WtE = waste-to-energy.

Source: The World Bank Group: Consolidated from various sources

2.3. Hurdles to Overcome to Achieve Innovations' Growth and Scale

The assessment of the status of SWM in the six AMS, which is presented in Tables 1 and 2, highlights gaps in policies; infrastructure; and financing for recovery, recycling, and plastic circularity. Innovations can fast-track and enhance SWM, in general, and plastic waste management, in particular. However, innovations in plastic circularity must overcome three main hurdles to attract investment, and be able to scale:

- **Lack of policy and financial incentives:** Lack of supportive policies, inconsistent enforcement of existing policies, and the exclusion of innovations, all work against the innovative businesses that are trying to have an impact on plastic waste, and they discourage investors from providing capital for innovations.
- **Lack of organizational capacity:** As early-stage innovations develop, they are vulnerable to market and policy pressures, and they can suffer from weak business models, an unclear product-market fit, lack of access to partnerships and networks, inexperienced leadership, and other challenges.

> **"Innovators in the region are mostly scientists and entrepreneurs who are operating social enterprises, and often they lack the business expertise to make a commercial success of their enterprise. Thus, it is not easy to scale their business or to prove its profitability. Many entrepreneurs only focus on ensuring that their solutions work, rather than on their cashflow and having a sustainable business model."**
>
> *Impact Investor, Singapore*

- **Limited access to capital:** Innovations in the six AMS may not be ready to raise funding, or they may lack access to investors as there is insufficient investment capital available in their country. While technology-driven solutions are more likely to attract private investors that are seeking commercial returns, other business models have limited financing options.

2.3.1. Lack of Policy and Financial Incentives

The lack of policy and financial incentives creates significant barriers to scaling innovations, and it restricts their access to financing.

Policies can hinder innovations: Some plastic-related policies and regulations lack clarity, which discourages innovations; for example, regulations on the use of recycled plastic in food packaging are a problem in Malaysia. Vague guidelines about using recycled content limit the use of locally produced recycled resin in food and beverage packaging because there are concerns that the recycled packaging is not "halal."[30, 31] Also, opportunities for public procurement are often not open to start-ups. In Indonesia, for example, businesses must have three years of audited financial statements before they can bid on government contracts, and this prevents start-ups from bidding. International financial institutions also have requirements regarding businesses' minimum years of operation, which bar start-ups from bidding.

Lack of implementation and enforcement of laws and regulations creates uncertainties for innovations: Although crucial laws and regulations for plastic waste management are enacted at the national level, sub-national entities are responsible for implementing and enforcing them. In Cambodia and Vietnam, stakeholder consultations for this study noted the low capacity of local authorities to implement and effectively enforce regulations that require segregation at source. The Philippines has a comprehensive solid waste management law, the Ecological Solid Waste Management Act of 2000 (RA 9003), but its implementation and enforcement has been limited.

Unless government policies are clear and predictable, investors will only finance the most profitable and well-established innovations, such as those that are recycling higher-value plastics, or that use commercial bioplastic technology. In Southeast Asia, from the beginning of 2018 up to the first nine months of 2022, private investors put less than 1 percent of their financing into early-stage innovations for waste management and plastic circularity. As discussed in the World Bank report "Where is the Value in the Chain? Pathways out of Plastic Pollution,"[32] to reduce the profits of linear business models and increase the profits of circular or green business models, the policy mix must be coherent. The overall impact of unclear, unpredictable policies is that they discourage investors.

Lack of supportive policies undermines innovative businesses and limits their market: Lack of SWM policies results in under-resourcing of the public and private services that

30 Foods and beverages that are not "halal" are those Islamic teachings bar Muslims from consuming—for example, pork and alcohol.

31 Ministry of Environment and Water (KASA). 2021. "Malaysia Plastics Sustainability Roadmap 2021–2030."

32 World Bank. 2022a. "Where Is the Value in the Chain? Pathways out of Plastic Pollution."

manage solid waste, including plastic waste. The stakeholders consulted for this study identified "segregation at source" as a foundational policy and an essential requirement for unlocking many innovations. In the six AMS, recycling innovators noted their significant challenges in selling recycled packaging because it is more expensive than packaging made from virgin plastic. As of March 2024, none of the six AMS had supportive mandates requiring the use of recycled content in packaging, which would boost the marketability of this packaging.

2.3.2. Lack of Organizational Capacity

Innovations in plastic waste management, recycling, and circularity in the six AMS face many of the same challenges as social enterprises. During consultations with stakeholders for this study, investors spoke about plastic recycling businesses' lack of sophistication as they are often informal, family-operated businesses. In addition, these businesses have inadequate cashflow and lack concern about their environmental and health impacts, as well as achieving plastic circularity.

As discussed in this chapter, some ESOs can be found in each of the six AMS, however, these are not focused on the plastic waste sector, nor do they provide sustained support over time. As a result, innovations often lack access to the knowledge, resources, and relationships necessary to develop into mature enterprises. High-potential innovators in the Future of Flexibles Innovation Challenge identified four key barriers to scaling their enterprise:[33]

- *Ability to form strategic partnerships with local manufacturers, global brands, or other actors in the plastic value chain.* For example, to produce at the scale needed to commercialize their products, businesses producing alternative materials require connections to potential manufacturing partners.
- *Technical feedback during product development pilots and testing.* Businesses need more research and testing to validate their market fit and pricing, as well as the environmental, and the occupational safety and health impact of their products and processes. For example, refill businesses need support to test their business model, which could be provided by securing a corporate partnership to run short-term trials or pilots.
- *Access to early-stage financing from investors to become investment ready.* Advanced recycling businesses need substantial capital up front so that they can access reliable feedstock and establish and expand their operations.
- *Market entry support and information about local regulations and stakeholders.* Businesses and technologies from outside the ASEAN Region need support to understand the region's business and regulatory environment.

ESOs can provide critical mentoring, partnerships, and technical assistance for innovators to help their enterprises to mature. The ESO innovation ecosystem is more robust in Indonesia, the Philippines, Thailand, and Vietnam than it is in Cambodia and Malaysia, where little support is available for entrepreneurs.

2.3.3. Limited Access to Capital

Lack of Capital: Given the early stage of innovations in the AMS, capital investment should prioritize Micro, Small and Medium Enterprises (MSMEs) from concessional[34] or philanthropic sources. The weak business models of the innovators that currently predominate in the six AMS need to be more robust to attract commercial investors. These investors need to see the potential for innovations to scale. Another constraint is the small size of the investment amounts available for early-stage plastic waste management, recycling, and circularity innovations (typically less than $1 million). Not only is access to capital limited for businesses from the start-up to the early-growth stage in the six AMS, so is the pool of potential investors—philanthropists, impact investors, and international financial institutions (IFIs).

The Missing Middle and the Mismatch of Innovators and Investors: In the six AMS, early-growth-stage plastic

33 The Incubation Network. 2022a. "2022 Market Insights Report, Future of Flexibles."

34 Concessional financing, which is facilitated primarily by international financial institutions, is the provision of loans or grants to eligible countries at below-market interest rates, and with flexible repayment terms.

circularity innovations seek comparatively small investments (up to $2 million) to enable them to scale and access better markets. These enterprises are in the "Missing Middle" category that is common in emerging market countries. This means that enterprises are too large to benefit from microfinance, too small or risky for commercial banks to support, and they do not offer the prospect of growing returns for investors, or the timely exit opportunities that venture capitalists typically seek. Recent research, which examined climate and sustainability ecosystem-related entrepreneurship in Southeast Asia, including circular economy and waste reduction enterprises, found that over half of the funds available were grants that came in amounts of less than $25,000.[35] This research also indicated that across all sectors, the lack of funding amounts of over $500,000 is due to the substantial risks involved with the untested, or minimally tested technology that plastic circularity innovations use.

Insufficient Track Record and Financial Transparency: Of the innovations this study assessed, few had a comprehensive and well-documented record of both their performance and their finances. This deficient documentation and lack of financial transparency adds to uncertainty about the ability of innovations and their business models to yield a financial return, which thereby increases their risk profile with potential investors.

This study focused on businesses that were participating in national or regional innovation challenges. There is no set of rules regarding how to scale innovations in plastic circularity because there have been very few successes, and no lessons learned have been documented. As indicated in this chapter, the ecosystem and policy environment in each of the six AMS is still at an early stage of development. The hurdles reported in the previous section are significant and must be addressed over time to increase the likelihood that innovations in plastic circularity will be able to attract the investment they need to scale.

In other emerging markets, innovations have taken a long time to mature from one stage to the next. For example, in Mexico, bottle-to-bottle PET recycling took 20 years to mature after being initiated by nonprofit and corporate actors, and it required multiple rounds of blended investment to reach commercial scale.[36] The government of India introduced EPR policies in 2016, but their implementation arrangements were still not finalized 8 years later in 2024. Also, for new technologies, the timelines to scale can be exceptionally long. For example, research shows that advanced recycling technologies took 17 years to reach commercial scale in developed markets.[37]

2.4. Innovation Support to Address the Gaps

Based on country profiles in the six AMS, the gaps identified are a good entry point for each country to initiate and scale innovations. Given the ongoing mismanagement and leakage of potentially recyclable plastic waste across the six AMS, a standard set of actions and priorities are needed for innovations in collection and segregation of waste, to maximize recovery while putting complementary efforts towards source reduction and advanced recycling as well as disposal of residuals. Tackling plastic pollution in the six AMS requires a systems approach that takes a complete life cycle approach to plastic by addressing gaps in ecosystem support, economic incentives, and initiatives to support upstream and midstream innovations. A coherent range of initiatives and policies benefiting multiple stakeholders across the plastic value chain is required to strengthen "reduce, replace, reuse, and repurpose," and drive plastic circularity.[38] While these challenges and gaps vary between countries in the ASEAN Region, some general recurring themes in Tables 3 and 4 highlight how innovations can address these gaps.

35 Aspen Network of Development Entrepreneurs. 2021. "Ecosystem Snapshot: Climate and Environmental Entrepreneurship in Southeast Asia."

36 Global Plastic Action Partnership. 2022. "Unlocking the Plastics Circular Economy: Case Studies on Investment."

37 Closed Loop Partners. 2021. "Accelerating Circular Supply Chains for Plastics."

38 World Bank. 2022a. "Where Is the Value in the Chain? Pathways out of Plastic Pollution."

Table 3. Gaps in Solid Waste Management and their Impacts on Plastic Waste Management

GAPS	PLASTIC WASTE MANAGEMENT
Low Rates of Waste Segregation at Source (Limited systematic segregation of waste at the point of origin that is based on material type and potential end-use)	• Inadequate waste segregation is due to lack of proper facilities and systems for segregating plastic waste at its origin, including insufficient bins for different types of plastic. • People's attitudes and habits do not always support waste segregation at source. • There is a lack of economic incentives for segregating plastic waste. Poor plastic waste segregation hinders the development of a sustainable recycling industry, which results in economic losses, and missed opportunities for green growth and green job creation in SWM. • Poor waste segregation limits recycling potential by reducing the quality and market value of recycled materials. • Mixed and contaminated waste streams from indiscriminate disposal make waste challenging to recycle and reintroduce into the economy.
Inadequate Collection Systems (Lack of structured processes to gather, transport, and store waste from its point of origin to a designated transfer site, treatment facility, or disposal site)	• LGUs have varying levels of capacity, capability, and commitment to SWM, including plastic waste management. Also, LGUs' implementation of waste collection programs is uneven. • LGUs have inadequate equipment and logistics, and especially the facilities for storing collected plastic waste, and vehicles for transporting it to an MRF or a recycling facility. • Inadequate collection results in a sizable percentage of plastic waste not being collected, and this is particularly true in rural areas and informal settlements. • Inadequate collection leads to improper disposal practices, including illegal dumping and open burning, which exacerbate environmental and public health issues, and harm land and marine ecosystems.
Limited Recycling Infrastructure & Capacity (Lack of comprehensive systems that are designed to transport recyclables, and convert them into reusable products or raw materials)	• Not enough recycling facilities are capable of sorting, recovering, and recycling plastic waste. In the six AMS, recycling relies heavily on the informal sector for manual sorting and rudimentary recycling. • Carrying out efficient sorting and recycling is hampered by outdated and unsafe technologies. Also, due to lack of advanced technology for different types of contaminated plastic waste, it cannot be converted into high-quality recycled plastic. Enhancing industrial networks' synergy is needed so that the waste from one industry becomes a resource for another. Limited basic as well as advanced recycling infrastructure constrains the circular flow of materials. In addition, a significant percentage of recyclable plastics are not processed due to recycling facilities not having the capacity to handle the large and increasing volume of plastic waste generated in urban and rural areas. The inability to effectively recycle plastics means that a significant percentage of valuable materials are lost that could be reused, which results in greater reliance on virgin plastics, and greater strain on the environment and public health. • Poorly developed end markets and limited market demand for recycled plastics make the process less economically viable for waste collectors and processors. Without a strong demand for recycled plastic, the economic incentive to recycle declines, along with the markets for recycled plastic. Also, the opportunities for green job creation and innovation are constrained. • Inconsistent quality standards lead to variability in the quality of recycled plastic products, which affects their marketability and usability. • The fragmented and uncoordinated plastic value chain leads to inefficiencies and missed opportunities for integrating recycling into broader SWM strategies.
Weak Regulatory Framework & Enforcement (An inadequate set of formal rules established by government to manage and oversee SWM)	• Stakeholders' engagement is limited due to a lack of mechanisms for engaging them in the regulatory process, which restricts the scope and effectiveness of regulations. • Penalties for non-compliance with plastic waste management regulations are inadequate, and so are incentives for compliance, as well as the identification of best practices in plastic waste reduction and recycling. • Despite some progress in the six AMS, weak regulations and enforcement prevent the development of a circular plastic economy. Policies, such as EPR, DRS, and the restriction of SUPs need to be put in place, and effectively enforced. • The lack of comprehensive SWM policies and standards undermines efforts to achieve plastic circularity, and it prevents a holistic approach to plastic waste management. This, combined with poor enforcement of regulations, exacerbates the waste problem, and impedes recycling.

GAPS	PLASTIC WASTE MANAGEMENT
Limited Public Awareness and Engagement (Inadequately informed and proactive collective action by communities)	• Limited public awareness about the negative environmental and public health impacts of plastic waste exacerbates social inequalities, as marginalized and vulnerable communities often bear the brunt of poor waste management practices. • Communication strategies and SWM educational programs are largely ineffective due to their limited scope and reach, and especially in rural and underserved areas. This results in low participation in recycling programs, inadequate waste segregation at source, and improper disposal. • Consumers have limited understanding of the principles for a circular economy, including the importance and the benefits of plastic waste segregation, reuse, and recycling. • Limited public awareness and engagement constrains the implementation of effective plastic waste management in the six AMS. Community-driven projects on plastic waste management remain the exception, and they do not scale and become mainstream.
Deficient Plastic Waste Data Management & Standards (Lack of systematic collection, storage, analysis, and reporting of information on SWM)	• Inadequate SWM data collection results in poor understanding of the scale and nature of the plastic waste pollution problem. • Even when data is collected, due to the lack standardization of data collection and reporting protocols, data analysis and utilization are not very effective. The lack of agreed-on metrics for measuring plastic circularity further complicates efforts to track progress and implement effective strategies. Also, the lack of standardized practices for plastic recycling results in products of varying quality. • The ability of stakeholders in the six AMS to conduct informed analysis; initiate targeted interventions; and develop effective, and evidence-based policies and strategies for plastic waste management is limited because data are often not understandable or easy to access. • The lack of accurate and comprehensive data on plastic waste generation, collection, recycling, and disposal in the six AMS limits the markets for recycled materials and discourages investments in recycling technologies.
Limited Private Sector Participation (Limited involvement of private entities in SWM)	• Unclear policy frameworks and low tariffs impact financial sustainability, and the lack of incentives discourages private investment in innovative waste management solutions and technologies, and especially in waste processing and plastic circularity solutions. • Despite the high volume of plastic waste generated in the six AMS, limited private sector participation results in underdeveloped markets for recycled plastic products. Also, the lack of design for circularity reduces the potential for plastics to re-enter the economy and be reused. • The limited demand for recycled plastic products is due to concerns about their quality, reliable quantities, and recycled plastics costing more than virgin plastics. These factors discourage investment in recycling and limits the viability of recycling programs. • It is challenging for the private sector to scale and adapt to the growing volume and changing nature of plastic waste and SWM.

Source: The World Bank Group

Table 4. Thematic Innovations to Address Gaps to Improve Plastic Waste Management

INNOVATION	PLASTIC WASTE MANAGEMENT
Technological Innovation in Plastic Waste Management	Artificial intelligence-enabled waste sorting machines significantly enhance the accuracy and efficiency of waste segregation by automating and improving its accuracy, and this results in higher quality recyclables and more of them. Advanced recycling technologies, including chemical recycling, handle difficult-to-recycle plastics, which increases overall recycling rates and reduces the volume of waste going to landfills. Mechanical recycling technologies are being improved so that they can recycle mixed and contaminated plastic waste more effectively.
Innovative Plastic Waste Collection and Segregation Systems	App-based waste collection services offer flexibility, improve household waste collection services, and reduce littering and illegal dumping. Sensor-based smart bins and waste collection systems ensure timely waste collection, and strengthen segregation at source.

INNOVATION	PLASTIC WASTE MANAGEMENT
Product Design Innovations	Circular design for recyclability, which uses compostable materials for SUPs, or adopts modular designs for easy repair and recycling minimizes waste generation. Using mono-materials for packaging, minimizing dyes and additives, and incorporating easily removable components creates more accessible products to recycle, reduces contamination, and increases recycling yields. Eco-design lessens the environmental footprint of a product and contributes to its circularity.
Digital Innovations	The blockchain ensures traceability and accountability along the supply chain by enabling recycled plastics to meet quality standards, and assisting with audits and compliance with environmental regulations. Big data analytics provides actionable insights for use in plastic waste management strategies, while the Internet of Things enhances the real-time monitoring of plastic waste collection and processing.
Policy and Regulatory Innovations	Innovative policies and regulations, such as EPR, plastic taxes, and incentives, reduce plastic waste and promote plastic circularity.
Innovative Business Models	Waste-banking models[39] incentivize consumers to segregate and return their waste. Waste trading platforms can connect waste generators with recyclers. DRS and other take-back schemes incentivize consumers to return plastic products or packaging after use.
Innovative Consumer Engagement Tools	Apps can be developed that educate consumers about proper waste segregation, offer incentives for recycling, and provide transparency about the end-of-life stage of their waste. The gamification of waste segregation or recycling through integrating game-like elements, such as point systems, rewards, or competitions, increases public participation in these activities.[40] Educational initiatives that use digital platforms and interactive content can raise consumer awareness about the importance of plastic circularity.

Source: The World Bank Group

39 Waste-banking models incentivize plastic waste management with financial mechanisms that promote reuse and recycling. For example, when individuals or communities collect recyclable materials, they can exchange them for cash, goods, or services at designated waste banks or collection points.

40 Gamification fosters a sense of responsibility and empowerment in communities and sustains long-term engagement.

CHAPTER 3.

The Innovation Landscape for Plastic Circularity

3.1. Introduction to Innovations in Plastic Circularity in the ASEAN Region

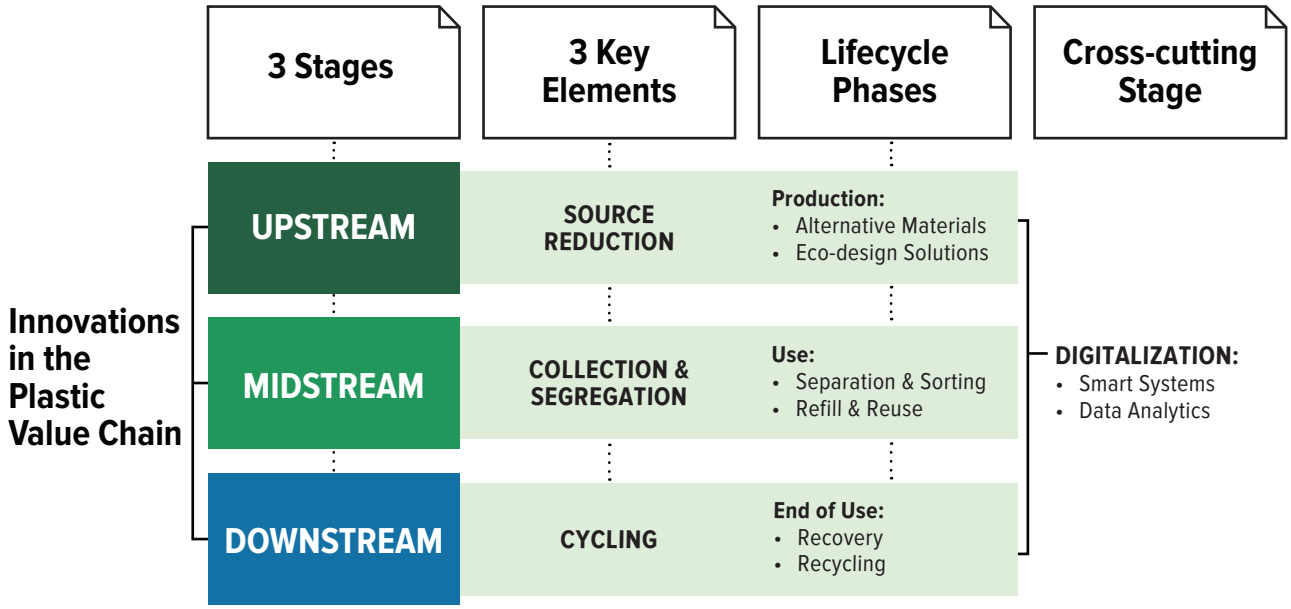
Gaps in solid and plastic waste management span the entire plastic value chain, from upstream, to midstream, to downstream processes. Innovations can be leveraged to develop effective collection systems, promote waste segregation at source, support advanced sorting and processing technologies, generate better quality feedstock, and develop the market for recycled materials. Integrating innovations at these critical steps could minimize plastic leakage into the environment and recover recyclable plastic waste, which would unlock the economic value of plastic waste. This chapter explores the types of innovations across the plastic value chain that are emerging both inside and outside the ASEAN Region.

Innovations in plastic waste are categorized according to the plastic value chain (see Figure 6), which comprises the key elements of the SWM hierarchy for plastic waste management: Source Reduction, Collection and Segregation, and Recycling. The plastic value chain comprises three stages (upstream, midstream, and downstream), in addition to a cross-cutting stage, which are defined as follows:

- **The upstream stage** includes production plastic materials and innovations at this stage contribute to *source reduction*. Innovations at this stage reduce the production and use of difficult-to-recycle plastic products, such as SUPs. These

Photo: Art display made from recycled and upcycled plastic materials. *Study team.*

Figure 6. Categorization of Innovations in the Plastic Value Chain



Source: The World Bank Group

innovations can be divided into (i) *Alternative materials and substitutions*, which are bio-based feedstocks, substituting plastic with less harmful materials with plant-derived materials, such as bamboo, coconut, and seaweed; and (ii) *Eco-design solutions*, which enhance recyclability to optimize materials by improving the yield and value of reclaimed plastics. The upstream stage of the plastic value chain drives the economic and material efficiency of plastic production, and it also fosters the development of advanced materials and sustainable practices that drive plastic circularity.

- **The midstream stage** focuses on innovations that minimize the use of plastic products in the product-delivery and consumer-use phases. Midstream innovations act on the critical elements, Collection and Segregation, in plastic circularity and these are divided into (i) *Separation and sorting*, which supports segregation at source, increases collection and separation efficiency, and opens up opportunities for businesses for recycling, reuse etc.; and (ii) *Refill and reuse*, which comprises diverse business models that limit SUPs and other plastic products by leveraging business models that target reuse, refilling, or product-as-a-service. Examples of this include package-free shops, refill systems that integrate reverse logistics' operations, capturing and reprocessing containers, and reusable packaging. The midstream stage contributes to environmental sustainability and plastic circularity.

- **The downstream stage** focuses on managing plastics at the end of their usefulness, including reintegrating post-consumer plastic back into the economy. This stage supports all forms of cycling, and especially recycling.[41] These innovations improve the recovery of recyclables through: (i) *Recovery*, which refers to preparation of plastic waste for the recycling process, and aims to increase the quantity, quality, and economic viability of recovered plastics; and (ii) *Recycling*, which focuses on converting recovered plastic waste into usable raw materials to close the loop in the plastic value chain.

41 Cycling comprises: *Recycling* processes post-consumer plastics that have been collected, cleaned, and sorted to make new materials. *Upcycling* transforms plastic waste into products of higher quality or value than the original. *Downcycling* is recycling that degrades the quality of materials and leads to use in lower-value applications. *Closed loop* is the optimum recycling process as end-of-life plastic is processed to make the same product again, which maintains its economic and material value. *Precycling* involves the strategic reduction of waste by preventing the generation of unnecessary plastics, and it is usually linked to the upstream stage.

Business models and technologies that enhance the value of plastic through processes such as separation, shredding/flaking, or pelletizing improve the recycling process, and result in higher-quality recyclable materials, reduce contamination risks, and elevate the overall quality of the recycled output.

- **The cross-cutting stage** focuses on digitalization and smart systems that integrate technologies from the Fourth Industrial Revolution and data analytics into the plastic value chain.[42] This stage facilitates the flow of information and materials across different segments of the plastic value chain, and innovations provide digital solutions and services that improve plastic waste management; make this more accurate and transparent; streamline operations; optimize resources; enable better decision-making with evidence-based data; and increase efficiency and performance. Innovations at this stage also assess citizens' engagement to measure their compliance with regulations, and the impact. Examples of digitalization include digital mapping to track plastic waste and products. Digitalization also helps stakeholders to account for their plastic usage; it enables auditing and providing assurance of plastic waste flows; and it quantifies the collected waste in line with current waste regulations, including those for EPR.

The roles of government and investors can significantly influence the success of early-stage innovations, especially the viability of their business models and their potential for scale and replication. All these roles will be explored in more detail in Chapter 4 on policies and Chapter 5 on investment. Most innovations occur upstream and have a cascading impact on the downstream stage. For example, refill and reuse innovations reduce the need to produce new plastic products, while innovations in digitalization can promote recycling, and provide an analytical basis for improving plastic waste management, and related decision making.

42 "The Fourth Industrial Revolution is characterized by the convergence and complementarity of emerging technology domains, including nanotechnology, biotechnology, new materials and advanced digital production technologies." (Lavopa and Delera. 2021. "What is the Fourth Industrial Revolution?")

3.2. Identifying and Assessing the Innovation Ecosystem

Innovations for this study were categorized according to the three stages of development between research and development (R&D) and commercialization. After R&D, early-stage innovations go through the following stages:

- **Creating the concept:** This stage is foundational for addressing the challenges of plastic waste management. This stage determines the subsequent pathways for ideation, research, and the definition of a comprehensive plan outlining the innovation's objectives and potential impact.
- **Piloting and refining:** This stage develops and tests prototypes. This stage ensures the practical scalability and reliability of conceptualized innovations, and it validates the robustness of the innovation's business model.
- **Ready-to-scale:** This stage implements validated innovations on a larger scale. This stage comprises developing robust strategies for scaling, as well as plans for market penetration, engaging with stakeholders, and addressing the continually changing challenges of plastic waste management.

These stages of development are neither linear nor irreversible. Instead, development is a highly iterative process involving failure, learning, and adjustment that shapes innovations into ones that are viable, scalable, and sustainable. The strategic interaction between the three stages of development, which align with the criteria for the "current scale of operations," the "potential for applicability and scalability," and the "robustness of the business model," confirms that early-stage innovations evolve with a focus on real-world applicability, scalability, and business resilience that achieves sustainable changes in how plastic waste is managed.

This study focused on innovations at the "Ready-to-Scale" stage, which are beyond the proof-of-concept, piloting, and refining stages. Therefore, each innovation in this study was evaluated regarding its "Readiness to Scale" and its

ability to attract private investment—in other words, this study assessed the strength of the business model, the innovation's adoption, and its applicability in the six AMS.

Criteria to Evaluate Innovations for their "Readiness to scale:" A total of 262 innovations were evaluated for this study regarding their readiness to scale. This was based on the following three key factors that support an innovation's level of development and readiness to scale as a proxy for investment readiness:

- *Robustness of the Business Model:* Notional, Nascent, or Robust.
- *Current Scale:* Small, Medium, or Large.
- *Potential for Scalability:* Low, Medium, or High.

The methodology for appropriately rating an innovation on each factor used objective data and resources, as much as possible, when these were available (websites, social media pages, news articles, innovation accelerator/incubation pages, etc.), and complemented with interviews and expert judgement of the technical consultancy firm.

- **Robustness of the Business Model:** The following proxies were applied: (i) Is it part of an incubator or receiving financing beyond seed funding? (ii) Does it publish data on its funding? (iii) Does the business have a presence and performance record in the market that shows some uptake? The latter could be considered instead of financial data. The business model's level of robustness was classified according to the following:
  - *Notional:* Unclear market opportunity, with no demonstrated business model; no revenues or negligible one; and unlikely to have received any third-party financing.
  - *Nascent:* Well-defined market opportunity; a business model that has not continuously earned revenue or demonstrated the ability to do so; and it is likely to have participated in an ESO program, or a similar one.
  - *Robust:* Demonstrated business model; recurring revenue streams; and it is likely to have received some third-party financing.
- **Current Scale:** This was assessed by reviewing a description of an innovation in the innovation database where it was found, the innovation's website, and its social media presence. The levels for ranking the current scale of each innovation were the following:
  - *Small*: The innovation is a local initiative or business, it operates in a single location such as a family-owned store, and it has an impact at the neighborhood or village level.
  - *Medium:* The innovation is providing a service that affects plastic waste generation or management, and it has an impact at the city level (or a substantial part of a city).
  - *Large:* The innovation is providing a service that impacts plastic waste generation or management at the regional level (such as a province or a defined waste shed),[43] or at the national level.
- **Level of Scalability:** This is a forward-looking indicator of an innovation's potential to grow and scale, which was based on: information provided in the database where the innovation was found; a review of the innovation's website and social media; and the judgment of the authors, which was based on the nature of the innovation, the market's needs, and demand for the business's product or service. The level of an innovation's scalability was ranked as follows:
  - *Low:* The innovation is highly localized, such as in a closed community, with a specific site and infrastructure that make it difficult to replicate elsewhere.
  - *Medium:* The innovation has potential to scale—for example, in settings or market conditions that are identifiable and achievable in the short term.
  - *High:* The innovation has demonstrated replicability and scalability, which means that its replication has been publicly reported more than twice.

43 A waste shed is a geographic region that has a common solid waste disposal system, or which an LGU has designated as an appropriate area for developing a common recycling program.

3.3. Innovations in ASEAN and other select Areas

The innovations in the study were organized according to the stages discussed in Section 3.1 and described, further, based on the specific innovations that were identified in the study under each stage.

3.3.1. Upstream Stage

Innovations that support *Source Reduction* by reducing plastic consumption, create or use more sustainable materials to replace SUPs and other hard-to-recycle plastic products. Upstream innovations that use *Alternative Materials* were identified, and based on their respective raw material, which are described below:

- *Synthetic*:[44] These materials are artificially created or synthesized to replace the plastic materials that are used in a variety of applications. Many of these synthetic materials are engineered to decompose naturally or under specific conditions, such as industrial composting. Examples of these materials include polylactic acid (PLA) plastics, chitosan-based films, and packaging made from mushrooms. Also, starch derived from corn, tapioca, sugarcane, rice, or sago can be converted into polymers and blended with petroleum-based additives to create "biodegradable" plastics (also called thermoplastic bio-composites). Such examples were found in the ASEAN Region, including an entrepreneur in Indonesia who produces biodegradable bags using cassava starch as the main biopolymer.
- *By-products*: These add value to by-products such as rice straw or crushed sugarcane bagasse that result from large-scale industrial manufacturing or agricultural operations. For example, a packaging manufacturer in Thailand uses rice straw, which is a by-product of rice paper production, to make molded packages for takeaway food.
- *All-natural:* These products, which are crafted from natural fibers and often locally sourced, are typically used in food-contact packaging. While there are drawbacks related to food safety, a shorter shelf life, and higher costs, the environmental impact of these products is notably low. Examples of the materials used include bamboo, banana leaves, coconut husks, and seaweed.

This study identified two examples of *Eco-design* innovations:

- **Design for recycling:** By making the materials and components of their products and packaging more readily recyclable, the overall yield and value of the recycled plastics increases (providing that proper disposal, collection, and recycling takes place). Examples identified in this study include eliminating PVC labels from PET bottles and transitioning from multi-layered to mono-material packaging.

44 Oxo-biodegradable additives or bio-additives, which are offered as an alternative to films and bags, are among the innovations in the ASEAN Region. However, plastics using bio-additives are not solutions to the plastic waste problem as they produce microplastics. These types of bio-degradants also destroy the integrity of recycled products, which impacts their quality and durability. (Biobag. 2017. "Are oxo-biodegradable plastic products environmentally friendly?")

Box 2.
An Alternative Material Innovation Case – Ecovative

In Western countries, the demand for eco-friendly materials for packaging that is an alternative to traditionally used Styrofoam is growing. Ecovative, a U.S.-based company, produces environmentally friendly packaging materials that are made from mushrooms and are lightweight, durable, and fire-resistant. Ecovative developed a method for growing mycelium (the root structure of mushrooms) in agricultural waste and sawdust, and the company uses this to create a cohesive material that has excellent cushioning properties. Unlike Styrofoam, which takes 500 years to decompose, the mushroom packaging takes 7 days to manufacture, and around 30 days to decompose at the end of its life. In 2021, Ecovative raised $100 million, and by 2024, several global businesses were using its packaging material.

- **Design for reuse:** This business model is often complemented by systems that increase products' lifespan by using more durable materials, as well as developing consumer loyalty systems that can track the number of times a product has been reused. An example is the redesign of refillable jugs for bulk water delivery in Indonesia.

3.3.2. Midstream Stage

This type of innovation reduces SUPs and other plastic products by leveraging a variety of business models that are concerned with reuse, refilling, and product-as-a-service. Also included in this category are innovations that support *Collection and Segregation*—post-consumer use—and that increase the potential for recycling.

- *Collection services:* These services and technologies offer a solution for emerging markets—for example, a company in India sells a mobile vacuum unit that collects street waste, including plastic waste, for further processing. Municipalities in 10 Indian States have purchased this novel, high-tech product.
- *Package-free shops:* These are retail stores (zero waste or bulk stores) that sell products in refillable, reusable, or plastic-free containers, or provide refill services when customers bring their own containers.
- *Refill systems:* Refill systems, which provide an alternative to purchasing products in a store, integrate a reverse logistics operation that captures and reprocesses containers, and customers are charged a deposit fee to incentivize their returns. Several businesses in the ASEAN Region use refill stations to provide drinking water.
- *Reusable packaging and containers:* This study identified reusable packaging solutions that are: centrally managed, a collective resource, and rely on customers to return reusable containers. For example, a start-up in Indonesia provides restaurants with reusable takeaway food containers and cups for hot beverages. Restaurant customers must pay a deposit for the containers they use, and they appreciate this sustainable approach.
- *Retail and online shops (Upstream and Midstream):* These business models offer consumers a way to shop that reduces their waste by selling products in bulk. Several entrepreneurs in Indonesia operate zero-waste bulk stores that are both brick-and-mortar and online stores. This model could also enable upstream innovations if stores require consumers to bring their own containers when purchasing bulk goods.
- *Basic segregation* recovers plastics from mixed waste for recycling. Contactless mixed waste processing separates collected waste at source into organic and non-organic waste (metals and plastics); and separating food waste from its packaging improves plastic recycling. This novel and high-tech process targets corporate clients.

Box 3.

Redesign Innovation Case – Beverage Industry Players (Lotte, Coca Cola & Evian)

The beverage industry is actively working to reduce its environmental footprint by adopting more sustainable packaging solutions such as label-free PET technology that uses laser technology to improve recycling. In 2020, Lotte Chilsung launched a line of label-free PET water bottles in Korea that uses a unique technology to print labels and designs on its bottles. Despite the slightly higher cost of label-free PET water bottles, an increasing number of consumers are purchasing this type of bottled water because of their concerns about protecting the environment. This environmentally conscious trend has been taken up by other global brands—for example, Evian plans to use 100 percent recycled PET bottles starting in 2025 and the company has launched label-free bottled water. Coca-Cola will change all of its plastic beverage containers to eco-friendly ones by 2025, and the company has already launched label-free bottled water.

3.3.3. Downstream Stage

The main goal of the downstream stage is to manage plastics at the end of their useful life through *Recovery* and *Cycling*, which requires constructing MRFs and recycling facilities. The Recovery and Cycling innovations identified in this study's analysis include:

- *Aggregation:* These business models and technologies focus on aggregation beyond recovery, which sorts plastics into different resins. For example, vertically integrated aggregation MSMEs that combine small-scale material recovery facilities (mini-MRFs) with mechanical processing, are currently operating in India and Indonesia. Reverse vending machines[45] are turning recycling into a more streamlined and user-friendly process by using automation, data acquisition, consumer engagement, and supply chain integration. Deposit-return systems, which refund a fee when consumers bring back their plastic items to an authorized collection point for recycling, keep high-value plastic products, such as PET bottles, separate so they are not contaminated by other types of waste in a recycling bin.
- *Mechanical processing and remanufacturing:* Business models and technologies that add value to plastic by separating, shredding/flaking, or pelletizing it, strengthen the recycling process, ensure better-quality recyclables, mitigate contamination risks, and enhance the overall integrity of the recycled output. In the ASEAN Region, technologies that produce high-quality, color-sorted flakes or pellets, which are suitable as feedstock for most circular "bottle-to-bottle" applications, are still relatively new. Some innovations that integrate the recycling process with the production of finished products have been implemented in India, Indonesia, Thailand, and Vietnam. For example, in India, a company manages small aggregation points to recover flexible plastic packaging, and it pelletizes the materials to produce carrying bags and films.
- *Advanced recycling and conversion technologies:* These innovations incorporate chemical or thermal processing of plastic waste to break the polymer chains into naphtha, monomers, or other chemical feedstocks by using pyrolysis, gasification, and leveraging heat to make specialized materials from plastic. These technologies often co-produce fuel or use plastic waste as an energy source. In Thailand, an innovative process converts plastic waste into bitumen for road construction. Businesses outside the ASEAN Region could transfer their technology or expand their operations in the region. However, financial sustainability, the environmental

45 A reverse vending machine facilitates the collection and recycling of plastic materials. Consumers deposit their used plastic containers (for example, beverage bottles) in a machine in exchange for a reward or other incentive. The machines automatically sort and compact the deposited items and prepare them for transportation to a recycling facility.

Box 4.
Refill/Reuse Innovation Case – Loop

Loop is a global start-up based in Canada that works with some of the world's largest brands and retailers to enable consumers to shop for products in durable packaging that can be reused multiple times. The company collects used packaging from consumers and retailers; returns their deposits; sorts, stores, and cleans the packaging; and provides the hygienically cleaned packaging to manufacturers for refilling. Loop also works with product manufacturers during the design and production stages of their packaging; for example, Loop collaborated with a global ice cream company to design and produce aluminum packaging that is easier to refill and reuse. Loop, which has worked with over 200 consumer product businesses and a dozen major retailers, primarily operates in Western countries, and it has leveraged private investment as well as innovative technologies and concepts.

Box 5.

Recycling Innovation Case – Prevented Ocean Plastic (POP) South Asia

Prevented Ocean Plastic (POP) South Asia is a pioneering plastic recycling company that is developing locally customized sorting and collection infrastructure for underserved communities worldwide. Its business model is based on collecting ocean-bound plastic waste, transporting it, and processing it into recycled plastic pellets to supply the global supply chain. POP South Asia uses advanced technology to produce products from recycled plastic pellets, employs people to collect plastic waste, and has introduced a unique certification method for recycled plastic that is made from marine plastic waste. This raises consumers' awareness about the marine plastic problem and encourages them to purchase recycled plastic, which creates a virtuous cycle to help solve the plastic waste problem. POP South Asia collects plastic from waste management facilities, as well as low-income collectors. The collectors pick up discarded plastic bottles in areas that are at risk of generating ocean pollution and they take the bottles to local collection centers for payment. The company has set up best-in-class collection and recycling infrastructure for coastal communities across Indonesia, which previously had limited or no collection. This approach is both preventing plastics leaking into the ocean and creating local income generation opportunities. POP South Asia compresses the collected plastic waste, transports it, washes it, and then processes it into flakes or pellets. The recycled plastic pellets are then delivered to global businesses for use in making products or packaging. These high-quality pellets comply with European Union and North American standards, which makes them a sustainable recycled plastic product. One bale of compressed bottles comprises over 10,000 individual bottles, and standard recycling production requires batches of nearly 100,000 bottles. The global outdoor recreation brand, Patagonia, produces sportswear and other equipment with recycled polyester that is made from POP-certified recycled plastic, and in early 2023, Patagonia launched a new line of athletic wear that is made with POP-recycled polyester.

impact, and the large amount of energy consumed by these processes are critical considerations in deciding whether innovations should be widely adopted.

Note about advanced recycling: Advanced recycling, which is a solution for hard-to-recycle resins, has several risks and challenges. From a financial perspective, most advanced recycling technologies require significant capital investment, and enormous scale. Also, the economics still need to be proven, given the need for source-segregated feedstock with low contamination levels. In addition, not all advanced recycling technologies have a better environmental performance.

3.3.4. Cross-cutting Stage

The cross-cutting stage engenders transparency across the plastic value chain. Innovations focused on this stage support real-time monitoring, automation, and consumer engagement by using digital technologies that are designed to map and trace the flow of materials, record the location of waste management infrastructure, and provide insights on waste volumes and composition. Some of the innovations observed in this category include:

- *Mobile applications (Midstream and Downstream):* These innovations facilitate convenience, and enable consumers to recycle through gamification or accessing on-demand collection services. Also, businesses can conveniently track financial transactions within the plastic recycling process, and these advancements enable monitoring progress throughout the value chain.
- *Technologies for traceability and visibility:* Traceability technologies such as the blockchain enhance visibility across the supply chain. These software systems enable the tracking of recycled plastics and clearly show their origins. Analyzing and setting parameters for traceability in plastic recycling provides a high level of assurance and quality control, and it ensures that the resulting material meets the necessary quality standards for consumers' reuse. Blockchain (ledger) technology is used by the Plastic Bank to track the flow of plastic waste in transparent manner.[46] These innovations indirectly support other activities, such as verifying the provenance of recycled plastics.

46 The Plastic Bank is a Canada-based project that established waste collection centers in the Philippines and in Indonesia. The project incentivizes waste collectors using blockchain technology by providing them with digital tokens that can be exchanged for goods and services.

- *Data analytics:* Digital services provide data collection, analysis, and insights into plastic circularity at the local, national, and global level. Data analytics is a digital service that tracks the flow of plastic waste material, conducts material composition analysis, or investigates other aspects, such as investments in plastic circularity.
- *Accounting and reporting for extended producer responsibility:* EPR-compliance services support the execution and roll-out of EPR programs. EPR accounting includes one or more services that connect waste generators with aggregators and recyclers, it tracks the origin and flow of plastic waste regarding its EPR monitoring status and targets, and it provides the regulator with certificates on the disposal of materials.
- *Footprinting:*[47] These innovations compute plastic usage in an organization across the lifespan of products: production, distribution, consumption, and disposal or treatment, post-consumption.

In the absence of more systematic waste collection, Boxes 6 and 7 highlight how platforms are being used to overcome this hurdle.

47 Footprinting is a comprehensive assessment of the environmental impacts of plastic materials over their entire lifespan.

3.4. Evaluating and Selecting Innovations for Investment

Based on the methodology presented in Section 1.4, each of the innovations in this study was assessed to determine its relative stage of development. Of the 262 early-stage innovations reviewed in this study, 48 percent were at concept stage, 36 percent were at piloting and refining stage, and 16 percent showed readiness to scale. This review of innovations in the six AMS found that about half of the innovations focus on the midstream stage, and especially refill and reuse, which is mainly driven by the private sector. This reflects the region's lack of market support for source reduction; the lack of infrastructure for recovery (MRFs) and recycling (recycling facilities); and the novelty of digitalization.

This study focused on ready-to-scale innovations that were beyond the proof-of-concept stage. However, as noted above, only 16 percent of the innovations studied could be categorized as ready-to-scale. These ready-to-scale innovations were subdivided into those that were upstream (34 percent), midstream (8 percent), downstream (40 percent), and cross-cutting (19 percent). Most of the 262 innovations were at the concept stage, or at the piloting

Box 6.
Operational Platform Innovation Case – Rubicon

Rubicon is a U.S.-based leader in the $2.1 trillion global waste and recycling industry. Since 2008, Rubicon has secured over 50 patents for technologies that use AI, computer vision, and the Internet of Things. Rubicon's cloud-based solutions connect waste collectors, collection trucks, consumers, and other stakeholders in highly fragmented SWM systems. Rubicon charges both collectors and consumers. For collectors, the mobile app lets truck drivers know when to pick up the waste. The app also tracks waste volumes and routes, which effectively manages the collection and movement of waste, while also providing real-time information on trucks' locations. Consumers can monitor how much of their waste is recycled or disposed of in landfills, and how often their waste needs to be collected. For hard-to-dispose items such as batteries, consumers can purchase disposal boxes through Rubicon's e-commerce platform. Rubicon works with thousands of recycling and transportation businesses to cut their operating costs and reduce their emissions, and it works with LGUs in more than 20 countries. Rubicon has attracted investments from several venture capitalists and impact investors, it has been listed on the New York Stock Exchange since 2022, and in 2024, it had market capitalization of over $200 million.

Box 7.

Using Platforms to Improve Collection Efficiencies

A relatively new plastic circularity innovation is the use of platforms and apps to connect the different elements of the plastic waste value chain. Regarding digitalization, cross-cutting innovations can help to improve the functioning of plastic circularity markets by connecting stakeholders (for example, consumers, waste pickers, and recycling businesses) to make collection efforts more efficient and provide traceability data to improve recycling performance. Platforms, and particularly those that reward consumers for recycling, utilize corporate partnerships to fund the rewards. However, platforms can also be used as part of an EPR mandate. For example, Kimberly Clark Softex has partnered with Duitin, a waste collection app in Indonesia to collect used diapers, which are a significant source of hard-to-recycle plastic that should be recycled on its own. Duitin also collects single-use chopsticks and other wooden products, which upcycling firms transform into new-end products. Where waste segregation is not fully developed, platforms can be a reliable source of downstream management that can feed into providing better recyclables and plastic waste management, and also incentivize consumers to change their behavior, and raise public awareness about why and how to improve waste management. Of the six AMS, currently, only Thailand and Indonesia have waste circularity platforms. Replicating or developing platforms in the other four AMS countries should be considered as an additional approach to managing plastic waste. However, platforms require adequate scale to succeed. Hence, good marketing campaigns, along with corporate partnerships, are vital. With a proven platform, more EPR activities could be tied to the platform.

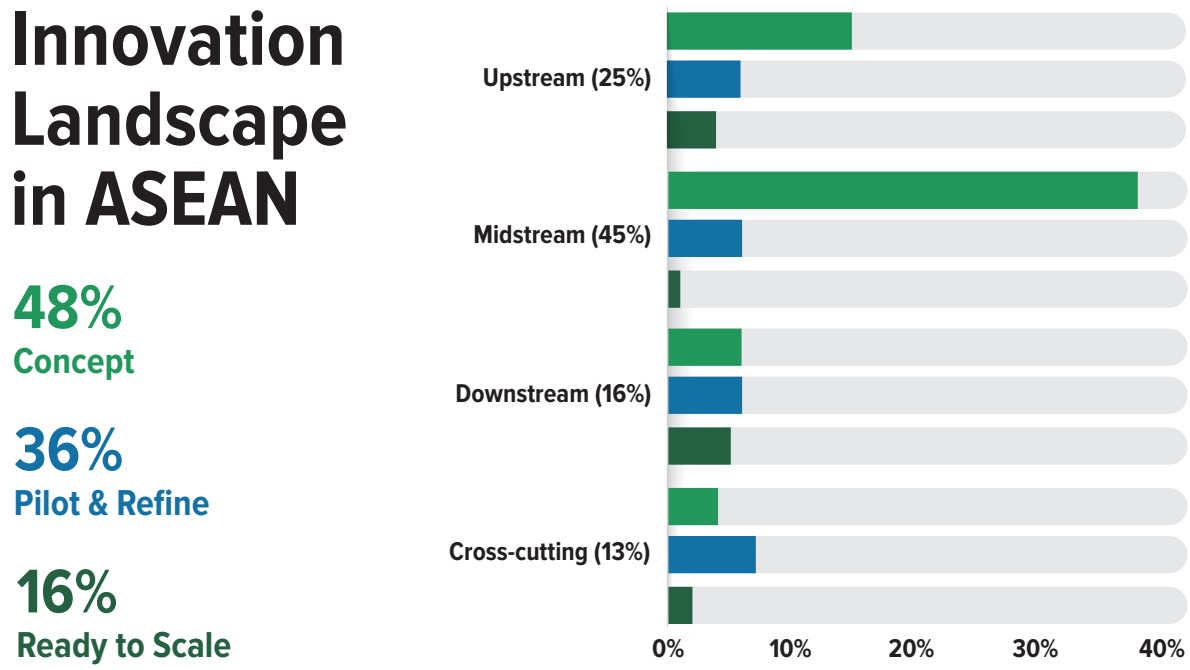
and refining stage of development, and, therefore, require strong policy and financial support, as well as capacity building to become ready to scale. Figure 7 shows the proportions of the ASEAN Region's innovations at each stage in the innovation landscape.

Some differences emerged between innovations across the various stages of development:

- **Upstream and Midstream Innovations** were primarily at the concept stage, with very few businesses demonstrating readiness to scale, which indicates the challenges they face with their business model, and insufficient profitability to scale.
- **Cross-cutting Innovations** were Operational Platforms, Digital Mapping, and Services for the producers and other generators of waste. These were primarily at the piloting stage, which indicates the recent trend to monetize sector data, which are lacking in the plastic value chain.
- **Recovery and Recycling and Redesign Innovations** were evenly represented across the three stages of development. This could indicate that modest but sustainable business models can scale under current market conditions.

This study found that most upstream (47 percent), midstream (84 percent), and downstream (33 percent) innovations were at the earliest concept stage. Cross-cutting innovations in digitalization were also well-represented in the concept and piloting stages (89 percent of the solutions reviewed across the two stages). As indicated by innovations' more significant transactions, downstream innovations for the recovery and recycling of plastic waste were more likely to be nearly ready to scale (29 percent), followed by those that were upstream (24 percent). Table 5 summarizes the results of this review.

Figure 7. Plastic Waste Management Innovation Landscape in the ASEAN Region



Note: The total does not add up to 100 percent due to the rounding of some of the percentages.

Source: The World Bank Group

Table 5. Readiness of Innovations by Stage

STAGE	CONCEPT	PILOTING & REFINING	READY TO SCALE
Upstream	47%	29%	**24%**
Midstream	84%	14%	**2%**
Downstream	33%	39%	**29%**
Cross-cutting	27%	62%	**11%**

Note: The total does not add up to 100 percent due to the rounding of some of the percentages

Source: The World Bank Group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입력해주세요.
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CHAPTER 4.

Policy Options to Stimulate Innovations to Advance Plastic Circularity

4.1. Overview of the Role of Policies in Driving Innovation and Investment

The public sector is a critical participant in managing plastic waste and advancing plastic circularity. Policies and related government actions establish the regulatory framework, infrastructure, and market context in which investments, and the possible scaling of innovations can occur at various stages of the plastic value chain. Also, governments can enable or inhibit plastic waste management, recycling, and circularity innovations.[48]

This section illustrates how government influences the innovation and investment ecosystems at multiple levels. First, this section discusses national-level policies and institutional arrangements that support plastic waste management by establishing the foundations for innovations in plastic circularity. This section then discusses the various policies, regulations, market-based instruments, direct financial support, and other types of support that specifically target innovations to enhance plastic circularity. This section also examines some relevant experiences with plastic innovations. This section is supplemented by Appendix 7, which highlights the perceived barriers and the associated supportive policies

48 OECD (Organisation for Co-operation and Development). 2021. "Promoting investment for green growth."

Photo: Vending machine and container deposit system. *Study team.*

To ensure sustainability, the policy framework and associated regulations that support investing in plastic circularity innovations must comply with the highest environmental and social safeguard standards.

to drive the development of plastic circularity in the six AMS and Appendix 8, which summarizes selected policies for SWM and SUP.

Innovation requires nurturing and support: With government assistance, technical and financial capacity building can be carried out through incubators and accelerators. Although not this study's key focus, this section discusses trade policies that could facilitate the transfer and adoption of innovations and technologies.

A sound institutional framework is essential for creating the right environment so that public interventions can deliver effective waste management policies. To be successful, this framework requires a set of clearly defined policy objectives and goals that are shared in strategic documents ("Goals and Priorities"); enlist public and private actors in the same institutional space ("Roles and Jurisdictions"); and enable coordination across different sectors and value chains ("Horizontal and Vertical Coordination").

Goals and priorities: Governments can drive SWM economies and the private sector to produce public goods and services. Transformational change can best be achieved, strategically—for example, by mainstreaming plastic circularity considerations in SWM through sector-wide planning and development. [49] The primary role of government is to set goals and policy objectives to tackle the challenge of scaling innovations for plastic circularity. Through consultative processes, such goals will result in a shared agenda and sectoral strategies that clearly outline the various system components, including the stakeholders involved. Scaling innovations is an emerging and unpredictable process of change.[50] Adding innovation to the package of solutions could have unintended consequences since innovations can interact negatively, as well as positively, with other solutions, and addressing these consequences at the market deployment stage is too late. From a policy perspective, one practical way to overcome the bottleneck is to institutionalize monitoring and evaluation in strategies so that they reflexively promote learning from policies.

Areas for potential policy interventions: In the six AMS, the line ministries develop regulations and guidelines, while the LGUs are responsible for implementing them. The overlap in jurisdiction between provincial and LGU authorities often results in gaps in SWM services.[51] The sizeable number of informal collectors who are beyond the government's reach adds another layer of complexity to SWM. At this point, policymakers can decide, for example, which actors to include in the core decision-making circle, and the extent of their inclusion, as well as where and when to increase investments. In Europe, research and technology businesses are increasingly embracing the objectives of achieving social impact and collaborating with all the types of innovation actors, including SMEs and large businesses.[52]

49 World Bank Group. 2020. "Mobilizing Private Finance for Nature."

50 Sartas et al. 2020. "Scaling Readiness: Science and practice of an approach to enhance impact of research for development."

51 Godlove and Pak. 2020. "2020 Policy Brief: Solid Waste Management in Kep Province."

52 Larrue and Strauka. 2022. "The contribution of RTOs to socio-economic recovery, resilience and transitions."

Box 8.

IFC Performance Standards on Environmental and Social Sustainability

Environmental and social safeguards should apply to all investments in accord with a country's system, including private sector investments in public goods such as plastic circularity. For commercial financing, the Equator Principles have traditionally been a risk management framework for financial institutions to use in assessing and managing environmental and social project risks, including investments in plastic circularity. IFC, which finances investments in the private sector in developing countries, has performance standards on environmental and social sustainability that are designed to mitigate potential adverse impacts. The following table summarizes IFC's key environmental and social safeguard policies—their purpose, key features, and their relevance and application to private investments in innovations for plastic circularity.

IFC PERFORMANCE STANDARDS	PURPOSE	KEY FEATURES	RELEVANCE & APPLICATION TO PLASTIC CIRCULARITY
PS1: Assessment and Management of Environmental and Social (E&S) Risks and Impacts	Ensures a structured approach to E&S risk and impact management.	• Requires clients (investors) to establish an environmental and social management system (ESMS). • Promotes informed decision-making through stakeholder engagement. • The ESMS acknowledges the differing risks in diverse business activities and at differing scales.	Establishes the foundation for identifying and managing E&S risks: • Encourages private sector investment in technologies and systems that are environmentally sound and socially inclusive. • Assures stakeholders of the responsible management of plastic waste-related projects.
PS2: Labor and Working Conditions	Safeguards workers' rights and enhances worker-client relationships.	• Advocates non-discrimination, equal opportunities, and fair treatment of workers. • Prescribes appropriate working conditions, terms of employment, and grievance mechanisms. • Prohibits child labor and forced labor.	Addresses labor concerns in solid and plastic waste management, especially those concerning informal sector workers: • Ensures fair labor practices and inclusion of informal sector workers. • Advocates workers' health and safety.
PS3: Resource Efficiency and Pollution Prevention	Advocates sustainable resource use and reductions in pollution.	• Promotes efficient use of energy, water, and other resources. • Aims to reduce green house gas (GHG) emissions. • Guides the prevention of pollution and the management of hazardous waste.	Directly aligns with the principles of resource efficiency, waste minimization, and plastic circularity: • Promotes sustainable production processes and reducing virgin plastic production. • Supports innovative projects along the plastic value chain.
PS4: Community Health, Safety, and Security	Protects local communities from the potential adverse impacts of project activities.	• Outlines measures to prevent or reduce risks to the local community. • Addresses land and water usage, infrastructure development, and potential conflicts.	Highlights community safety in SWM & plastic reduction initiatives: • Endorses community-based solid and plastic waste management systems. • Ensures that waste-related facilities and practices do not compromise the local community's public health.
PS5: Land Acquisition and Involuntary Resettlement	Aims to avoid, or, when unavoidable, minimize resettlement, and ensure an equitable compensation package.	• Seeks to avoid or minimize physical and economic resettlement. • Advocates fair compensation, assistance, and livelihood restoration for displaced persons.	Ensures that the land used for plastic circularity projects is acquired fairly, with adequate market-based compensation: • Fair land acquisition for new plastic waste-related projects or waste management facilities. • Offers protection against projects displacing communities.

IFC PERFORMANCE STANDARDS	PURPOSE	KEY FEATURES	RELEVANCE & APPLICATION TO PLASTIC CIRCULARITY
PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Ensures conservation of biodiversity and sustainable natural resource management.	• Highlights protection of critical habitats. • Promotes sustainable management and use of natural resources. • Advocates adopting a mitigation hierarchy (avoidance, minimization, restoration, and offset).	Protects biodiversity by preventing plastic pollution leaking into the environment: • Supports innovations that prevent land-based plastics from entering marine ecosystems. • Advocates whole landscape approaches that integrate SWM and plastic waste management with biodiversity conservation.
PS7: Indigenous Peoples	Safeguards the rights, dignity, and livelihoods of Indigenous Peoples.	• Recognizes and respects the rights, culture, and knowledge of Indigenous Peoples. • Requires free, prior, and informed consent for projects affecting Indigenous Peoples' lands and resources.	Protects the rights of Indigenous communities in areas targeted for plastic management initiatives: • Ensures that plastic circularity projects do not infringe upon Indigenous lands or resources. • Engages Indigenous communities in decision-making processes.
PS8: Cultural Heritage	Ensures conservation and fair access to cultural heritage.	• Advocates for the protection of tangible and intangible cultural heritage. • Highlights the importance of equitably sharing the benefits from commercialization.	Ensures the broader acceptability and sustainability of projects, while respecting cultural heritage: • Ensures that SWM or plastic reduction initiatives do not harm cultural sites or practices.

IFC's Performance Standards provide a comprehensive set of requirements that guide businesses in managing environmental and social risks. By adopting these standards, investors, innovators, and stakeholders in the ASEAN Region plastic value chain can collaboratively drive a sustainable and inclusive shift toward a circular economy for plastics.

Source: IFC (International Finance Corporation). 2012. "IFC Performance Standards on Environmental and Social Sustainability."

Policy coordination sheds light on the procedural aspects of policymaking and implementation:

- Horizontal coordination of policies is required across the sectors that are impacted or influenced by plastic circularity—for example, the chemical, food, and energy sectors. Coordination occurs directly through inter-ministerial coordination, and indirectly through overarching strategies, such as the "Framework for Circular Economy for the ASEAN Economic Community."[53]
- Vertical coordination at the national and the LGU level also needs to be considered. Initiatives created at the regional level require two-way coordination to leverage and generate change at the national and local levels.
- Coordination across the plastic value chain is a key factor in successfully integrating innovative plastic circularity solutions.
- Coordination of environment, science, and technology policies requires attention—establishing a clear channel to support business innovations is crucial for identifying the policy triggers and levers that can drive successful SWM innovations.

To ensure sustainability, the policy framework and associated regulations that support investing in plastic circularity innovations must comply with the highest environmental and social safeguard standards. The International Finance Corporation (IFC) supports and guides investments with its performance standards on environmental and social sustainability, which are summarized in Box 8.

53 ASEAN (Association of Southeast Asian Nations). 2021b. "Framework for Circular Economy for the ASEAN Economic Community."

4.2. Policy Instruments for Triggering Plastic Innovation

Discussions about each policy instrument followed the stages in the value chain: Upstream, Midstream, and Downstream, whenever applicable, to highlight which policy interventions were deemed more important at the various stages of plastic circularity. The following sections describe these aspects to capture the potential for innovation. The categorization of policy instruments for innovation is based on "A Practitioner's Guide to Innovation Policy,"[54] but this has been adapted to focus on later-stage innovations.

Regulations, Standards, and Market-based Policy Instruments: Regulations set standards for certain products to support a shift to cleaner alternatives and stimulate innovation. In 2018, the European Union (EU) published a communication acknowledging that regulations concerning waste and chemicals need to be better aligned to be effective in impacting the uptake of secondary raw materials.[55]Also, in 2018, the EU published technical guidance on waste characterization and classification, including plastics.[56] More reactive and common types of policies are market-based instruments, such as taxes and fees. Only a handful of countries (mainly in Europe) have levied comprehensive plastic packaging taxes. In 2018, the European Commission (EC) developed a regional strategy on plastics to make "all plastic packaging on the EU market recyclable by 2030,"[57] and in 2021, the EC created the *plastics own resource*, which comprises a national contribution based on the amount of non-recycled plastic packaging waste.[58] Some countries have tied the scale of tax to *minimum content requirements,* such as requiring a certain percentage of recycled plastics in packaging, which creates a level playing field across a category of manufactured goods. In the United Kingdom, manufacturers are taxed if their products contain less than 30 percent recycled plastics. In contrast, in Spain, products with over 30 percent of recycled content are taxed less, which incentivizes producers to increase recycled content.[59]

Although not adopted as regulations, countries have initiated formal discussions on using alternative materials to plastics. The EC has prepared a *Plastics Life Cycle Assessment*, which uses the EU *Product Environmental Footprint* methodology.[60] A World Bank Group tool, *The Plastic Substitution Tradeoff Estimator,* also evaluates the potential environmental impacts of plastics and compares them to the alternatives available.[61]

A softer regulatory tool to promote innovation upstream in the value chain entails adopting *green design or eco-design standards,* which is also known as designing for recyclability. Such policies drive producers to innovate, but these are primarily large brands and their packaging suppliers. Globally, the most comprehensive framework is the EU's *Ecodesign for Sustainable Products Regulation*, which was updated in 2022, and builds on the EU's previously published *Directive*. The updated regulation expands the scope of the products covered, and it is expected to formulate regulations that prioritize resource-intensive sectors, including plastics.[62]

Policy instruments closing the loop in SWM and increase material circularity: The most notable scheme is EPR, which extends producers' liability to the end-of-life stage of their packaging by assigning fees based on the volume and type of packaging put on the market. The fees are eco-modulated, which means that fees are higher for harder-to-manage materials. EPR is a broad suite of policy instruments that support plastic circularity (Table 6).

54 Cirera et al. 2020. "A Practitioner's Guide to Innovation Policy: Instruments to Build Firm Capabilities and Accelerate Technological Catch-Up in Developing Countries."

55 EC (European Commission). 2018a. "Final communication from the Commission to the European Parliament, the Council."

56 EC (European Commission). 2018b. "Commission notice on technical guidance on the classification of waste."

57 European Parliament. 2018. "European strategy for plastics in a circular economy."

58 EC (European Commission). 2018c. "Plastics strategy"; EC (European Commission). 2021a. "Plastics own resource."

59 Government of the UK. 2022. "Plastic Packaging Tax: steps to take." Peszko. 2023. "Plastic taxes: a guide to new legislation in Europe."

60 EC (European Commission). 2021b. "Life Cycle Assessment of alternative feedstocks for plastics production."
EC (European Commission). 2021c. "EU Commission Recommendation on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations."

61 World Bank. 2022d. "Plastic Substitution Tradeoff Estimator Technical Guidance Note."

62 European Parliament. 2023b. "Ecodesign for sustainable products."

Table 6. Extended Producer Responsibility Scheme

TYPE OF COLLECTION	MANDATORY EPR SCHEMES	VOLUNTARY EPR SCHEMES
Street collection	Product take-back requirements	Product Stewardship Initiatives
	Advanced Disposal Fees	Corporate Social Responsibility Initiatives
	Combined upstream tax and downstream subsidy	
Separate collection	Deposit-Return System (DRS)	

Source: Laubinger et al. 2022. "Deposit-refund systems and the interplay with additional mandatory extended producer responsibility policies."

Globally, Deposit-Return Systems (DRS) are some of the most influential supply policies, and their median return rate performance is 84 percent.[63] DRS have spurred innovation in developing reverse vending machines for collection, and operational platforms and services that enable traceability. In the ASEAN Region, this type of initiative still needs to become well-established. In 2024, a DRS for beverage containers was being considered in Singapore.

Of the six AMS, Vietnam and Thailand have enacted legislation, but implementation has been delayed, partly due to the COVID-19 pandemic. In 2022, Thailand adopted a stricter SUP ban and developed tax incentives to encourage recycling that produces domestic waste feedstock. Also, starting in 2025, plastic waste imports will be banned in Thailand.[64] Such policies, when implemented carefully, and with consideration of the consumers and businesses that may be impacted, can drive opportunities for innovative solutions to scale—for example, ones for takeaway food and beverage containers that replace the expanded polystyrene with molded fiber alternatives. Several AMS are considering SUP restrictions in some form, and the proliferation of innovations for alternative materials has substantial potential to scale if policies are enacted and enforced.

Direct Financial Support Tools: Governments also help innovations to scale through catalytic funding that leverages a broader category of investors. Several policies related to the plastic waste management ecosystem have been developed to provide financial support for businesses that contribute to the sustainability of their operations.

Loans provided by governments or via intermediaries enable businesses to access capital investment or working capital on better terms than what is available in the market. By guaranteeing innovations' financing, governments can support the provision of private financing for innovations, and especially for SMEs that lack collateral. These concessional loans have longer-term maturity and grace periods and, thus, they facilitate better opportunities for financing circular business models.[65] Across the six AMS, commercial loans do not appear to be available for early-growth-stage businesses. Currently, there are only a few financing products with underlying Circular Economy metrics, and most are part of more comprehensive initiatives that focus on energy efficiency in housing and manufacturing. One successful example is Indorama Ventures. This Bangkok-based intermediate petrochemical producer secured the world's first "blue loan" in 2020—a financing package of $300 million from IFC, the Asian Development Bank, and Deutsche Investitions–und Entwicklungsgesellschaft. By 2025, this loan is expected to enable Indorama Ventures to recycle 50 billion PET bottles per year in Brazil, India, Indonesia, the Philippines, and Thailand, and effectively divert this plastic waste from leaking in the environment.[66]

Credit bonds are issued as alternatives to loans and sold as debt securities to investors. Some of these bonds address

63 Reloop Platform. 2021. "Factsheet: Deposit Return Systems – System Performance."

64 Office of the Prime Minister (Thailand). 2023. "Thailand prepares to implement laws to control plastic waste imports, unlocking problems of accepting waste from other countries."

65 GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH). 2022."Financing Circular Economy –Insights for Practitioners."

66 Indorama Ventures. 2020. "New Blue Loan to Help Indorama Ventures Recycle 50 Billion PET Bottles a Year by 2025." A blue loan is an innovative financial instrument whereby the funds raised are certified and tracked exclusively for projects that support a blue economy.

"For the Philippines, EPR is a good first step, albeit imperfect: The EPR Act highly incentivizes the processing of plastic waste and encourages, but does not incentivize, upstream to midstream innovations. So again, here we [have] a landmark policy which again focuses on incentivizing downstream."
Entrepreneurial Support Organization, Philippines

environmental and social issues, and the market for these *green, social, and sustainability bonds* (GSSBs) has grown remarkably since the World Bank issued its first green bond in 2008.[67] The public sector, including government agencies, international financial institutions, and LGUs, comprised 30 percent of total issuances in 2023.[68] However, the appetite for this type of financing is lower in emerging markets. In 2023, this comprised only a small fraction (15 percent) of the total amount of financing issued, as investors were more likely to face challenges, such as a weak regulatory framework, lack of institutional capacity, and a lack of data on potential borrowers. "Greenwashing" (falsely claiming or exaggerating environmental benefits) is another concern, as resources should only be allocated to projects with a significant impact.

Sustainability-linked bonds (SLBs) provide a more targeted approach as the financial and structural characteristics are based on the issuer achieving environmental, social, and governance metrics within a defined timeframe. SLBs are more accessible for businesses, as they do not require pre-defined eligible projects or heavy capital expenditures.[69] The ASEAN Capital Markets Forum, which is comprised of ASEAN market regulators, developed the ASEAN Sustainability-Linked Bond Standards (ASEAN SLBS) to facilitate using SLBs to fund businesses that are contributing to sustainability.[70]

Innovation vouchers are small grants allocated to innovative SMEs so that they can purchase advice on business management and how to apply technology. An initiative to provide vouchers is simple to design and implement, with minimal "red tape."[71] Vouchers are also demand-oriented, which means that SMEs can define what they want from advisors based on what they need. However, due to vouchers' simplicity to execute, this policy instrument runs the risk of being a one-off transaction for businesses, which achieves limited behavioral change.

Equity finance instruments comprise governments taking equity in small, young, and high-risk innovative businesses. These instruments include a *government venture capital (GVC) fund* that collaborates with a private investor to provide businesses with both capital and advice. GVCs, which are provided in economically lagging regions, run a higher risk of political interference, which can significantly alter the efficiency of the initiatives.[72] In 2012, the French government launched Ecotech, which, as part of the *Future Investments Program*, has a fund of €150 million (~$162 million) that targets solid waste management and the circular economy.[73]

Grants and matching grants for collaboration and infrastructure development are the direct allocation of funding from public agencies to private businesses or other innovation actors, such as public and higher education research institutions.

67 World Bank. 2022c. "Sovereign Green, Social and Sustainability bonds: Unlocking the Potential for Emerging Markets and Developing Economies."

68 World Bank. 2023. "Green, Social, and Sustainability (GSS) Bonds: Market Update – January 2023."

69 World Economic Forum. 2022. "What are sustainability linked bonds and how can they support the net-zero transition?"

70 Climate Bonds Initiative. 2022. "ASEAN Sustainable Finance State of the Market 2022."

71 Cirera et al. 2020. "A Practitioner's Guide to Innovation Policy: Instruments to Build Firm Capabilities and Accelerate Technological Catch-Up in Developing Countries."

72 Alperovych et al. 2020. "Bridging the equity gap for young innovative companies: The design of effective government venture capital fund programs."

73 Bpifrance. 2023. "Capital Innovation."

Innovations are primarily found in the Midstream and Downstream segments, such as reverse vending machines that automate collecting, sorting, and handling the return of used plastic containers to support a DRS.

Increased R&D support has been valuable in countries such as Indonesia, the Philippines, and Vietnam, which have insufficient support mechanisms for the needs of individual enterprises. This approach fosters cooperation between academia and the private sector, and subsidies can play a parallel role. After a plastic bag ban was implemented in Rwanda in 2008, the government provided subsidies for manufacturers of alternative materials and products, which resulted in the proliferation of small businesses offering alternative materials.[74] Grants are recommended in the development stage of technologies, rather than the commercialization stage, because public subsidies can distort the scale-up of markets and crowd out private actors.

Infrastructure development that is specific to SWM and plastic circularity is often subsidized by the government. This infrastructure is essential for plastic innovation and is primarily developed in the Midstream and Downstream of the plastic value chain. Lack of infrastructure (MRFs, recycling facilities, and sanitary landfills) prevents innovations across all segments of the value chain. Also, innovations cannot access reliable feedstock from plastic waste.

Innovations are primarily found in the Midstream and Downstream segments, such as reverse vending machines that automate collecting, sorting, and handling the return of used plastic containers to support a DRS. From a policy perspective, the development of such innovations is facilitated either by providing grants or, indirectly, by providing effective regulatory conditions.

Other support tools: Other policy instruments support businesses by providing non-financial incentives.

Capacity Building and Training for SMEs: SMEs need capacity building to foster innovations and help secure skilled human resources. In general, training is a resource-intensive activity and a burden for SMEs since it costs more per worker due to SMEs' small number of staff.[75] Since 2001, the Korea Chamber of Commerce has operated the National Human Resources Development Consortiums Program, which helps and reimburses SMEs for organizing and conducting in-service training for their staff.[76]

Informal training is becoming more critical because of its effectiveness in enhancing SMEs' capacities. Trainings are prioritized based on how they directly affect a company's performance.[77] Informal training is favored by SMEs because it is more cost-effective than formal training, although the latter would provide better skills' development.[78]

Technology transfer for SMEs could be implemented by universities, public research organizations, or larger businesses. Governments could accelerate this process by supporting the successful launch of innovations through to commercialization, which would increase businesses' risk tolerance, and ensure that they have access to the data, skills, infrastructure, and collaborative networks, which they need to innovate.[79] Some governments have increasingly taken a hands-on approach in supporting SMEs to develop a bridge between basic research and commercial applications. In Germany, the federal government promotes industry-wide joint research with funding of €181 million (~$195 million), which supports higher education institutions and public research institutions in conducting research that has commercial applications.[80]

74 World Bank. 2022a. "Where Is the Value in the Chain? Pathways Out of Plastic Pollution."

75 Lee. 2016. "Skills Training by Small and Medium-Sized Enterprises: Innovative Cases and the Consortium Approach in the Republic of Korea."

76 Korea Chamber of Commerce and Industry. 2023. "SME Training Support Center." (Korean language)

77 Ibid.

78 OECD (Organisation for Co-operation and Development). 2013. "Skills Development in SMEs: Highlights."

79 OECD (Organisation for Economic Co-operation and Development). 2022a. "OECD Reviews of Innovation Policy: Germany 2022: Building Agility for Successful Transitions."

80 AiF (Arbeitsgemeinschaft industrieller Forschungsvereinigungen). 2024. "Innovative Power Through Collaborative Research."

Box 9.

Case study: The Role of Government in Thailand's Entrepreneurial Ecosystem

Thailand's GPP Plan is part of the National Economic and Social Development Plan that promotes sustainable consumption and production. The first GPP Plan was implemented from 2008 to 2011, and it resulted in the development of Green Cart Criteria for Office Consumables such as printer paper and toilet rolls; durable goods such as steel furniture; and services such as photocopier rental. A second GPP Plan (2013 to 2016) promoted the initiative from the central level down to local authorities. The Pollution Control Department of the Ministry of Natural Resources and Environment is responsible for executing the GPP Plan, in collaboration with relevant ministries and stakeholders. As a result of this policy, the number of green certification schemes for products and services has increased (for example, the Thai Green Label) and additional support has been provided. The GPP Plan demonstrates the government's commitment to developing bioplastics, and GPP has expanded the demand for plastic alternatives. The government of Thailand has also introduced various measures to facilitate SMEs' access to funding and launched capacity-building programs to boost the competitiveness of Thai SMEs. These include the Thai Credit Guarantee Corporation Portfolio Guarantee Scheme, the Business Security Act (B.E. 2558, 2015), the Bank of Thailand's revision of several financial regulations, and capacity-building programs. To support particularly innovative technologies and business models, the Thai National Innovation Agency and the National Science & Technology Development Agency target the digital economy and innovative start-ups. The Thai Ministry of Industry focuses on three key areas: improving manufacturing processes; increasing waste management, reuse, and recycling; and promoting the growth of circular enterprises. Thailand also has tax incentives to boost the use of more sustainable materials for plastic packaging. For example, from 2019 to 2021, the Thai government provided a two-year tax incentive for businesses that used biodegradable plastics in their packaging, rather than virgin plastics. Also, a tax deduction of 1.25 times the amount spent on purchasing biodegradable packaging was available for buyers of local bioplastics, and this deduction was extended from 2022 to 2024.

Source: Switch Asia. 2020. "Thailand steps up with new policy to promote environmentally friendly products and services."

A Technology Protection Program finances protecting SMEs' technologies from theft, and it enables SMEs to safely distribute their technology. This protection is crucial for providing a safe environment where SMEs can conduct the research necessary to develop their innovations. In Korea, to ensure that SMEs are paid fairly for the technologies they develop, the Ministry of SMEs and Start-ups supports SME innovators' development of technology, and it punishes those who try to steal it.

Clusters, technology parks, and competence centers: Creating a physical or virtual space where businesses can interact with external actors helps to develop and maintain an innovative ecosystem that responds to businesses' need for knowledge. Also, these spaces enable businesses to collaborate with more diverse partners. *Science and technology parks* facilitate businesses' innovation by providing them with a physical location and infrastructure. Many countries operate *competence centers* that focus on the theme of plastic circularity. For example, in Finland, Haaga-Heila University of Applied Sciences created the *Competence Center for Circular Economy* to provide a digital platform that promotes circular business models to businesses.[81] Similarly, in Switzerland, the *Plastic Innovation Competence Center* was created as a one-stop-shop for industry to address the technological challenges related to plastic, and customize solutions.[82] Germany has taken a more comprehensive approach by creating a network of 26 competence centers.[83]

Incubators and accelerators finance early-stage support for young, innovative businesses by providing them with facilities and mentoring services. Incubators offer businesses physical space on flexible terms, while accelerators are typically growth-oriented and provide their services through a highly selective, cohort-based program that can last for a

81 Competence Center for Circular Economy. 2023. "The Competence Center for Circular Economy accelerates Finland's transition to a circular economy."

82 Plastics Innovation Competence Center. 2023. "Offering."

83 BMWK. 2023. "What is Mittelstand-Digital?"

year.[84] For example, the Korea Environmental Industry and Technology Institute (KEITI) operates the eTechHiv for green businesses,[85] and the Indo-Pacific Plastics Innovation Network (IPPIN), which was set up by Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO), provides a 10-week plastic circularity accelerator program.[86] These initiatives target innovations that are beyond the proof-of-concept stage, have a viable product, and a defined business model.

GPP arrangements can help to commercialize and scale plastic circularity innovations by creating demand.[87] Environmental agencies are leading GPP, but governments and LGUs are increasingly exploring GPP too, as a tool for green economic growth.[88] GPP is often used to leverage reducing plastic pollution; for example, the city of Seoul in Korea used a GPP policy to eliminate 90 percent of disposable plastic by 2020. Countries such as India and Thailand (see Box 9) have developed GPP guidelines for a variety of goods that range from office paper and carpet to construction supplies, but only a few guidelines target recycled plastics. In Singapore, the Land Transportation Authority recently piloted using materials made from plastic waste in road construction.[89]

The successful implementation of GPP across the public sector depends on having an enabling framework with institutional arrangements, regulations, an incentive structure, monitoring, reporting, and capacity building.[90] A coherent set of environmental criteria should be used in the contract tendering process to guide producers, and these should include technical specifications during the pre-awarding phase, or as selection criteria during the post-awarding phase.[91] The technical specifications should be mandatory and focus on environmental performance standards such as the use of sustainable plastic alternatives, requirements for recycled content in paper (a minimum content requirement), and certified IT equipment.[92] The Dutch Public Procurement Expertise Centre (PIANOo) set up the Sustainable Public Procurement (SPP) website, which is an online portal dedicated to government purchases of sustainable products and solutions. This portal runs its own "Criteria tool" that applies the government's environmental criteria, and when proposing solutions, bidders are asked to indicate whether their ambition level is "basic," "significant," or "ambitious".[93]

Ecolabels require the certification of the environmental characteristics of products and services, and they must make these characteristics public. An important objective of ecolabels is shifting the responsibility for compliance from users to suppliers. Suppliers are involved in the certification process, and they must pay any expenses required to ensure that their products comply with the certification standards.

4.3. International Policy Triggers for Plastic Innovation

Whether the six AMS achieve plastic circularity through their innovations depends on their national innovation system. Also, the broader context—the international policy environment—is critical in shaping and enhancing a country's innovative capabilities. This section discusses the role of trade policies and the international transfer of technologies to enable plastic innovation in the six AMS. Economic research suggests that the deregulation of foreign direct investment (FDI), as well as the reduction of tariffs on relevant products leads to improvements in

84 Bone et al. 2017. "Business incubators and Accelerators: The National Picture."

85 World Bank. 2024. "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions: Supplementary Note for Scaling Innovations for Plastic Circularity with Investment in ASEAN."

86 CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2024. "Accelerator: It's time to accelerate your impact today!"

87 The European Union is a leader in integrating environmental considerations into public procurement and defines GPP as "a process whereby public authorities seek to procure goods, services, and works with a reduced environmental impact throughout their life cycle." (European Commission. 2024. "What is green public procurement?")

88 World Bank. 2021a. "Green Public Procurement: An Overview of Green Reforms in Country Procurement Systems."

89 Kok. 2023. "LTA trials use of plastic waste to pave roads."

90 Ibid.

91 Appolloni et al. 2019. "Implementation of green considerations in public procurement."

92 EPA (United States Environmental Protection Agency). n.d. "Electronic Product Environmental Assessment Tool (EPEAT)."

93 PIANOo. 2023. Sustainable Public Procurement. https://www.pianoo.nl/en/public-procurement-in-the-netherlands/sustainable-public-procurement-spp

Photo: Waste collection facility labeled for proper waste segregation. *iStock/goc.*

the quantity and quality of domestic innovations and the number of patents.[94, 95] Such liberalization of trade and investment applies across the plastic value chain, but these improvements are particularly valuable at the upstream stage, given the overwhelming contribution that SUPs and hard-to-recycle materials make to mismanaged plastics in the six AMS. Also, implementing trade liberalization at the regional level could help to counter the low tariffs that virgin plastics enjoy, globally. Notably, substitute products are subject to higher tariffs, which further disadvantages them in comparison with plastic products.[96]

Trade Agreements: With regard to plastic waste management, the "Basel Convention on Control of Transboundary Movements of Hazardous Wastes" (hereafter abbreviated as the Convention), which was adopted in 1989, regulates the cross-border movement of hazardous and other wastes, and obliges parties to the Convention to ensure that such wastes are properly managed.[97] The Convention was amended in 1992 and 1995 to restrict the export of hazardous wastes from Liechtenstein, countries in the EU, and the Organisation for Economic Co-operation and Development (OECD). However, as of the first quarter of 2024, only four ASEAN countries (three of the six AMS) had ratified the amendment.[98] Additionally, with regard to plastic, the Convention was amended in 2019 to provide a clearer definition of the types of plastic waste that fall under the Prior Informed Consent procedure, which requires that the exporting parties formally secure the approval of the importing parties before they ship plastic waste.[99] The six AMS have each made efforts at the national level to curb plastic imports. Malaysia is the frontrunner, having banned all plastic imports in 2019; Thailand did the same in 2021; Vietnam will by 2025; while Indonesia, Cambodia, and the Philippines are lagging. Tariffs directly affect access to markets and they have a significant impact on the supply and demand for plastic substitutes. The United Nations

94 Liu and Wang. 2021. "The Impact of FDI on Domestic Firm Innovation: Evidence from Foreign Investment Deregulation in China."

95 Celli et al. 2022. "Better, Faster, Stronger: Global Innovation and Trade Liberalization."

96 UNCTAD (United Nations Conference on Trade and Development). 2023. "Plastic Pollution: The pressing case for natural and environmentally friendly substitutes to plastics."

97 UNEP (United Nations Environment Programme). 2011. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes.

98 Secretariat of the Basel Convention. 2019a. "Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal."

99 Secretariat of the Basel Convention. 2019b. "Basel Convention Plastic Waste Amendments."

Technology diffusion is a critical factor for enhancing efficiency, sustainability, and environmental responsibility. The diffusion process involves technology transfer, but also the assimilation of these innovations by different stakeholders.

Conference on Trade and Development (UNCTAD) found that plastic substitute products usually face higher import tariffs (5 to 35 percent), while the tariff for plastic is below 10 percent, and this affects the financial viability of plastic substitutes worldwide.[100],[101] Under the Bio-Circular-Green Economy program launched in 2015 by Board of Trade of Thailand, the government provides corporate tax holidays, as well as import duty exemptions for the machinery used by the producers of certain bioplastics.[102] Having encouraged both foreign and domestic investment, Thailand is now the world's second-largest producer of bioplastics, after the U.S.[103]

Foreign Direct Investment: Technology transfer is a key driver in promoting economic and knowledge development worldwide, and this is particularly important with regard to nascent technologies. Although significant advancement has occurred in achieving plastic circularity, most of the patented technologies are held by entities in OECD countries and China (80 percent in 2017), and technology transfer to other countries is limited.[104] FDI is the largest source of external finance in many developing economies, and it eases capital constraints, contributes to gross output, increases the employment rate, and aggregates productivity through positive productivity spillovers.[105, 106] Green FDI is increasingly gaining attention through progress in achieving environmental and climate goals.[107] While there is no single definition for green FDI,[108] UNCTAD has emphasized the important role of government policies and initiatives for green sectors; the role of investment promotion agencies in identifying how to maximize FDI in a country's green industry sectors; and the importance of sectors having relevant knowledge, and a focused strategy.[109]

Technology diffusion refers to the process through which innovations related to plastic materials, production activities, recycling methods, and other relevant technologies across the plastic value chain are adopted in the country.[110] Technology diffusion is a critical factor for enhancing efficiency, sustainability, and environmental responsibility. The diffusion process involves technology transfer, but also the assimilation of these innovations by different stakeholders. Technology diffusion is facilitated by favorable government policies, financial incentives, collaboration among stakeholders, and public awareness about environmental issues. The rate of diffusion is influenced by regulatory

100 UNCTAD (United Nations Conference on Trade and Development). 2023. "Plastic Pollution: The pressing case for natural and environmentally friendly plastic."

101 The discrepancy is even more striking between two products that are functionally identical but are made from different raw materials. Globally, the average tariffs on plastic and paper straws are 7.7 percent and 13.3 percent, respectively.

102 BOI (Board of Investment). 2021. "Investment Support Measures for Packaging Business in Thailand."

103 Royal Thai Embassy, Washington, DC. 2023. "Thailand is now the world's second-largest maker of bioplastics."

104 OECD (Organisation for Economic Co-operation and Development). 2022b. "Global Plastics Outlook: Economic Drivers, Environmental Impacts, and Policy Options."

105 Saurav and Kuo. 2020. "The Voice of Foreign Direct Investment: Foreign Investor Policy Preferences and Experiences in Developing Countries."

106 Liu and Wang. 2021. "The Impact of FDI on Domestic Firm Innovation: Evidence from Foreign Investment Deregulation in China."

107 Green Invest, UNEP (United Nations Environment Programme), and the Columbia Center on Sustainable Investment. 2017. "Green foreign direct investment in developing countries."

108 Definitions of green FDI include UNCTAD's definition, "Greenfield FDI in renewable energy, recycling activities and low-carbon technology manufacturing"; OECD's definition, "FDI in Environmental Goods and Services (EGS), proxied by FDI in electricity, gas and water sectors"; and FDI Intelligence's definition, "Greenfield FDI in solar, wind, biomass, hydroelectric, geothermal, marine and other renewable power generation." UNCTAD (United Nations Conference on Trade and Development). 2016. "The Observer: Promoting Green FDI: Practices and Lessons from the Field."
OECD (Organisation for Economic Co-operation and Development). 2011. "Defining and Measuring Green FDI."

109 UNCTAD (United Nations Conference on Trade and Development). 2016. "Promoting Green FDI: Practices and Lessons from the Field."

110 Stoneman and Battisti. 2010. "The Diffusion of New Technology."

environments, market demands, technological capabilities, and socio-economic factors, and therefore diffusion can vary significantly. SMEs can benefit from spillovers from technology diffusion through technology transfer that enhances SMEs' operational efficiency, competitive edge, and environmental compliance. However, SMEs tend to be worse off when they must compete with foreign businesses in the same industry. The long-term benefits of technology diffusion depend on whether the receiving country has the capacity to match the transferred technologies and skills with local capabilities.[111]

Achieving plastic circularity is imperative for continuing to use plastic and minimize its adverse effects. Many policies have already been explored and adopted in the six AMS to address this issue from various angles, and at national, regional, and global levels; however, significant gaps remain. Most policies focus on SWM, and how waste can be better managed, and they need to be complemented by promoting innovations that could transform the plastic economy. Policymakers can best support innovations by addressing the whole value chain, as well as supporting SMEs and markets, more broadly. Accelerating the adoption and implementation of these policies should significantly strengthen the opportunities for innovation to play a role in improving plastic waste management, recycling, and circularity.

One essential and final consideration is ensuring that instruments are well aligned to serve higher strategic objectives, and that they are coordinated, holistically, to create synergies. Holistic coordination of policy measures is a problem that many countries face in tackling cross-cutting societal challenges. However, some countries can provide the six AMS with a wealth of knowledge and expertise on coordinated policy measures, and critical insights on how to tackle plastic pollution and increase plastic circularity. For example, with its K-Circular Economy, Korea has created links between policies and overarching strategies.

By the end of 2024, ASEAN countries may become subject to a legally binding instrument on plastic pollution, which the UN is currently negotiating. Whether this UN instrument is modest or ambitious, it will require both the public and private sectors to act. By developing and implementing effective policies and regulations that substantially reduce plastic pollution, the ASEAN Region's role could be standard setting.

Photo: Oysterable reverse vending machine for collection of recyclables and reusables. *Oysterable.*

111 UNCTAD (United Nations Conference on Trade and Development). 2010. "Foreign direct investment, the transfer and diffusion of technology, and sustainable development."

CHAPTER 5.

Investment Needs and Opportunities in Innovations for Plastic Circularity in the Six AMS

As this study has highlighted, investors are reluctant to finance plastic circularity innovations due to three main hurdles when trying to scale up (see Section 2.3). In addition, across the ASEAN Region, the funds flowing into innovations that address plastic pollution are insufficient for innovations to scale.

To effectively address plastic pollution, the six AMS must support appropriate innovations to mature, targeting the gaps in their solid waste management systems and prioritizing the identification, adaptation, and replication of innovations that have proven successful in other parts of the world, ensuring their integration across the ASEAN Region. Along with developing sustainable materials, these innovations should also implement advanced recycling technologies and waste management systems. In addition, funding mechanisms should support feasibility studies, pilot projects, and technology transfer agreements that facilitate the replication process.

Photo: Facility processing plastic waste into recycled plastic pellets. *iStock/undefined.*

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5.1. Development Profile of Innovations in the Plastic Circularity Ecosystem in the Six AMS

Characteristics of Innovators: As the innovation analysis presented in Chapter 3 illustrated, 89 percent of the plastic-related innovations assessed for this paper are at the seed stage of development (the initial start-up phase, with little or no revenue generation), or at the very early growth stage (when products or services are being piloted or tested in the marketplace). Only a small number of innovations (11 percent) are at the ready-to-scale or expansion stage, where they are consistently producing revenue.

Investment activity and ecosystem by country: Of the investors and capital providers already active in the waste sector in the six AMS, many have a presence in Singapore, the ASEAN Region's financial hub. In addition to country-specific support in each AMS, this regional hub can provide opportunities for engagement with potential investors.

Across the six AMS, diverse sources of capital are scaling innovations, and these align with the four innovation stages along the plastic value chain (see Chapter 3).

- **Production (upstream stage):** As discussed in Chapters 3 and 4, upstream business models face challenges unless policies and regulations facilitate further interventions or incentives. A subset of these more disruptive solutions could be more attractive, high-risk/high-reward investment opportunities (such as the company, Synthetic). Venture capitalists and corporate venture capitalists[112] can support early-stage innovations, and private equity can provide support at later stages. Corporate bonds are also helpful when brands and producers want to increase recycled content. In Latin America, for example, such bond issuances have helped to drive the growth of bottle-to-bottle recycling technologies, and demand for high-quality recycled PET.[113]
- **Use (midstream stage):** Early-stage support for pilots of refill/reuse models is provided by donor agencies and ESOs. For example, the 2022 SUP Challenge, which was funded by GIZ's PREVENT Waste Alliance and local partners in South and Southeast Asia, has accelerated some refill/reuse start-ups.[114] However, as refill/reuse solutions in the six AMS lack a proven track record, they do not appeal investors who are seeking financial returns.
- **End-of-Use (downstream stage):** Depending on the downstream solution and the risk-reward profile, different investors are involved. Foundations and impact funds provide grants and low-interest loans to social enterprises (such as participants in the Incubation Network's programs). Venture capital providers have shown interest in advanced recycling technologies, although not yet in the ASEAN Region. At later stages of their development, IFIs and private equity funds have invested in businesses that provide better mechanical recycling. For example, the Recycling Modernization

112 Corporations with a vested interest in specific industries or technologies.
113 Global Plastic Action Partnership. 2022. "Unlocking the Plastics Circular Economy: Case Studies on Investment."
114 The Incubation Network. 2022b. "The SUP Challenge."

Fund (RMF) is a national initiative designed by the Australian government to boost the capacity of existing recycling infrastructure and commercialize or scale emerging or trial technologies (early-stage ones) for processing challenging-to-recycle plastics.[115] The Plastics Technology Stream established under the RMF receives applications from Australian state and territory governments that have identified prospective projects in businesses, research institutions, LGUs, and NGOs. Also, to subsidize business models, a few downstream solutions (recovery models, in particular) are considering using plastic credit mechanisms.[116]

- **Digitization (cross-cutting stage):** Digitization attracts venture capital providers, with notable examples in countries where EPR implementation creates a greater incentive to adopt tools that support mandated participation and accounting.

Understanding the relative maturity of each stage provides additional guidance on the types of investment that are most needed to advance innovations to the next stage. Appendix 4 details the type of capital used in the ASEAN Region. Appendix 5 provides examples of financing criteria used by selected investors for plastic circularity investments. Table 7 lists the categories of investors who play essential roles in driving technological advancements and economic growth.

Table 7. Potential Sources of Capital for Early-stage Companies

TYPE OF FUNDING	DEFINITION	STAGE OF INVESTMENT
Self-financing	Funding comes from personal savings, family, and friends.	Concept - Pilot
Seed Investors	Typically, these are the first to provide funding for start-ups and innovative projects. They offer initial capital to help entrepreneurs validate their ideas, develop prototypes, and conduct feasibility studies. They also take a relatively high level of risk in exchange for equity in early-stage ventures.	Concept - Pilot
Angel Investors	High-net-worth individuals invest their personal capital in start-ups and emerging companies. They often provide not only financial support but also mentoring and industry expertise. They typically become involved during the early stages of a company's development, and help it grow and succeed.	Concept - Pilot – Readiness to Scale
Venture Capitalists (VCs)	Institutional investors manage pooled funds from various sources, such as private investors, corporations, and government entities. They specialize in investing in start-ups and high-growth companies and, typically, at the early to mid-stages of development. VCs often provide significant funding, guidance, and connections to help start-ups to scale quickly.	Concept - Pilot – Readiness to Scale
Corporate Venture Capital	Corporations with a vested interest in specific industries or technologies may establish corporate venture capital arms. These entities invest in start-ups and innovations that align with their strategic objectives. Corporate investors not only provide financial resources, but also potential partnerships, distribution channels, and market access.	Concept - Pilot – Readiness to Scale
Private Equity Firms	Private equity firms focus on later-stage investments in mature companies. While they may not directly participate in the earliest stages of innovation, they often acquire and invest in companies with proven technologies or products. Their involvement may include restructuring, expanding, or optimizing the operations of companies.	Readiness to Scale
Incubators and Accelerators	These provide start-ups with funding, mentoring, resources, and a structured program to help them develop and grow rapidly. While they may not be traditional investors, they play a critical role in nurturing innovation, and preparing start-ups for subsequent funding rounds.	Concept - Pilot

115 Department of Climate Change, Energy, the Environment and Water (Government of Australia). 2023. *Investing in Australia's waste and recycling infrastructure.*

116 A plastic credit mechanism is a market-based instrument designed to reduce plastic pollution. Plastic credits are awarded when an entity recovers or recycles a certain amount of plastic waste. These credits can then be sold to others such as businesses producing or using substantial amounts of plastic in their operations, and the credits will offset their plastic footprint.

TYPE OF FUNDING	DEFINITION	STAGE OF INVESTMENT
Crowdfunding Platforms	These enable individuals and the general public to invest in innovative projects and start-ups. This funding model is a decentralized approach to raising capital, which is often in exchange for rewards, equity, or tokens. Crowdfunding can provide early-stage capital and validate market demand for innovative ideas.	Concept
Family Offices	These manage the financial affairs of wealthy families, and often invest in innovation projects and start-ups as part of a diversified investment portfolio. Family offices may take a long-term view, and provide patient capital to support innovative ventures.	Concept - Pilot
Strategic Investors	These are established companies that invest in start-ups and innovations to gain access to new technologies, markets, or talent. Their investments are typically aligned with their strategic goals and can lead to partnerships, collaborations, or acquisitions.	Concept - Pilot – Readiness to Scale
Government and Public Sector Investors (State-owned Enterprises)	These investors support innovations through grants, subsidies, and research programs, and they often aim to stimulate technological advancements, economic growth, and competitiveness in their country. Their funding may target a wide range of innovation activities, from basic research to product development.	Concept - Pilot

Source: The World Bank Group

5.2. Overview of Investments in Innovations in Waste Management, Recycling, and Plastic Circularity in the Six AMS (2018–2022)

Between January 2018 and September 2022, there were 88 transactions in the six AMS, which were worth over $1.59 billion (see Chapter 3), including 42 at an early stage of development, with a reported aggregate investment of $11.4 million (see Table 8.).[117]

The analysis in this paper reveals some key trends:

- Global and regional plastic producers are making strategic, larger investments in plastic recycling, and particularly in recycling PET (for example, Indorama Ventures PCL's $300 million blue loan from IFC/ADB/DEG to fund the expansion of its PET recycling capacity in the ASEAN Region and Latin America).
- Early-stage technology-enabled business models are technology-oriented venture capitalists' choice of investment. Venture capital businesses have financed a small number of deals in the six AMS, which have focused on technologies for plastic circularity.
- Early-stage innovations, such as digitization and refill/reuse innovations primarily receive small investment amounts of non-interest paying capital, such as grants or prize money.
- As the value of many transactions is not reported, this lack of transparency prevents institutional investors from analyzing the investments made in the sector.

The limited number of transactions made in the six AMS since 2018 indicates considerable potential for investors to grow and scale innovations in plastic circularity from the early stage of the development cycle. Implementation of the recommendations in Chapter 6 could support investors in deploying their financing along the plastic value chain.

As indicated in Table 9, of the six AMS, Indonesia's overall start-up financing ecosystem is regarded slightly ahead of the others. As the ASEAN Region's largest economy, Indonesia rivals Singapore in the average size of its early-stage venture capital investments and Indonesia

117 The financing amounts for a sizable number of these transactions were not disclosed.

Table 8. Investments in Plastic Waste Management, Recycling, and Circularity in the Six AMS, by Stage (January 2018–September 2022)

BY STAGE	UPSTREAM	MIDSTREAM	DOWNSTREAM	CROSS-CUTTING	TOTAL
All transactions in plastic waste management, recycling, and circular infrastructure and innovation					
Number of deals	27	8	41	12	88
Aggregate value ($ million)	23	1	1,489	77	1,590
Number of deals with an undisclosed value	11	4	21	0	36
Early-stage transactions* (subset of total transactions above)					
Number of deals	20	7	4	11	42
Aggregate value ($ million)	2.00	0.70	0.22	8.10	11.02
Number of deals with an undisclosed value	8	0	2	4	14

Source: Plastics Circularity Investment Tracker 2023

* Early-stage deals included accelerator/incubator financing; angel funding; convertible notes; equity crowdfunding; grants; non-equity assistance; pre-seed finance; product crowdfunding; seed finance; early-stage venture capital; and Series A, Series B, Series C, and Series D funding.

Table 9. Number and Value of Plastic Circularity Investments in the Six AMS, by Country (January 2018–September 2022)

COUNTRY	CAMBODIA	INDONESIA	MALAYSIA	THE PHILIPPINES	THAILAND	VIETNAM	TOTAL 6 AMS
All transactions in plastic waste management, recycling, and circular infrastructure and innovation							
Number of deals	4	38	16	6	9	15	88
Aggregate value ($ million)	0.05	32	402	0.02	1,074	81	1,590
Number of deals (value undisclosed)	1	18	5	5	2	5	36
Early-stage Investments (subset of total investments above)							
Number of deals	3	24	2	3	2	8	42
Aggregate value ($ million)	0.05	8.5	0.3	0.02	0.07	2.5	11.4
Number of deals (value undisclosed)	0	11	0	2	0	1	14

Source: Plastics Circularity Investment Tracker, 2023

has the region's largest number of "unicorns".[118] This study's consultations with investors who are interested in plastic circularity investments in the $2 million to $10 million range, put Indonesia ahead of the other five AMS. Thailand and Malaysia were investors' next choice, followed by Vietnam and the Philippines. Cambodia, which has a smaller economy, and is not one of the region's top 10 contributors to plastic pollution, did not appear to be a target for investors. These choices of investors are broadly reflected in the number and the value of known transactions. Appendix 6 shows selected venture debt providers and their products.

In addition to the relevant issuer's linkage to the plastic value chain, the transactions, which are summarized in Table 10, have two common characteristics: a creditworthy borrower and a large amount raised—and, thus, sizeable individual investments. Both factors facilitate the ability of large institutional investors to invest their capital. In contrast, in the six AMS, plastic circularity innovations requiring capital seek smaller amounts of funding and have little or no credit history. Innovations that are not yet ready to scale are less likely to access capital and they indicate future capital needs. Engaging investors in the near future will be essential to ensure that future demand is met. Appendix 2 summarizes the top 10 plastic circularity transactions by deal value in the six AMS from 2018 until the first nine months of 2022.

Table 10. A Selection of Innovative Plastic Circularity Finance Offerings in Emerging Markets (2020–2022)

DATE	ISSUER	COUNTRY	INNOVATIVE FINANCIAL INSTRUMENT	AMOUNT
March 2020	Indorama Ventures	Thailand	Sustainability-linked Ninja Loan	$255 million
August 2020	Coca-Cola FEMSA	Mexico	Green Bond	$705 million
September 2021	Coca-Cola FEMSA	Mexico	Sustainability-linked Bond	MXN9.4 billion
November 2020	Indorama Ventures	Thailand	Blue Loan	$300 million
November 2021	Indorama Ventures	Thailand	Sustainability-linked Bond	THB10 billion
July 2021	Duy Tan Plastics Corporation	Vietnam	Green Loan	~$60 million**
May 2021	Natura Cosméticos SA	Brazil	Sustainability-linked Bond	$1 billion

Note: MNX = Mexican Peso; THB = Thai Baht

Source: Plastics Circularity Investment Tracker, 2023

** Economist Impact. n.d. "How a green financing deal with HSBC helped a plastics producer open a recycling factory."

118 In finance, a "unicorn" is a privately held start-up company valued at over $1 billion.

CHAPTER 6.

Creating the Enabling Environment and Markets to Improve Investments in Plastic Circularity Innovations

Significant efforts are required for plastic circularity innovations to attract investors and have a significant impact on circular economy goals, overall. Scaling innovations in plastic waste management in the six AMS requires the creation of profitable and sustainable markets for plastic circularity along the plastic value chain and addressing the three main hurdles identified (see Section 2.3).

In addition, in each of the six AMS, SWM is at a different level with regard to implementing innovations in plastic circularity across the plastic value chain (see Chapter 2): (i) Cambodia, Indonesia, and the Philippines have a nascent SWM ecosystem; (ii) Indonesia and the Philippines, which both have thousands of small islands, require special solutions for SWM due to their geographic challenges, and the lack of capacity in island LGUs and communities; and (iii) Malaysia, Thailand, and Vietnam, all of which have large cities and have an emerging SWM ecosystem.

Photo: Worker logs in bales of sorted, cleaned and compressed plastic waste. *Shutterstock/V.stock.*

Given the status of individual countries' SWM, scaling up plastic circularity innovations in the ASEAN Region requires identifying and supporting innovations to address the key infrastructure and technological gaps in plastic waste management. The ASEAN Region's current innovations have limited capacity to grow and scale across the four development stages of the plastic value chain. These stages are: (i) Upstream stage innovations that reduce the sources of plastic waste, (ii) Midstream stage innovations that collect plastic waste and segregate it at source, (iii) Downstream stage innovations that improve the recovery of plastic waste in MRFs and recycling facilities, and (iv) Cross-cutting stage innovations that provide digital tools to improve transparency and accountability.

A viable strategy to enable innovations in the six AMS would be through developing and enforcing effective policies and regulatory frameworks. Based on countries' plastic and SWM status, a variety of policy levers are needed to stimulate the growth of innovations.

Policies that support innovations in the midstream and downstream stages should be a focus in the AMS because these would tackle the urgent issues of recoverable plastic materials and plastic residue leaking into the environment. Also, if policies for innovations in the upstream stage are supported, this would provide comprehensive support for innovations across the whole plastic value chain and help to address the issues of inefficient plastic waste management and the consumption of SUPs.

To scale plastic circularity innovations in the six AMS, regional cooperation is needed to support a complex endeavor that requires sustained effort and the collaboration of multiple players. This also requires adapting strategies, policies and technological solutions to the unique challenges and opportunities present in each country. From a policy perspective, a practical way to overcome the risk of negative consequences is to institutionalize monitoring and evaluation in strategies, and thereby promote adaptive learning.

The following section presents recommendations that are based on the analysis undertaken in this study concerning how to support the creation of functioning markets for plastic circularity.

Photo: Cushion fabric made from upcycled plastic. *iStock.*

6.1 Scaling Innovations by Stage

6.1.1. Value Chain Stage

Gaps in SWM and the impacts on plastic waste management were identified in Chapter 2, and the types of plastic circularity innovations across the plastic value chain were detailed in Chapter 3. About 48 percent of the innovations were at concept stage, and only 16 percent demonstrated readiness-to-scale (see Figure 7). About half of the innovations focus on the midstream stage and are increasing collection and separation efficiency through refill and reuse. Innovations in the other stages are lagging, and they reflect the lack of market support for source reduction, the lack of infrastructure for recovery and recycling, and the novelty of cross-cutting innovations in digitalization.

Regarding plastic waste management innovation in the ASEAN Region, a sizeable portion of innovations occur in the midstream stage of the plastic value chain—collection and segregation (about 45 percent). Innovations in the upstream stage that achieve source reduction comprise 25 percent of the innovations reviewed and innovations in the downstream and cross-cutting stages are fewer (16 percent and 13 percent, respectively).

About 47 percent of upstream innovations are still in the early concept stage. This stage comprises turning ideas for products and services into prototypes or business concepts, and it precedes the piloting and refining stage. A substantial number of upstream innovations in plastic waste management face challenges in progressing to the piloting and the ready-to-scale stages. This suggests that innovations may need more sustained support at the concept stage to validate their prototypes with field testing so that they can move on to the piloting stage.

At the midstream stage, over 85 percent of innovations are at the concept stage, and only a very small percentage go on to become viable businesses. As a result, only 2 percent of innovations are ready to scale, which indicates that most innovative midstream businesses do not grow beyond the concept and piloting stages. However, supportive policies, public awareness, and public and private investment at the midstream stage could drive innovations for the collection and segregation of plastic waste, as well as innovative business models, such as package-free shops, refill systems, and reusable packaging.

The downstream innovations analyzed in this study were few, and they were divided across the concept, piloting, and ready-to-scale stages. This could be due to the need for capital intensive investments in MRFs and recycling infrastructure, and in advanced digital technology. Downstream innovations could produce better feedstock by improving recycling, and digital technology could enhance the efficiency of the plastic value chain, and both indicate a need to scale innovations in these areas (see Chapter 3). Recovery and recycling innovations could lead to better recycling, as well as proper disposal that prevents the leakage of plastic waste into the environment.

There were only a few crosscutting innovations in this study, which suggests the novelty and the narrow focus on digitalization or enhancing the efficiency of the plastic value chain by applying smart technologies or operating platform-based centralized businesses. With the need for data to support decision-making, enhance public awareness, and increase private sector involvement, all countries should invest in more and better support for the innovators that are working on improving transparency and accountability in the waste sector.

In this context, the key components of investment for innovations should include:[119]

- **Expansion of Circular Economy Initiatives:** Circular economy principles lie at the heart of addressing plastic pollution. Investments should foster the expansion of initiatives that encourage the redesign, reuse, and recycling of plastic products. This entails promoting the development of eco-friendly product designs, the establishment of recycling infrastructure, and the implementation of dedicated plastic waste reducing policies (for example, EPR).
- **Infrastructure Development:** Investments to develop infrastructure and equipment to collect, sort, recycle, and

119 Note: research and development were outside the scope of this paper.

manage the disposal plastic waste, efficiently, should comprise developing MRFs, recycling centers, and enhancing solid waste collection and disposal systems.

- **Innovation Adoption and Integration:** The adoption of innovations requires substantial investments in policy and institutional development, capacity building, and public awareness campaigns. Financial support should be allocated to design and implement education and training programs that encourage industries to adopt sustainable practices and technologies. Also, governments should collaborate with industry stakeholders to develop comprehensive regulatory frameworks, which incentivize the adoption of circular economy practices and penalize environmentally detrimental ones.
- **International Collaboration and Knowledge Exchange:** Investments should facilitate knowledge exchange and partnerships with countries that have successfully implemented circular economy strategies. Funding mechanisms should support participation in international forums, research collaboration, the establishment of joint ventures with technology providers, and ensure that the six AMS remain at the forefront of innovation in combating plastic pollution.
- **Monitoring, Evaluation, Reporting, and Verification:** Transparent and accountable mechanisms for monitoring and evaluating the impacts of investments are crucial. This information, which requires data, is necessary to enable policymakers and stakeholders to make informed decisions, refine strategies, and optimize resource allocation. Thus, adequate funding should be allocated to establish comprehensive data collection and public reporting systems and carry out impact assessments and performance evaluations.

6.1.2. SWM Ecosystem Type

Strategic interventions should prioritize areas where rapid and significant changes are possible, are based on the country's SWM status, and on the strategic areas that address immediate needs, as well as the long-term goals of plastic management.

Fostering plastic circularity in a nascent SWM ecosystem (Cambodia, Indonesia, and the Philippines) requires a holistic and comprehensive approach across the plastic value chain. The strategic focus should first be on strengthening basic policies and regulations to address their limitations and/or poor implementation. Given the material loss of valuable recyclables, innovations midstream and downstream are needed, but they should be upstream as well to reduce sources of plastic waste. These should be supported, too, by community engagement in waste collection and segregation at source, which would maximize the recovery of recyclable products and reduce plastic leakage. As stated in Section 6.1.1, countries need to focus on midstream and downstream innovations, accompanied by appropriate policies (see Section 4.1). Efforts by government or companies to introduce reverse vending machines or upcycling also need additional support. The relatively high collection ratio, and the prominence of the informal sector, for example in Metro Manila in the Philippines, could serve as a foundation for innovation, as has been shown by the local companies that have already launched innovative plastic waste management businesses. These SMEs would benefit from government loans, as well as loans from microfinance institutions and banks. Weak demand for recycled plastics, low recycling capacity, and dependence on high-quality imported plastics impede innovations' scale up, despite the availability of technology that can produce food-grade rPET. Thus, additional efforts are required to

Strategic interventions should prioritize areas where rapid and significant changes are possible, are based on the country's SWM status, and on the strategic areas that address immediate needs, as well as the long-term goals of plastic management.

further enhance plastic circularity through innovations.

Upstream innovations, such as eco-design and production have potential, but they require governments to institute robust regulatory frameworks and policies. Effective policies include restricting the use of SUPs through taxes and requiring and incentivizing the use of recycled and alternative materials.

For countries with emerging ecosystems (Malaysia, Thailand, and Vietnam), downstream innovations should seek investments to develop more sophisticated infrastructure and technologies for MRFs and recycling. In addition, the recycling market, which currently focuses on PET, could expand, given that these countries use other recyclable plastics, such as HDPE and LDPE. Attempts to innovate could also shift toward advanced recycling techniques such as chemical recycling, which would improve feedstock quality. Cross-cutting initiatives should go beyond digitalization to maximize big data, the Internet of Things, cloud management, and AI to improve operational platforms so that they achieve transparency and accountability in the plastic value chain.

In Indonesia and the Philippines, which are island states, attention should be paid to research about how to resolve plastic waste issues on small islands. Given islands' limited space for SWM infrastructure, their lack of resources, and their weak technical and financial capacity, Indonesia and the Philippines should prioritize: (i) Upstream innovations for source reduction to minimize the use of hard-to-recycle plastic; reduce use of plastic products and packaging; and implement local regulations that support limiting the latter. (ii) Midstream innovations, such as DRS, or other business models that provide financial incentives for returning plastic products. This could significantly improve collection rates by incentivizing distributors and consumers to properly dispose of their waste or recycle items of marginal economic value. Small islands should prioritize innovative waste collection systems involving community participation and emphasize refill and reuse solutions for plastic products. Community-led collection centers serve as effective focal points for proper waste management and disposal. (iii) Downstream, innovators should implement innovative, decentralized, "low-tech", and cost-effective recovery and recycling technologies that are suitable for small-scale, locally managed operations. Low-cost segregation technologies such as simple sorting systems are cost-effective and suitable for island settings that have limited resources, while cross-cutting innovations could share best practices in waste management and build regional and international partnerships.

Based on a country's typology, and the status of its SWM development and capacity, the focus for solid and plastic waste management should be on leveraging additional sources of financing (see Chapter 5), which can support and scale plastic circularity innovations. Each country's approach should be dynamic so that the development of its SWM capabilities adapt to the unique and changing challenges of its environment (see Table 11).

Box 10.
Island Solutions

Island economies, such as those in Indonesia and the Philippines, face unique challenges. Although their main cities are large enough to have the economies of scale needed for affordable solid and plastic waste management, less-populated islands cannot afford prohibitive SWM costs. On small islands, reducing upstream plastic use should be a high priority as the ability to process plastic waste is far more limited. Bans of SUPs could expand markets for alternatives, as well as encourage greener tourism. Limiting the availability of plastic, which is easier to do on a small island, could also ensure that the island stays cleaner and more attractive for tourists. Small island economies need more innovative, smaller-scale waste management solutions that are suited to their waste volumes, type of waste, and local management capabilities. At the very minimum, improving collection, and setting up a waste sorting facility would provide the basics to begin properly managing plastic waste. In addition, knowledge sharing at the regional level would facilitate piloting innovations and exchanging information about what does, and does not work. Mauritius is an excellent example of an island nation that has banned SUPs and which encourages refill-reuse solutions.

Table 11. Prioritization of Innovation Across the Plastic Value Chain in the Six AMS

STAGES	NASCENT ECOSYSTEM	SMALL ISLANDS	EMERGING ECOSYSTEM
Upstream: Source Reduction	++	+++	++
Midstream: Collection & Segregation	+++	+++	++
Downstream: Recovery & Recycling	+++	+++	+++
Cross-Cutting: Transparency & Accountability	++	++	+++

Note: + designates the level of importance: ++ important; +++ critical.

Source: The World Bank Group

Categorizing innovations across the plastic value chain according to their technology, methodology, and related policies is crucial so that countries develop effective strategies that are tailored to their needs and SWM status (see Chapter 2). To ensure that interventions are effective, sustainable, and scalable, the unique challenges, capacity, and resources of countries with nascent, emerging, and island based SWM systems must be considered (see Table 12). Each country's approach should be dynamic, evolve with the development of its SWM capabilities, and able to adapt to the challenges in its environment.

Key success factors that enable innovations in plastic circularity to scale:

- *Align with end-of-use infrastructure:* Packaging that is made from alternative materials could be mismanaged if the infrastructure to manage this waste stream is insufficient. Alternative materials that look like plastic products may end up in the plastic waste stream and contaminate the recycling system.
- *Support competitiveness:* Alternative materials should be required to meet the same performance standards and be the same price as virgin plastics. Innovators may encounter challenges in accessing feedstock due to underdeveloped supply chains, and the need to be cost-effective, which can impact the viability and scalability of their business model. Technological breakthroughs in the large-scale production of bioplastic alternatives have resulted in greater investments in commercial-grade production facilities.
- *Change consumer behavior:* New recovery services often require consumers to dispose of their waste in the right receptacle for each type of waste. To be successful, these models require effective marketing and public education campaigns, along with the equipment needed to ensure adoption. To achieve impact and earn a profit, most operational platform innovations require multiple stakeholders to change their behavior. Recruiting users requires sustained marketing efforts, financial incentives, and conducting educational activities in the local language. Maintaining active users depends on providing tangible rewards. While traceability is critical for supply chain management, some stakeholders who are not digitally savvy may view platforms that have a degree high transparency as overly intrusive, and this can become an obstacle to adoption.
- *Scale SWM funding:* Solid waste collection from households and businesses is typically mandated by SWM policies. When implemented at scale, private sector solutions focusing on recovery could be implemented across the LGUs. Without policies to fund such services, recovery businesses will be unable to scale, and waste will not be collected.
- *Develop end markets:* Processing plastic waste into high-quality recyclables must be cost-effective. Unless there are customers who are willing to pay a fair price for recycled materials, even low-tech solutions, such as manual sorting and mechanical shredding of plastics will struggle to stay in business. The lack of local or

Table 12. Prioritization of Innovations Based on a Country's Stage in the Plastic Value Chain and its Typology

INNOVATION STAGES/SWM ECOSYSTEM	NASCENT ECOSYSTEM	SMALL ISLANDS	EMERGING ECOSYSTEM
Upstream – Policies & Regulations for Source Reduction: • **Technologies:** Develop alternative materials & enhanced material manufacturing. • **Methodologies:** Institute LCAs for products, and sustainable product design principles. • **Policies:** Implement regulations to limit SUPs and incentives to use sustainable materials.	BASIC RECOMMENDATIONS ONLY Emphasize basic policies to reduce the generation of plastic waste, and especially of SUPs, and limit plastic leakage; and conduct public awareness campaigns on the benefits of reducing plastic consumption.	• Focus on strict controls of plastic imports. • Given the limited space that communities have for SWM, and the resulting leakage of plastic waste, develop strong policy frameworks that drastically reduce plastics' use in the tourism and fishing industries.	• Implement and enforce advanced regulatory frameworks that mandate reducing plastics' production and use. • Promote innovations for alternative materials & eco-design. • Support ESOs and PPPs to develop sustainable alternative materials.
Midstream – Collection & Segregation: • **Technologies:** Implement advanced sorting and segregation systems that use AI and IoT to optimize waste collection. • **Methodologies:** Implement community-based waste management models, and awareness raising and education programs on proper waste segregation. • **Policies:** Implement mandatory regulations on waste segregation and EPR.	• Implement simple, cost-effective innovations such as community-based collection. • Establish basic segregation practices at the household level. • Develop low-cost technologies for sorting and collection.	• Focus on efficient localized, specialized, and compact waste collection systems that are suitable for a small geographic area and leverage community participation.	• Prioritize collection and integrate advanced sorting and segregation systems. • Develop robust systems for household and industrial waste segregation.
	• Encourage business models that reduce plastics or extend the use of such products—for example, refill/reuse and product-as-a-service.		
Downstream – Recovery & Recycling: • **Technologies:** Enhance recycling processes and chemical recycling methods. • **Methodologies:** Integrate SWM systems and conduct recycling efficiency assessments. • **Policies:** Require minimum recycled content and incentives for the recycling industry.	Emphasize building basic infrastructure for MRFs and recycling. Promote small-scale community-led recycling initiatives. Include the informal sector in SWM.	Explore innovative small-scale recycling technologies.	Invest in more sophisticated recycling technologies such as chemical recycling. Use PPPs to develop large-scale infrastructure for waste processing and recycling. Implement policies to support the recycling industry.
Cross-Cutting – Transparency &Accountability: • **Technologies:** Implement blockchain technology for supply chain transparency and accountability across the plastic value chain. • **Methodologies:** Develop and implement standardized data collection and reporting frameworks and stakeholder collaboration models. • **Policies:** Develop and implement SWM regulations that promote transparency and the public disclosure of SWM data.		• Implement technologies such as the blockchain for tracking SWM. • Build strong partnerships in SWM, including regional and international collaboration for knowledge sharing & resource exchange. • Share best practices in SWM. • Promote transparency and efficient SWM practices through data collection and sharing, and the development of digital platforms.	

Source: The World Bank Group

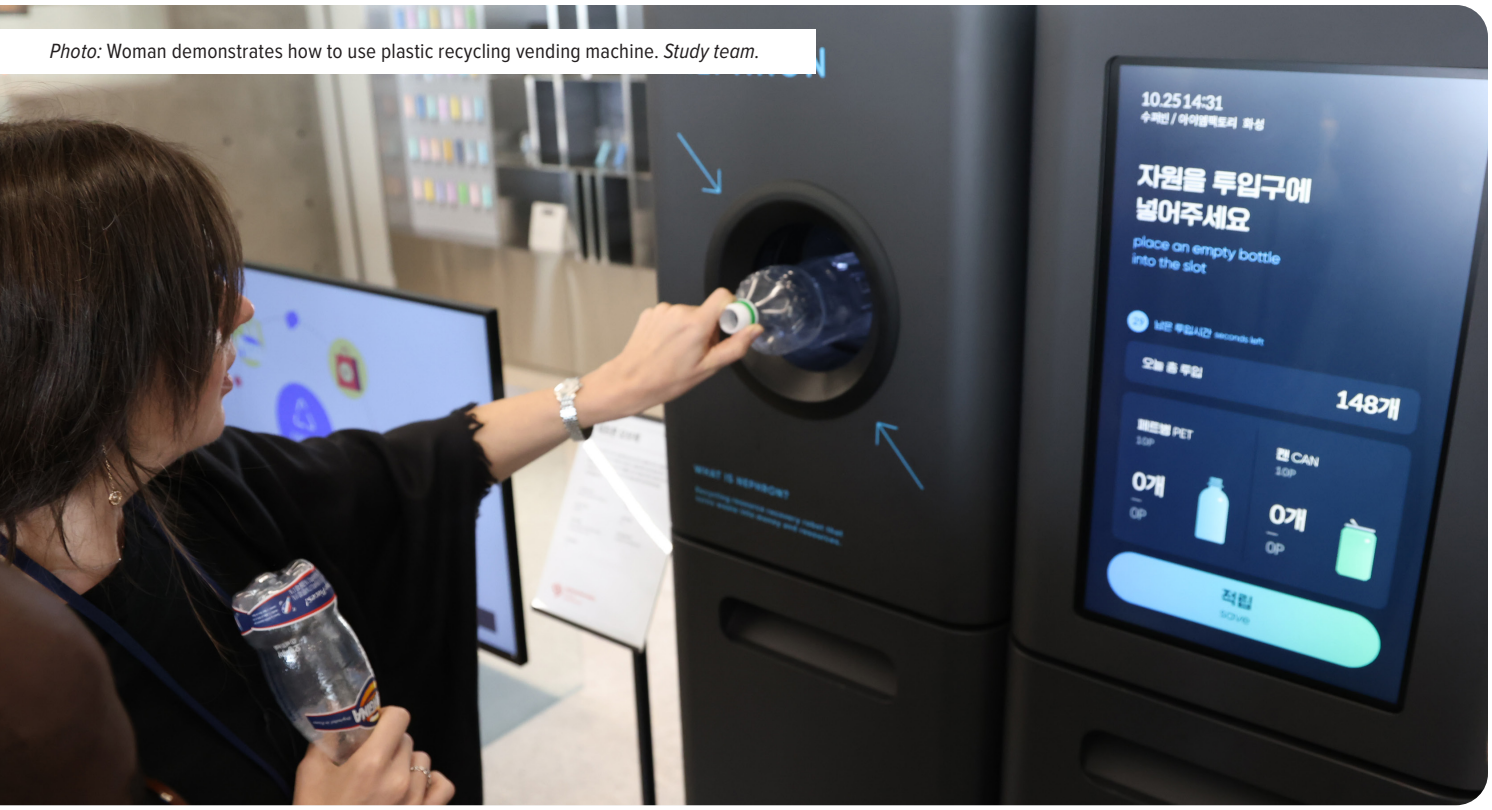

Photo: Woman demonstrates how to use plastic recycling vending machine. *Study team.*

regional end markets will restrict the demand for recycling innovations.

- *Construct recovery and recycling infrastructure:* Redesigning packaging to make it recyclable will only be effective if recovery and recycling infrastructure is widely available. This means increasing the collection and segregation of waste so that more recoverable material is available for recycling.
- *Achieve critical mass:* While launching a mobile app is easy and inexpensive, reaching scale in a crowded ecosystem takes time and effort. The critical challenge for operational platforms continues to be attracting large buyers and sellers so that a critical mass of active users is reached, and the platform delivers value and impact.
- *Improve access to feedstock:* Scaling recycling innovations requires access to enough materials, and strong policies that support commercial operations. Significant barriers can arise due to insufficient feedstock because waste collection and segregation are not enforced, and there is not enough funding for local recycling infrastructure.

6.2 Supportive Policies and Financial Incentives for Plastic Circularity Innovations

6.2.1. Policy Gaps and Coordination to Address Institutional Failures

Due to the diverse economic and development stages of SWM in the six AMS, the policies and practices for plastic and solid waste management need to progress from a nascent to an emerging ecosystem. For innovations in the upstream stage of the plastic value chain to evolve so that they support source reduction, effective policies and regulations must be issued and enforced. Also, the collaboration of a wide range of stakeholders is required, which includes central government agencies, LGUs, businesses, and consumers.

- *Nascent Ecosystem.* For countries in the early stages of SWM development, basic policies could include: (i) banning non-essential and the most harmful plastic products;

(ii) introducing DRS for bottles; and (iii) imposing fines for inappropriate SWM practices. Also, a foundational policy framework for SWM is necessary to establish clear and enforceable regulations for source reduction and SWM. This framework should also include defining the roles and responsibilities of the various stakeholders (government, the private sector, and communities). Basic SWM regulations will encourage investment if they ensure that all communities apply them, and that the large informal sector is integrated into local SWM systems.

- *Emerging Ecosystem:* Countries with emerging SWM development should focus on improving and expanding the use of already developed policies and infrastructure and adopting innovative approaches for dealing with their various challenges. Advanced SWM policies for source reduction would complement the implementation of extended producer responsibility regulations that make producers responsible for the end-of-life management of their plastic products and packaging. Policies for GPP would support innovators in developing alternative materials. Other regulations, such as ones that restrict certain additives, would increase the plastics available for recycling, and as plastics become easier to recycle, this would increase the potential for investments in innovation. Also, mandates that require recycled content in packaging and products would encourage the development of markets for downstream innovations in recovery and recycling. In addition, related policies would strengthen the development of robust systems for SWM, and especially the development of more sophisticated designs for recycling. This, in turn, would improve the monitoring and collection of data on waste, which government authorities need so that they can make policy and operational decisions, which are based on accurate data and information.
- *Small Islands' Ecosystem:* It is important to implement upstream policies to control plastic consumption and the amount of plastic waste that is discharged on an island. Upstream innovations can include policies to reduce the import and use of specific problematic plastic items, such as the plastic bag ban introduced in Samoa in 2019, and the plastic bag levy in Tonga.[120] Policies can also reduce plastic waste from tourism—for example, day tourists visiting Mabul Island in Malaysia are required to carry their plastic waste back to the mainland.[121] Establishing and implementing policy incentives for specific industries such as tourism can effectively reduce the use of plastic products, and improve the collection, recovery, and recycling of plastic waste. As tourism businesses on small islands need to address their own plastic waste, they should collaborate in encouraging innovations in plastic circularity.[122]

The roll-out of plastic waste management regulations should be carried out with enough lead time to allow the private sector to respond. As part of implementing regulations, building government systems and capacity for enforcement is critical for achieving credibility, so that investors will be willing to risk investing. The government of Korea has provided policies, systems, technology, and the targeted training necessary to establish effective waste collection and segregation systems, and successful recycling markets. This has been financed with funds such as Korea's *Recycling Industry Growth Fund* that fosters waste circularity under the *Environmental Policy Loan Program*. Synergy has been created, too, by combining innovative private sector approaches, such as *Superbin*, which produces plastic pellets from PET bottles by using AI. For more information, see the "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions." Supplementary Note to this report.

To transition from a nascent to an emerging SWM ecosystem (see Table 13), a country needs to strengthen its implementation of policies and regulations by shifting from a basic regulatory framework to more complex policies, such as EPR. This transition should foster a culture of innovation that results in the adoption of new technologies and practices for SWM and progresses from basic waste collection and disposal infrastructure to advanced processing and recycling

120 World Bank. 2022b. "Technologies and Solutions to Manage Plastic Waste in Small and Remote Islands."

121 Ibid.

122 IUCN (International Union for Conservation of Nature). 2023. "Waste-Free Islands."

Table 13. Transitioning SWM Innovations from a Nascent to an Emerging Ecosystem in the Six AMS

INNOVATIONS BY STAGES	NASCENT ECOSYSTEM	EMERGING ECOSYSTEM
UPSTREAM (Policies & Regulations for Source Reduction)	Basic policies and regulations to incentivize the reduction of plastic use, and the development of alternative materials: Implement tax breaks or targeted subsidies for companies that invest in developing environmentally friendly alternatives to materials with virgin plastics. Drive innovations in alternative packaging by enforcing the restriction of SUPs.	Advanced policies for reducing plastic use and promoting sustainable alternatives: Implement regulations that mandate the eco-friendly design of products and packaging, and reduce plastic use from the design stage. Adopt GPP policies that prioritize products with less virgin plastic, as well as sustainable packaging.
MIDSTREAM (Collection & Segregation)	Focus on enhancing the efficiency of the collection and segregation of plastic waste: Initiate government-supported community programs for waste segregation and collection, and provide resources and training to encourage local innovations. Integrate the informal sector into government SWM systems.	Support sophisticated systems for collection and segregation: Invest in fully automated waste sorting facilities that use advanced technologies such robotics and AI. Implement incentive schemes for households and businesses that effectively segregate their waste.
DOWNSTREAM (Recovery & Recycling)	Encourage the development of low-cost recycling and recovery processes: Provide grants or subsidies to finance communities or the informal sector in operating "low-tech" sorting and recycling facilities, and particularly facilities that can handle low-value and hard-to-recycle plastic. Provide financial and technical support for establishing local recycling facilities.	Focus on advanced recycling technologies and the development of markets for recycled products: Support advanced sorting and mechanical and chemical recycling facilities. Create policies that promote the market for recycled materials such as mandatory recycled content in certain products.
CROSS-CUTTING (Transparency & Accountability)	Implement digital systems for tracking waste flows and improving data collection to support evidence-based policymaking. Mandate public reporting on waste management by businesses that generate waste.	Implement blockchain technology for tracking and verifying nascent SWM practices. Foster international partnerships and adopting regional and global SWM best practices and standards.

Source: The World Bank Group

facilities. This should also improve engagement with local communities, and broader collaboration at the national level that harmonizes regulations and investments. To sum up, innovations in plastic circularity can enable countries with a nascent SWM ecosystem to "leapfrog" their policies, practices, and technologies to develop an emerging SWM ecosystem.

In addressing the challenge of circularity along the plastic value chain, tailored innovation-related policies are crucial for both nascent and emerging SWM ecosystems. These policies should be strategically focused on different stages of the plastic value chain: Upstream (source reduction), Midstream (collection and segregation), Downstream (recovery and recycling), and Cross-cutting (transparency and accountability), and they should be based on each of the two SWM ecosystems, as indicated in the country typology presented in Chapter 2. These policy recommendations are not an exhaustive list; rather they are based on a preliminary analysis, and further analysis is required to assess the efficiency and efficacy of these policies within their national context.

6.2.2. Financial Incentives to Address Market Failures

Common plastic products are underpriced, overused, and have a negative societal cost. As plastic circularity innovations

In a nascent plastic circularity ecosystem, business competitions can help jump-start the sector; however, the main purpose of competitions is to generate awareness and interest, and signal that plastic circularity is a government priority.

are not financially competitive, the negative result of plastic waste-related externalities is borne by society at large. This market failure impedes the development of plastic circularity innovations so that *getting the pricing right with proper financial incentives will facilitate the market for plastic innovations.* This can be done either through taxes or penalties that raise the cost of using virgin plastic, or through providing subsidies and tax breaks for creating, implementing, or using plastic circularity innovations. Financial incentives can encourage the development and scaling of plastic circularity innovations throughout the product cycle, and also incentivize different stakeholders.

The government of Korea provides financial support through various loan programs, such as the Environmental Policy Loan and green financing, as well as financing programs for each growth stage of SMEs. These aim to promote the recirculation of waste and support the growth of the environmental industry. At the upstream stage, research grants to universities and other research institutions can initiate plastic circularity innovations—for example, identifying indigenous plants that can provide an alternative to plastic in packaging. Financial incentives, such as grants, subsidies, or low-interest loans, can also be given to the businesses that adopt circular practices.

In a nascent plastic circularity ecosystem, business competitions can help jump-start the sector; however, the main purpose of competitions is to generate awareness and interest, and signal that plastic circularity is a government priority. As firms become more advanced, public financing incentives such as matching grants or low-interest loans can de-risk investing in plastic circularity innovations. For firms with proven innovations, more complicated financing instruments such as public-private partnerships can be used to scale operations.

On a larger scale, a plastic circularity outcome fund could finance the development of a number of plastic circularity innovations by providing payment if they achieve a successful outcome. Although an outcome fund is more complex to set up, as it requires attracting investors to provide financing upfront, an outcome fund has the potential to quickly scale the most effective innovations by providing outcome payments within the timeframe of the fund. Outcome funds are beneficial for innovations that are not yet profitable but have positive externalities that are large enough to warrant recognition and payment now. In cases where scaling is sufficient to make innovations profitable, traditional investment funds, such as the Lombard Odier Investment Managers (LOIM) Plastic Circularity Fund, invest in plastic circularity innovations that have a higher expected rate of return.[123] The LOIM Fund is a private equity fund that targets reducing plastic waste and GHG emissions within the plastic value chain, while also delivering market returns.[124]

Key Success Factors for Policies and Financial Incentives to Support Plastic Circularity:

- *Define acceptable standards and incentives for source reduction and reuse.* The proliferation of products with labels that claim to achieve a positive impact confuses consumers, and they risk being perceived as "greenwashing." Clear policies on the quality and use of recycled plastic in packaging for food and personal care items would support the production of safer and more appropriate recycled plastic, as well as alternative packaging. It would also boost the success of refill/reuse models.
- *Strengthen policy mandates and enforcement.* Vertical and horizontal coordination of policies across government levels and ministries is needed to implement and enforce policies, consistently. The capacity of government systems

123 Alliance to End Plastic Waste. 2022. "New Fund will Target Plastic Waste as an Investible Opportunity."

124 Hall. 2023. "LOIM Fund Takes Three Steps to Plastics Circularity."

also needs to be developed to properly enforce regulations and effectively use monitoring and evaluation (M&E) tools to measure accountability. Although manufacturers redesign products across regions, country-level incentives such as tax advantages for tethered bottle caps, for example, are lacking in the six AMS. New policies need to be enacted on a regional basis and properly enforced (see the Supplementary Note on Korea for additional examples of best practices).[125]

- *Develop supportive policies for transparency and accountability.* Successful digital mapping innovations are contingent on policies that support the demand for services such data collection and reporting. EPR implementation requires accurate and transparent tracking and reporting within supply chains, and this can be addressed by blockchain technologies. However, unless plastic reduction is mandatory and enforced, digitalization will be limited to proactive global and local businesses.

6.2.3. Creating Market Demand

To accelerate the development of functioning plastic circularity markets, the potential for innovations must be substantial enough to attract investment. There are three fundamental ways to accelerate market demand: (i) enforce regulations, (ii) activate prominent stakeholders' demand, and (iii) strengthen public awareness campaigns. A sectoral approach can also help to transition the linear plastic economy into a circular one. Focusing on specific industries can mobilize a range of plastic circularity innovations. For example, a green tourism strategy can encourage the development of plastic circularity innovations across the hospitality industry such as by replacing SUP shampoo and body wash products with ones in refillable bottles and providing water in refillable glass bottles. Applying a more customized approach to a sector can help businesses to comply more readily by addressing their initial difficulties, and this can speed up the implementation of plastic circularity innovations.

Sectoral Regulatory Changes: Governments can boost the demand for innovations both in their own offices (such as not using SUPs and segregating waste at source) and in their procurement. As one of the largest procurement entities in any country, government can play a significant role in helping plastic circularity markets to succeed. GPP, which considers bidders' environmental impact in the procurement process, can drive the demand for green innovations (see Chapter 4). Although start-ups are usually barred from bidding on government contracts, their technology can be licensed or sold to larger firms that are qualified to bid, and this can increase the demand for plastic circularity innovations. There are many benefits to rolling out GPP. For example, GPP can be transformative in driving industries to develop environmentally friendly products and services so that they can qualify for public procurement. Additionally, as GPP considers the entire life cycle of a product, this can result in savings over the long term. Implementing GPP now ensures that governments develop the procurement tools they will need in future to purchase complicated green products and services. Almost all countries in the OECD have strategies and policies on GPP. As documented in the "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions" Supplementary Note to this paper, Korea provides excellent examples of best practice. After the Korean government signaled the scale-up of GPP, the market for green products became more competitive and diversified.[126] For another example of GPP, see Box 9 on GPP implementation in Thailand. While government entities are a crucial source of demand for green products, large firms, universities, hotels, and restaurants should be encouraged to minimize their use of plastic, and instead use products made with alternative materials or recycled plastic. Voluntary compliance is preferable, as has occurred with the Singapore Packaging Agreement; however, over time, as industries adapt and innovators respond, minimizing the use of plastic should be legally required.

125 World Bank. 2024. "Innovations for Plastic Circularity in Korea: Enabling Conditions and Solutions: Supplementary Note for Scaling Innovations for Plastic Circularity with Investment in ASEAN."

126 OECD (Organization for Co-operation and Development). 2015. "Going Green: Best Practices for Sustainable Procurement."

Recommendations on Sectoral Regulatory Changes and Large-scale Adoption:

- *Move the linear plastic economy toward a more circular one through buy-in from key stakeholders, and especially businesses, communities, and consumers.*

    (i) Manufacturing, services, and retail sectors ensuring better compliance through a customized sectoral approach: In addition to EPR, other policies that support the reduction of SUPs should be implemented with subsidies for the businesses (hotels) that adopt a circular economy model—for example, closed-loop recycling systems or business models that are based on product-as-a-service.

    (ii) Government targeting digitalization: The government has a pivotal role to play in fostering the evolution of sophisticated digital and operational platforms. These are essential for enabling the seamless transition of waste materials from one industry to another, where they can be repurposed as raw materials. By implementing such platforms, the government can encourage industries to look beyond traditional waste disposal methods and view waste as a valuable resource. This shift in perspective can lead to innovative uses of waste materials, reduce environmental impact, and promote sustainability. In addition, digital and operational platforms can provide crucial data and insights, which facilitate the identification of waste materials that can be redirected as resources for other industries. This approach can stimulate economic growth and inspire new business models. For example, companies specializing in the processing and transformation of waste into usable materials can emerge, which creates new job opportunities and contributes to the economy.

    (iii) Government targeting GPP: To demonstrate the feasibility of GPP, it could start with pilot projects in selected government agencies, and then report on GPP's benefits to drive demand for greener products and services. Large companies and other private entities should also be encouraged to implement green procurement. GPP requires developing criteria for evaluating suppliers' environmental performance, which could lead to certifying those suppliers that meet higher sustainability standards.

- *Audit current government plastic usage and waste management practices.* Initially, audits could be piloted in specific ministries and benchmarked against SWM best practices to identify gaps and areas with potential for improving recovery and recycling. This could incentivize the development of advanced data collection and analytical tools that could be used to gain insights into waste generation patterns, collection ratios, and recycling rates, as well as enable better evidence-based policy and operational decisions. Finally, the development of stakeholder engagement programs could enable various stakeholders to engage, promote a participatory approach to SMW, and increase the demand for innovations in plastic circularity.

Public Awareness: In all six AMS, consumer awareness was low, and this was reinforced by limited waste collection and lack of support for waste management and plastic recycling. Plastics are convenient and a part of daily life; however, an effective public awareness campaign could be instrumental in addressing many plastic waste issues from reducing the demand for virgin plastic, to encouraging segregation at source, and increasing the demand for alternatives. Public awareness campaigns could also be used to demonstrate the business case for proposed government plastic waste policies and regulations, and get buy-in.

Activating large-scale consumers, such as governments, universities, large firms, hotels, and so on, could quickly increase demand for upstream plastic alternatives, as well as downstream source segregation. For example, Kenya's government conducted an effective social media campaign aimed at government officials to push them to implement

necessary regulatory reforms and bans. The campaign, which was paired with banning plastic bags and imposing large fines, as well as prison time for manufacturing plastic bags, resulted in an 80 percent decline in SUP bags.[127] In Kenya, as is the case in the six AMS, solid and plastic waste was blocking waterways and causing flooding, and due to this problem, public buy-in for the ban was more easily achieved.

Switching from multi-layered plastic sachets to ones made with a mono-material will make sachets more readily recyclable, this will only be effective if consumers change their behavior to properly segregate waste at source, and if recycling facilities are available to process the greater volume of segregated waste and the wider variety of recyclable resins.

Recommendations for Improving Public Awareness:

- Coordinate messaging in regional campaigns across the six AMS that promote reducing plastic waste as a shared mission. For example, to achieve better impact, test different campaign messages and various media (such as TV, social media, and billboards) to determine which type of messaging is the most effective for building public awareness about the need for plastic circularity.
- Work with local schools and communities to integrate responsible consumption into the environmental education curricula in schools. Schools should also pilot plastic reduction and waste segregation, which will help to instill these values into future generations. Campaigns are more effective when there is direct involvement in interventions, and schools can play a critical role in this regard.

ESOs play a pivotal role in fostering innovations in plastic circularity across the plastic value chain.

127 Global Plastics Policy Centre. 2022. "Kenya Plastic Bag Ban Notice No. 2356 – The Environmental Management and Co-ordination Act (Plastic Bag Ban on Secondary Packaging)."

6.3 Direct Support to Plastic Circularity Innovators

6.3.1. Building Organizational Capacity

Support is needed at the enterprise level to scale innovation. While not all innovations can succeed, the likelihood of their success increases if the key barriers that innovators face are recognized (see Chapter 2), and efforts are made, collectively, at multiple levels to address these barriers. The entrepreneurs consulted as part of this study's stakeholder consultations reported needing help with partnerships, business development, and fundraising (see Section 1.5: Stakeholder Consultations). In the six AMS, there are opportunities for SMEs to play a role across the plastic value chain in raising innovations from the concept stage to the readiness-to-scale stage, which could bring in substantial investment. This is particularly true for innovations originating in the ASEAN Region.

ESOs play a pivotal role in fostering innovations in plastic circularity across the plastic value chain. As ESOs provide direct support for plastic circularity start-ups, building ESOs' capacity and their service offerings could help to facilitate start-ups' growth. Thus, ESOs could be instrumental in addressing the fast-growing challenges of plastic waste management in the six AMS. Notably, the ESO innovation ecosystem is more robust in Indonesia, the Philippines, Thailand, and Vietnam than it is in Malaysia and Cambodia, where there is little support for entrepreneurs (see Section 2.3.2: Lack of Organizational Capacity):

- *Nascent SWM Ecosystem:* ESOs can build the capacity of the local businesses that are involved in sustainable plastic management by conducting training programs and workshops, providing technical expertise and knowledge transfer, and enabling local enterprises to adopt and effectively implement circular economy principles. In Cambodia, the Ministry of Environment, in collaboration with various international agencies, runs innovation challenges that support start-ups. Across the ASEAN Region, the United Nations Development Programme runs the Ending Plastic Pollution Innovation Challenge (EPPIC) to support plastic circularity innovators by providing

seed funding and networking opportunities with impact investors. Innovators are encouraged to work with organizations such as Impact Hub, SHE Investments, Khmer Enterprise, and EPPIC, which provide incubator programs that offer members technical assistance and funding to support their innovations.

- *Emerging SWM Ecosystem:* In an emerging SWM ecosystem, an ESO could help innovations to progress from the concept stage to the ready-to-scale/commercialization stage. With its better-connected plastic circularity network, an ESO could help innovators to access timely financing, participate in plastic innovation competitions, and connect with markets. An ESO could also advise enterprises on their product's design; help with testing and research to validate market fit and pricing; benchmark products against similar ones to ensure that they have a competitive edge; and provide a review or facilitate getting reviews from others. In addition, an ESO can help to set up PPPs for innovations in plastic circularity, as well as facilitate their access to much needed investment. ESOs can engage with policymakers too, to advocate the development and implementation of policies and regulations that target innovations in plastic circularity and play a critical role in developing a regulatory environment that supports innovations and investments in plastic waste management. In Vietnam, the ESO NPAP, identified "Boosting Innovation" as one of its six impact areas, and the Vietnam Climate Innovation Center is an ESO that targets green innovations, including ones concerned with plastics. Some other ESOs in Vietnam are the Evergreen Lab, Green Hub, and CL2B. In Malaysia, the ESO MRANTI has partnered with private entities Grab and KLEAN to operate reverse vending machines. In Thailand, the ESO NIA focuses on plastic waste management through its Social Innovation Platform, and on the bioeconomy and circular economy through its Innovation for Economic Platform. NIA is working with the Thai Bio-plastics Industry Association, private companies, and local universities on innovating bio-based alternatives to plastics. Another participant in the ecosystem that supports plastic circularity innovations is the Plastics Institute of Thailand, which supervises innovative public-private partnerships. In countries with an emerging SWM ecosystem, ESOs can assist innovators by: (i) developing capacity, building resilience, and providing technical expertise; (ii) facilitating networking and partnership opportunities; (iii) helping innovators to access funding and investors; (iv) supporting market access and commercialization; (v) implementing monitoring and evaluation; and (vi) engaging in policy advocacy and regulatory guidance.
- *Small Islands:* Small islands should target midstream refill and reuse innovations (see Section 3.1). In Indonesia, the Alliance to End Plastic Waste (AEPW) has supported more than 50 projects with small grants, and is evolving into an organization that provides concessional loans and non-recoverable grants that de-risk and catalyze additional investment. OPPA, Instellar, Ecoxyztem, Enviu, and the Plastics Innovation Hub (the Hub)[128] support new innovations across the plastic value chain by creating markets with prospective buyers. In Vietnam, which has a number of small islands, the Hub collaborates with the Vietnam Administration for Seas and Islands, and unlike the Indonesia Hub that focuses on upstream innovations, the Vietnam Hub prioritizes strengthening midstream innovations in collection and segregation, and downstream innovations in recycling. In the Philippines, the DOST has provided funding for developing technologies that recycle plastic and produce alternatives to plastic.[129] Government loans are typically focused on innovations that produce alternative products,[130] and the Development Bank of the Philippines finances start-ups through its Green Financing Program. For small islands, ESOs are helping innovators by: (1) tailoring their technical expertise and capacity building to the specific plastic and SWM issues of small islands that are geographically isolated, have low solid waste management capacity, and lack the resources to make improvements; (ii) developing local circular economy models, identifying and developing niche markets for recycled products,

128 The Hub, which was set up through the collaboration of the CSIRO; the Ministry of Education, Culture, Research and Technology; and innovators and investors, operates in Vietnam as well as Indonesia.

129 UNCTAD (United Nations Conference on Trade and Development). 2022. "Intersessional panel of The United Nations Commission on Science and Technology for development."

130 Arayata. 2021. "Biodegradable plastic manufacturer gets P3-M loan from DOST."

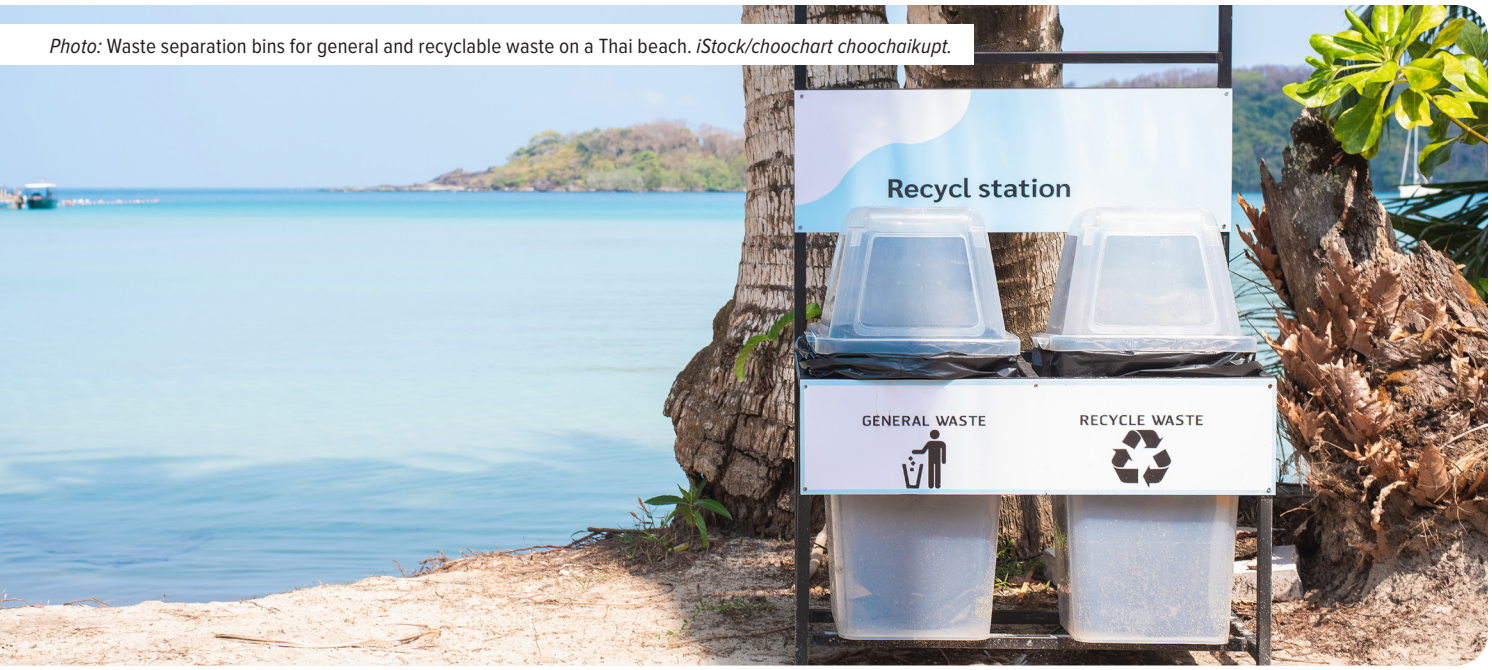

Photo: Waste separation bins for general and recyclable waste on a Thai beach. *iStock/choochart choochaikupt.*

and establishing a sustainable local plastic supply chain; (iii) facilitating community engagement by promoting local stakeholders' commitment to sustainability and responsible plastic and SWM; (iv) supporting regional collaboration beyond individual islands, which is needed due to their limited market size; (v) accessing dedicated sources of funds and investment that are customized to the unique challenges and potential of small islands' plastic circularity markets; (vi) lobbying for supportive policy frameworks that are tailored to the needs of small islands; and (vii) conducting assessments of the impact of plastic and SWM practices to understand how they affect the environment in small islands, and developing metrics for measuring sustainability.

To sum up, for small islands, ESOs can catalyze and sustain innovations in plastic circularity, as they have a comprehensive approach that includes technical support, funding, policy advocacy, and stakeholder collaboration—all of which contribute to transforming the plastic value chain into a more sustainable and circular model.

Recommendations for Building Organizational Capacity:

- *Nascent Ecosystem:* Encourage early-stage innovations with short-term programs that are carried out by ESOs or universities. In countries that have few plastic circularity innovations, creating awareness about and the demand for plastic circularity solutions is necessary. For example, short-term programs such as "boot camps" or "hackathons" with a plastic circularity theme can showcase aspiring entrepreneurs who have plastic circularity innovations that are tailored to their country's context.
- *Emerging Ecosystem:* Build ESOs' capacity to provide innovations with incubation and acceleration support that is tailored to the circular plastic economy. This includes providing information on a country's regulations, potential markets, and corporate sponsorship opportunities. To help businesses scale beyond early-stage pilots, ESOs need to be knowledgeable about stakeholder relations, regulations, and public contracting processes. Building ESOs' capacity to provide such services and knowledge will make it easier for enterprises to navigate market opportunities and take advantage of them.

  To increase efficiency and quality, Malaysia, Thailand, and Vietnam should transition from manual to automated sorting and segregation technologies, such as having sorting lines that use optical sorting, near-infrared spectroscopy, and magnetic density separation. It is essential for Malaysia, Thailand, and Vietnam to start planning and investing in such innovations so

that they can effectively promote innovation across the four stages of the plastic value chain. While these high-level technologies should appeal to manufacturing investors, only 2 percent of the midstream innovations are ready to scale (see Table 5 and Figure 7). The proximity of Thailand and Vietnam to China gives them access to the Chinese market to sell their lower cost recycled plastic pellets and flakes, and the opportunity to strengthen their downstream plastic and SWM systems and infrastructure so that they can revitalize plastic circularity through innovations.

6.3.2. Access to Financing

With conducive solid and plastic waste management policies in place, as well as technical support, providing financing is the next important step in helping plastic circularity innovations to scale. However, it may be difficult to attract interest from private investors that seek commercial returns if innovations are at stages that require the adoption of policies before they are able to scale. Other ecosystem factors must be activated as well to create fully functioning plastic circularity markets. Table 14 summarizes the type of financing that is available to fund plastic circularity innovations at different stages of their development (see Chapter 5).

For the six AMS to encourage investment, innovative financial mechanisms and terms must be applied to bridge the financing gaps in the default capital ecosystem. Chapter 3 showed the relative maturity of innovations in the ASEAN Region, with most of them still at the concept and piloting stages, and not yet ready to scale. As these innovative solutions mature, they will need access to diverse types of capital from a variety of sources. Over the course of an innovation's life cycle, it needs different types of financing, which range from small grants at the concept development stage to more complex types of investment. In recent years, several thematic bonds and loans have been created—for example, in Indonesia, a number sustainability-linked bonds have been issued[131] —but the majority of these funds target larger infrastructure projects. However, plastic waste management, recycling, and circularity innovations with clear environmental benefits should be able to access or indirectly benefit from these sources of capital. Countries with an emerging ecosystem need to bridge the SWM infrastructure gap in the downstream stage of the plastic value chain by developing sorting and recycling facilities that are capital intensive, which means they still require concessional loans, in addition to private and blended finance. Countries with a nascent ecosystem, including island countries, require grant funding and technical assistance for "low tech" and cost-effective innovations in SWM, which take into consideration their lower level of socio-economic development and lack of capacity. At the midstream stage, the nascent ecosystem relies on community-based segregation and collection. In emerging ecosystems in urban areas, LGUs need to invest in high-quality trucks for collection and improve their transfer stations.

Impact funds and venture capital firms specializing in debt financing offer a viable solution for growth-stage plastic circularity enterprises in the ASEAN Region. A notable example of this in Indonesia is POP Southeast Asia. This venture, which is a collaboration between a local recycling company and a broker from the United Kingdom, has significantly expanded its collection and recycling operations across Indonesia. In 2022, the United States Agency for International Development's Clean Cities, Blue Ocean Program awarded POP a grant for buying waste consolidation equipment for a new facility in Semarang, Java.[132] Such financial support has been instrumental in increasing private capital providers' potential returns on their investment and, thus, it has created a more attractive investment landscape. In addition, regional, bilateral, and national plastic pollution reduction programs provide an opportunity to increase access to capital for smaller-scale investments.

131 Global Plastic Action Partnership. 2022. "Unlocking the Plastics Circular Economy: Case Studies on Investment."

132 Waste consolidation equipment comprises the machinery and tools that are used to compact, compress, or otherwise reduce the volume of waste materials.

Recommendations to Access Financing:

- *Nascent Ecosystem:* Create small pools of capital for local innovators by providing grants or contracts with governments and IFIs.
- *Emerging Ecosystem:* Promote innovative approaches to bridging the mismatch between the returns sought by investors, and innovators' need for patient capital so that they have time to refine their business model. IFIs, impact investors, and commercial banks could offer more flexible terms by providing blended finance vehicles and instruments. Local or regional financial intermediaries could also help to recruit prospective investors, and facilitate partnerships and co-investment opportunities that focus on appropriate innovations in the six AMS.

Table 15 summarizes the recommendations to address local innovators' limited access to capital, and these are prioritized by each country's typology.

Table 14. Potential Types and Sources of Capital for Innovations Across the Plastic Value Chain

STAGE OF DEVELOPMENT	1: CONCEPT	2: PILOT & REFINE	3: READY-TO-SCALE
UPSTREAM (Policies & Regulations for Source Reduction)	Non-debt/non-equity capital *Technology-oriented solutions:* Private and public research and development grants, in collaboration with universities and research institutions *Low-technology solutions:* Access to philanthropic funding	Venture capital or angel/ wealthy family investors and impact investors	Financing at scale through corporate venture capital In the long term, larger infrastructure could be financed through joint ventures, including corporate venture capital
	A combination of innovations self-financed by manufacturers of fast-moving consumer goods and packaging to fund the design of products for refill and reuse		
MIDSTREAM (Collection & Segregation)	ESOs or corporations (pilots); non-debt/non-equity capital	(Further opportunities to scale depend on policy incentives and changing consumers' behavior)	
DOWNSTREAM (Recovery & Recycling)	Non-debt/non-equity capital—for example, grants from donor agencies, foundations, angel investors, or wealthy family investors		Corporate venture capital (joint ventures or mergers and acquisitions); IFIs (as part of larger blended finance investments for infrastructure); Debt/venture capital debt; bank loans; and equity
CROSS-CUTTING (Transparency & Accountability)	Corporations (pilots); non-debt/ non-equity capital	Venture capital, angel investors, wealthy family investors, and impact investors	Potential to attract additional profit-seeking investors
		(Further opportunities to scale depend on policy incentives and corporate reporting requirements)	

Source: The World Bank Group

Table 15. Recommendations and Prioritization for Limited Access to Capital

STAGES	NASCENT	SMALL ISLANDS	EMERGING MARKETS
Financial instruments (grants, low-interest loans)	+++	++	++
Blended finance, including public-private partnerships	+	+	+++

Note: + designates the level of importance: + basic; ++ important; +++ critical.

Source: The World Bank Group

6.4. Regional Cooperation

Cooperation at the regional level could provide greater market stability due to the larger size of the market, and the predictability of regulations across the six AMS countries. In the previous sections, suggestions have been made about what can be done at the regional level. These recommendations include: (i) pooling knowledge and best practices to speed up the adoption and replication of plastic circularity innovations; (ii) standardizing practices and requirements across the ASEAN Region so that businesses can operate more easily from one country to another, which would thereby accelerate improvements in plastic circularity; (iii) data collection and public reporting; and (iv) financing. Since 2022, the Intergovernmental Negotiating Committee on Plastic Pollution, led by the United Nations Environmental Programme, has been developing an international legally binding document on plastic pollution that will be ready by the end of 2024. This document addresses the whole life cycle of plastics, and it is expected to influence plastic production, consumption, and waste management globally.

Regional cooperation also plays an essential role in providing the data and information needed to develop sound policies and interventions. In the case of Korea, the government is promoting cooperation with neighboring countries by establishing sub-organizations in the environment field, as well as the science and technology field, which include KEITI and the Korea Institute for Advancement of Technology (KIAT). Cooperation occurs not only through regional organizations such as the EU and ASEAN, but also through the National Cooperation Center, bilateral development assistance, and the Global Network of the Korea Standards Association that reviews better practices and shares success stories from Korea with other countries. By analyzing these success stories and developing effective strategies in the six AMS, it should be possible to make significant progress in plastic waste management. Such collaboration could be carried out through new or existing online or offline platforms or hubs, and it could be applied more effectively if stakeholders collaborate in discussing how to apply it.

Regionally, additional financing incentives could be strengthened and leveraged through a platform that is managed by a qualified financial intermediary that offers both technical assistance and financial resources for start-up/early-stage companies, as well as growth-stage ones. Financing could be pooled through a regional fund, a fund-of-funds, or a guarantee facility that encourages the allocation of financing from financial intermediaries and local banks. Such an intermediary could also facilitate local "marketplaces" by building awareness and introducing local innovations to investors across the impact-return spectrum and enabling the transfer of advanced technologies from more developed markets to each of the six AMS.

Recommendations for Regional Cooperation:

- *ASEAN Ambitions:* In the coming years, the six AMS will be subject to the legally binding instrument on plastic pollution of UN Intergovernmental Negotiating Committee on Plastic Pollution. Whether this instrument ends up being modest or ambitious in scope, the process will set the stage for greater attention and activity from both public and private actors, which will provide an opportunity for the ASEAN Region to harmonize its policies and standards.
- *Regional Coordination for Equitable Plastic Policies in the Six AMS:* Given the important level of trade across the six AMS, coordinating plastic policies at the regional level is necessary to: "level the playing field" for manufacturers in different countries, reduce compliance burdens, and build economies of scale so that packaging standards are consistent throughout the region.
- *Promote technology transfer:* Transfer technical innovations in plastic circularity from outside the ASAEN Region to support nascent local entrepreneurs through vehicles developed by the private sector, financed with government incentives, and supported by adequate policies. With a sufficient level of support from policies, capacity-building, and catalytic funds, innovations could boost plastic waste management and plastic circularity, and address the plastic pollution challenges in the ASEAN Region.

- *A Regional Platform for Sharing Practices and Business Models:* Through an ASEAN regional platform that offers resources and expertise for innovators, provide information on practices and business models in local languages so that countries can learn from each another. This regional platform could give ESOs the latest regulations, notices about green government procurement, and sources of green financing information so that they could help their clients to respond to regional opportunities.

6.5. Conclusion

The severity of the plastic waste challenge within the ASEAN Region has escalated to a critical point that urgently requires a set of strategic responses, including leveraging local innovations. The complexities of the fast-rising volume of plastic waste and leakage into the environment demand that all stakeholders work together, from the policymakers who enact legislation, to the entrepreneur's driving innovation, down to the consumers who shape market demand through their purchases. Along with identifying and implementing effective solid and plastic waste management policies and regulations, innovations should be sought that can fill the gaps in plastic waste management and catalyze the transition to plastic circularity.

By championing a full suite of policies, from waste management protocols and incentives for green entrepreneurship to consumer education campaigns, the AMS can set new benchmarks for environmental governance of plastic waste management. If the AMS can provide replicable models of success to address plastic pollution, their efforts will resonate far into the future, and across the globe. Thus, it is critical for the AMS to act with foresight, and fully leverage the instruments of policy, finance, innovation, and collective action to steer the region toward a future with robust plastic waste management, and no plastic leaking into the environment. To effectively scale plastic circularity, the combined and concerted efforts of communities, businesses, and public sector agencies must be fully mobilized and rise to the challenge.

As previously discussed, the selection of innovations from three centralized databases provided a practical approach for identifying innovations in the ASEAN Region. By registering in a database to participate in an innovation challenge, work with an accelerator, or join an incubation program, entrepreneurs indicated their desire to attract more capital to scale their innovation. While these databases likely did not include all of the plastic circularity innovations that were operating in the six AMS when this study was carried out in 2022 and 2023, the databases' focus on early-stage innovations made it possible to examine emerging solutions and pinpoint ones that were at a formative stage. This identified innovations with promise regarding their ability to scale, have an impact, and benefit from additional backing and resources. Unfortunately, due to lack of resources, it was not possible for this study's research team to engage, directly, with innovations and entrepreneurs in each AMS, which limited the study's ability to evaluate innovations more rigorously. Also, the status of the innovations in this study could have changed since the study was carried out.

To build on the insights provided in this paper, the authors recommend carrying out a more in-depth examination in each of the six AMS. This could be undertaken through country-specific innovation mapping that would involve examining the innovation-related policies, industry-specific initiatives, incentives, and support structures that are in place to foster innovation. By examining these aspects, a more complete and nuanced view of the ASEAN innovation ecosystem could be obtained, which could guide the development of strategies and actions that are tailored to the specifics of the innovation landscape in each country.

In addition, the transfer of technologies and innovations from other countries that are both viable and scalable should be explored, along with other countries' innovative business models. Valuable insights and experience can be gained from countries that already have an established track record in developing successful innovations in plastic circularity, and this should include both developed countries (North-South transfer) and developing countries (South-South collaboration). Cross-border technology transfer and knowledge exchange also have the potential to significantly enhance innovations, as well as their sustainability across the ASEAN Region.

Appendices

List of Abbreviations

7IMDC	7th International Marine Debris Conference
ADB	Asian Development Bank
AEPW	Alliance to End Plastic Waste
AI	Artificial Intelligence
AMS	ASEAN Member States
ASEAN	Association of Southeast Asian Nations
BMA	Bangkok Metropolitan Administration
BPA	Bisphenol A
CFR	Collected for Recycling
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEG	Deutsche Investitions – und Entwicklungsgesellschaft/German Investment Corporation
DOST	Department of Science and Technology
DRS	Deposit-Return System
EC	European Commission
EPPIC	Ending Plastic Pollution Innovation Challenge
EPR	Extended Producer Responsibility
EPS	Expanded Polystyrene
E&S	Environmental and Social
ESMS	Environmental and Social Management System
ESO	Entrepreneur Support Organization
EU	European Union
FDI	Foreign Direct Investment
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH/German Corporation for International Cooperation
GPP	Green Public Procurement
GPPP	Green Public Procurement Policy
GSSB	Green, Social, and Sustainability Bond
GVC	Government Venture Capital
HDPE	High-Density Polyethylene
IFC	International Finance Corporation
IFI	International Financial Institution

IoT	Internet of Things
IPPN	Indo-Pacific Plastics Innovation Network
IUCN	International Union for Conservation of Nature
KEITI	Korea Environmental Industry and Technology Institute
KIAT	Korea Institute for Advancement of Technology
LDPE	Low-density Polyethylene
LGU	Local Government Unit
LLDPE	Linear Low-Density Polyethylene
LOIM	Lombard Odier Investment Managers
M&E	Monitoring and evaluation
MLP	Multilayered Packaging
MoE	Ministry of Environment
MONRE	Ministry of Natural Resources and Environment
MRANTI	Malaysian Research Accelerator for Technology and Innovation
MRF	Material Recovery Facility
MSMEs	Micro, Small and Medium Enterprises
MSW	Municipal Solid Waste
MSWS	Municipal Solid Waste System
MT	Metric Ton
NIA	National Innovation Center
NPAP	National Plastic Action Partnership
NSWMC	National Solid Waste Management Commission
OECD	Organisation for Economic Co-operation and Development
OPPA	Ocean Plastic Prevention Accelerator
PE	Polyethylene
PEF	Product Environmental Footprint
PET	Polyethylene Terephthalate
PIANOo	Professioneel en Innovatief Aanbesteden, Netwerk voor Overheidsopdrachtgevers/Dutch Public Procurement Expertise Centre
PLA	Polylactic Acid
POPSEA	Prevented Ocean Plastic Southeast Asia
PP	Polypropylene
PPP	Public-private Partnership
PS	Polystyrene
PVC	Polyvinyl Chloride
R&D	Research and Development
RA	Republic Act
RAP	Regional Action Plan

RDF	Refuse Derived Fuel
RMF	Recycling Modernization Fund
rPET	Recycled Polyethylene terephthalate
SEA-MaP	Southeast Asia Regional Program on Combating Marine Plastics
SICA	Social Impact Challenge Accelerator
SLBs	Sustainability-linked Bonds
SMEs	Small and Medium Enterprises
SPA	Singapore Packaging Agreement
SPP	Sustainable Public Procurement
STP	Science and Technology Parks
SUP	Single-use Plastic
SWM	Solid Waste Management
TCG	Thai Credit Guarantee Corporation
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
VC	Venture Capital
WBG	World Bank Group
WtE	Waste-to-Energy

Appendix 1. Country Profiles for the Six AMS

Summary of Waste Management, Policy, and Innovation Environment in the Six AMS

LEGEND	✔ - Enacted	(✔) - Future/Planned or partial enactment	↻ - Considering	✖ - Not yet considering	✔ - Priority for innovative solutions

	CAMBODIA	INDONESIA	MALAYSIA	PHILIPPINES	THAILAND	VIETNAM
SOLID AND PLASTIC WASTE MANAGEMENT						
MSW collection coverage	86% in cities & district centers	60% of urban population	80% in urban areas	40% in urban areas	20%–100% of the population	85% urban & 40% rural population
Share of MSW collected	72% in cities & district centers	39% (plastic only)	95% in cities Undeveloped rural collection	10–95% (collection efficiency)	46–91% across all provinces	
PLASTIC WASTE MANAGEMENT						
Top three resins found in the environment	PP HDPE LDPE	PP LDPE PS	LDPE HDPE PP	PP PE PS	PE PP PS	PP HDPE PET polyester
Key plastic waste types – materials with the highest rates of mis-management	Food wrappers & packaging Shopping bags Beverage cups & bottles Plastic straws	Plastic bags Transparent plastic Sachets Beverage bottles Other plastics (diapers, straws)	Takeaway bags Containers (food packaging) Plastic bottles & cups Plastic films (packaging)	Plastic bags Sachets Plastic bottles Plastic bottle caps & lids Straws Stirrers	Plastic bags Snack bags & pouches. Trays, boxes, cups Other packaging Plastic bottles	Hard & Soft plastic fragments Fishing gear Plastic bags Styrofoam food containers
Informal sector's collection of plastics for recycling	3,000 waste pickers collecting the majority of plastics	2 million informal waste collectors supporting recycling	99.9%	>90%	90% in Bangkok, Rayong & Chon Buri	90%
Plastic recycling rate	<1%	10%	20%	9%	9–19%	10–15%
POLICIES (SELECTED)						
Segregation at source	✔	✔	✔	✔	✖	✔
Material ban/Bag tax	✔	↻	✔	↻	✔	✔
Use ban: SUP	↻	(✔)	↻	↻	✔	(✔)
Waste import bans	✖	✔	↻	✖	(✔)	(✔)
EPR for packaging	✖	✔	(✔)	✔	↻	✔
Innovation policies	✖	✖	✖	✖	✔	✖

	CAMBODIA	INDONESIA	MALAYSIA	PHILIPPINES	THAILAND	VIETNAM
PRIORITIES FOR INNOVATIVE SOLUTIONS						
Innovation for collection, segregation, processing & recycling	✔	✔	✔	✔	✔	✔
Multilayered packaging/sachet alternatives		✔		✔		
SWM innovations for small islands		✔		✔		
Innovations to support EPR				✔		✔

Sources: Pucino et al. 2020. "Plastic Pollution Hotspotting and Shaping Action: Regional Results from Eastern and Southern Africa, the Mediterranean, and Southeast Asia"; National Solid Waste Management Commission Philippines Website. World Bank. 2020. "Mobilizing Private Finance for Nature"; World Bank. 2021b "Market Study for the Philippines, Malaysia and Vietnam: Plastics Circularity Opportunities and Barriers"; World Bank. 2022a. "Where Is the Value in the Chain? Pathways out of Plastic Pollution"; World Bank. 2024. "What a Waste Global Database"; WWF (World Wildlife Fund) Malaysia. 2020. "Study on EPR Scheme Assessment for Packaging Waste in Malaysia"; WWF (World Wildlife Fund) Thailand. 2020. "Scaling Up Circular Strategies to Achieve Zero Plastic Waste in Thailand"; NPAP Indonesia (National Plastic Action Partnership). 2020. "Financing System Change to Radically Reduce Plastic Pollution in Indonesia: A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership.

Appendix 2. Top 10 plastic circularity transaction by deal value in the Six AMS (2018-9M 2022)

The following table lists the top 10 plastic circularity transactions that have taken place in the six AMS since 2018. Nearly all 10 transactions involve well-established businesses that are involved in waste management solutions. None of the top 10 transactions involved early-stage ventures or start-ups.

COMPANY	SOLUTION	INVESTOR(S)	INVESTMENT TYPE	DEAL VALUE ($ MILLION)	YEAR	COUNTRY
Indorama Ventures Public Company Ltd	Recycling		Debt Financing Sustainability- linked bond	303	2021	Thailand
Indorama Ventures Public Company Ltd	Recycling	IFC, ADB, DEG	Development Bank Financing Debt Financing	300	2021	Thailand
Indorama Ventures Public Company Ltd	Recycling		Debt Financing Sustainability- linked Ninja Loan	255	2020	Thailand
Indorama Ventures Public Company Ltd	Recycling		Debt Financing Green Loan	212	2020	Thailand
Alam Flora Sdn Bhd	Recovery	Malakoff Corp Bhd	Corporate/ Strategic Investment Merger/ Acquisition	209	2019	Malaysia
Cenviro	Recovery	SK ecoplant	Corporate/ Strategic Investment Merger/ Acquisition	80	2022	Malaysia
SMHB	Services (for producers & waste generators)	HSS Engineers	Corporate/ Strategic Investment	69	2018	Malaysia
Duy Tan Plastics Manufacturing	Recycling		Debt financing/ loans	60	2020	Vietnam
Berjaya EnviroParks	Recovery	Berjaya Group	Corporate/ Strategic Investment Merger/ Acquisition	19	2020	Malaysia
Inocycle Technology Group	Recycling		IPO	11	2019	Indonesia

Source: Plastics Circularity Investment Tracker, 2023

Appendix 3. Stakeholder Consultations

List of Interviewees: The following is a list of the various stakeholders in alphabetical order that The Circulate Initiative consulted for the purposes of this study. Most of these sources were engaged through a series of one-on-one consultations conducted during the 7th International Marine Debris Conference (7IMDC):

Incubators, accelerators, and other entrepreneur support organizations

1. Enviu/Zero Waste Living Lab
2. Impact Hub Phnom Penh
3. Instellar
4. Makesense
5. Seedstars
6. Techo Startup Center
7. The Incubation Network

Investors

1. ABC Impact
2. Asian Development Bank
3. Circulate Capital
4. Damson Capital
5. Global Innovation Fund
6. ICM Falk Foundation
7. inBest Ventures
8. International Finance Corporation
9. North-East Family Office (NEFO)
10. Rumah Group
11. Sagana

Ministries and other official sources

1. Khmer Enterprise
2. Ministry of Economy and Finance, Cambodia
3. Ministry of Environment, Cambodia
4. Ministry of National Resources and Environment, Vietnam
5. National Coordinator for the Marine Plastic Environment, Cambodia
6. Pollution Control Department, Ministry of Natural Resources and Environment, Thailand

Associations, corporations, development agencies, and other businesses

1. Alliance to End Plastic Waste
2. Center for Southeast Asian Studies
3. Dow
4. Dow Venture Capital
5. Commonwealth Scientific and Industrial Research Organisation (CSIRO)
6. GIZ

7. Mekong Inclusive Ventures
8. Philippine Alliance for Recycling and Materials Sustainability (PARMS)
9. Save Philippine Seas
10. The Growth Drivers (TGD)
11. United Nations Development Programme, Cambodia
12. Worldwide Fund for Nature

Questions: The following is a list of the types of questions that were asked of the stakeholders who were interviewed in this study. However, not all of these questions were discussed with all of the stakeholders; instead the questions below were customized, depending on the type of employer; the employer's role in plastic circularity; and the role of the individual interviewee.

Innovation-specific questions were asked of investors, official sources, and other businesses:

1. How do you define innovations?
2. What is your perspective on the state of the innovations tackling plastic waste in the six AMS – prototyping, testing/conducting trials, commercialization?
3. Are there some parts of the plastic value chain that have more innovative solutions than others? Which are these? Why?
4. What is your experience in working with innovators tackling the plastic waste crisis in the six AMS?
5. Which barriers to scalability or replicability do these innovations face?

Investment-specific questions were asked if these applied to the innovators, official sources, and other businesses:

1. What is your view of the prospects for investing in the plastic circularity value chain in ASEAN and the six AMS?
2. Which barriers to investment do you see (a) across the value chain, as a whole; and (b) with regard to specific innovation stages?
3. When you assess a prospective investment, how do you weigh anticipated financial returns versus having a broader impact (for example, the environmental, social, and governance [ESG] impact)?
4. What is your optimal holding period for an investment?
5. In ASEAN and the six AMS, where do you see financing gaps along the plastic value chain, and what form do these gaps take—for example, which actors are absent in the financing ecosystem; and which financial products are not available?
6. Are there specific policies, which you think could improve the attractiveness/bankability of investments within the value chain?

Policy-specific questions were asked if these applied to innovators, investors, and other businesses:

1. What are some of the policies or other initiatives (public or private sector-led) that might foster greater innovation and support existing innovators?
2. What are some of the key policies tackling the plastic waste challenge in your country, and how effective are they?
3. How do you ensure that any national-level policies and regulations related to tackling the plastic waste challenge are implemented at a local level?
4. Are regulations enforced?
5. How do you think policies could support the innovative businesses involved in tackling plastic waste?
6. How could multilateral development banks support ASEAN member states in tackling the plastic pollution challenge?
7. What form might an ASEAN-wide "platform" to support innovations and investments in plastic waste management and alternatives to plastic take, and what role might the platform play in fostering a more enabling environment for plastic circularity innovation in the ASEAN Region?

Summary of the panel discussion held during the 7th International Marine Debris Conference on key actions needed to advance innovation and investment in ASEAN's plastic circular economy.

The 7th International Marine Debris Conference, which was held in September 2022, provided a timely opportunity for stakeholders to make recommendations regarding the legally binding instrument on plastic pollution that the Intergovernmental Negotiating Committee of the United Nations Environment Programme was planning to develop. The conference brought together representatives from government, industry, academia, civil society, and other relevant stakeholders to discuss the latest solutions for achieving plastic circularity and catalyzing action to stop marine litter and pollution. During the conference, the World Bank Group held a panel discussion that explored the opportunities and challenges for driving policies and investments to scale plastic circularity innovations in the ASEAN Region. The following points summarize this panel discussion:

Improving infrastructure should be a priority to curb plastic waste leakage in the ASEAN Region. Inadequate infrastructure contributes significantly to Southeast Asia's plastic pollution problem, and especially inadequate infrastructure for collecting, cleaning, and processing plastic waste. This results in the leakage of plastic waste into the environment, as well as a missed opportunity to capture and maximize the full value of recycled waste in the region's economy. Depositing waste in landfills and incinerating it are short-term solutions, but with sufficient investment and support, adequate waste management and recycling infrastructure can be built that makes use of the plastics in the waste stream.

Advance the Circular Economy through knowledge sharing. Due to differences in the stages of plastic circularity across Southeast Asia, making improvements in plastic waste management should be tailored to the local conditions in each country. However, it would be valuable for countries that are just starting to improve their plastic waste management system to learn from others in the ASEAN Region, and outside the region that have successfully implemented policies and programs to advance their Circular Economy. For example, it is important to ensure that there is enough quality feedstock for recycling as this is necessary to drive the demand for recycled plastics.

Investments from all sources, including development finance institutions and the private sector, are needed to fund adequate solid waste management infrastructure in the ASEAN Region. The efforts of a single actor are not enough to build an adequate solid waste management system. While the public sector is responsible for creating the

foundations for waste management systems and operations, private sector financing is also needed to bolster government investments so that they match the increasing scale of the plastic pollution problem. Also, blending public and private capital can go a long way in de-risking investments, and setting the stage for more funding. Positive developments and commitments from both the public and private sectors have occurred such as the approval of a $20 million grant for the World Bank Group's Southeast Asia Regional Program on Combating Marine Plastics (SEA-MaP) that is facilitating the SWM efforts of a number of stakeholders at both the regional and country levels. In addition to financing, businesses are needed to drive innovation across the plastic value chain, and governments can use several regulatory tools to incentivize these new solutions.

The promulgation and enforcement of plastic waste management laws and regulations are essential for creating an enabling environment for innovation and investment. Korea is a good example of a country that for decades has implemented supportive plastic waste management policies and regulations, which range from banning single-use plastics and discouraging hard-to-recycle ones, to implementing frameworks that promote resource circulation and the recycling industry. As a result of these regulations, and the significant efforts of key stakeholders within the plastic waste ecosystem, Korea has achieved one of the highest recycling rates in world. This support has enabled the government to introduce schemes that have expanded stakeholders' responsibilities to shift toward circularity practices that reduce, reuse, and recycle plastics. Recent developments in extended producer responsibility policies across Southeast Asia include the passage of new laws in the Philippines and Vietnam that are helping to create a market for businesses in waste management and recycling, reinforce the sector's growth prospects, and attract investors.

Create a sustainable market that attracts stakeholders' participation. To achieve an effective transition to circularity, the public and private sectors need to develop good partnerships with other and establish a market with strong growth prospects and a pipeline of investible solutions that will attract investors. Governments have a key role to play in this through introducing policies that encourage the demand for recycled materials, as well as providing incentives to encourage and assist businesses to innovate and take the lead in this sector. Governments can also play an important role through supportive policies that are designed to accelerate investment, or by using bilateral and multilateral funding to invest, directly, in innovators and entrepreneurs in both the formal and informal sectors. The transformation to a circular plastic value chain can only be achieved when the entire ecosystem works together to scale infrastructure and innovations that will help to mitigate leakage and redefine the future of waste. With the plastic pollution problem gaining global attention, panelists agreed that now is the time to catalyze progress by addressing systemic gaps.

Appendix 4. Key Types and Sources of Capital in the ASEAN Region

Investment in plastic circularity innovations in the six AMS is led by a small, but committed, group of funders and impact investors. The following table presents the key types and sources of capital in the ASEAN Region.

TYPE OF CAPITAL	NON-DEBT, NON-EQUITY FINANCE (GRANTS AND PRIZES)
Sources and Examples	*Foundations:* Foundations, which are also called charitable foundations, philanthropic foundations, and trusts provide funds for plastic circularity innovations to non-profit businesses and other ecosystem actors such as entrepreneur support organizations (ESOs). With their grants, foundations can be a source of early-stage financing for plastic circularity start-ups. US foundations make program-related investments with no-interest or low-interest loans in nonprofit and for-profit entities that provide a return on capital. For example, the Alliance to End Plastic Waste (AEPW) has supported more than 50 projects in specific regions under its four strategic pillars: waste management infrastructure, innovation, education and engagement, and plastic waste clean-up. The AEPW began by giving relatively small grants, which is still does, but its investment activity has evolved into a more project-finance-oriented approach that provides (a) concessional loans of $1 million to $6 million, and (b) non-recoverable grants of $3 million to $5 million that act as a catalyst for additional investment by de-risking projects. Other examples include: • Partnership for Growth (P4G), which operates in Indonesia and Vietnam, has provided more than $500,000 for grants that fund refill/reuse enterprises. • The Google Foundation (a corporate foundation) is a $500,000 operational platform based in Indonesia, with additional funding available through the APAC Sustainability Seed Fund,[133] and the DBS Foundation in Singapore. These provide grants to social enterprises, including a total of $250,000 for start-ups in Indonesia that produce alternative materials. • The ICM Falk Foundation launched the ICM Circular Innovation Grant Program in 2022, which provides grants of up to $5,000.[134]
	Donor Agencies (DAs) and International Financial Institutions (IFIs): Multilateral and bilateral development agencies provide funding to promote economic development and social welfare in developing countries.[135] DAs and IFIs offer small grants directly or, more commonly, through an intermediary (an ESO). These amounts range from $5,000 to $500,000, but smaller awards are more common, and they target enterprises at the concept and piloting stages. Investments may take the form of non-recoverable grants awarded to projects as a developmental benefit for their participation in an incubation or acceleration program, or as cash for winning a plastic pollution innovation competition or a request for proposals. In the six AMS, some examples of DAs and IFIs that are active in funding plastic circularity innovations include the Norwegian Agency for Development Cooperation (NORAD), Australian Department of Foreign Affairs and Trade (DFAT), United States Agency for International Development (USAID), Asian Development Bank (ADB), and Global Affairs Canada (GAC). The Norwegian Ministry of Foreign Affairs and NORAD have funded several innovation activities that focus on reducing marine plastic pollution in the ASEAN Region, including the Ending Plastic Pollution Innovation Challenge (EPPIC) in 2021, which offered four winners up to $18,000 each in seed financing, and other benefits.[136] A similar program that focuses on innovative solutions for plastic waste in Cambodia is managed by the United Nations Development Programme (UNDP). Australia's DFAT, in partnership with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), which is Australia's national science agency, and the Indonesian Ministry of Education, Research, and Technology (Kemenristek), established the Plastics Innovation Hub Indonesia in 2021. Comprising both incubation and accelerator programs. the platform provides up to AU$300,000 in seed funding, and access to the Kemenristek's Kedaireka Matching Fund Program.[137] Other donor agencies are also involved in supporting innovations for addressing plastic waste in emerging markets, including GAC, which has provided multi-year funding for The Incubation Network for its programming in South and Southeast Asia that promotes gender equity, and provides support for vulnerable workers. In 2022, USAID launched its $62.5 million flagship initiative, Save Our Seas, which funds projects in Indonesia, Thailand, and Vietnam to improve the management of plastic waste, and create innovative Circular Economy models.

133 AVPN (Asian Venture Philanthropy Network). 2022. "APAC Sustainability Seed Fund."

134 ICM Falk Circular Innovation Grant Program. 2022. "Empowering local innovation, leadership, and entrepreneurship for global impact."

135 OECD (Organisation for Economic Co-operation and Development). 2021c. "Official development assistance (ODA)."

136 UNDP (United Nations Development Programme), Norwegian Ministry of Foreign Affairs, and NORAD (Norwegian Agency for Development Cooperation). 2023. "Ending Plastic Pollution Innovation Challenge."

137 Kedaireka. 2021. "About Matching Funds."

TYPE OF CAPITAL	NON-DEBT, NON-EQUITY FINANCE (GRANTS AND PRIZES)
Sources and Examples	In 2020, ADB launched the "Technology Innovation Challenge for Healthy Oceans" for projects piloting technologies that prevent plastic waste and accelerate the transition to a Circular Economy by significantly reducing or eliminating single-use plastics.[138] The first winner of the challenge in 2020, which was awarded $500,000, was Koinpack, an Indonesian deposit-based system for reusable plastic packaging.[139]
	Entrepreneur Support Organization (ESO) Incubators and Accelerators: An ESO is an intermediary that supports, trains, mentors, and sometimes provides financing for existing or potential founders of start-ups, or it can help a start-up to identify sources of financing and apply for it. ESO programming usually supports an incubator or accelerator that helps start-ups to advance to early-stage development. Some ESOs offer their services in return for shares in the participating company. As an intermediary supporting ESOs across the ASEAN Region, The Incubation Network (TIN) has provided approximately $2 million in support for innovations in Southeast Asia and India, which was provided either through an ESO or directly to ventures, SMEs, and NGOs. Since participating in at least one of TIN's programs, the network's Indonesian, Filipino, Thai, and Vietnamese alumni have raised a reported $9 million in external funding.
Criteria and Requirements	• The purpose of the funding must be charitable, have impact, and be development-oriented in nature. As intermediaries, ESOs generally adopt a more thematic approach to supporting purpose-driven businesses. • The recipient must be a nonprofit, charitable entity, or otherwise be able to qualify as a grantee/vendor with the funding agency (for example, a social enterprise). • For tax reasons, there are often barriers that prevent directly supporting for-profit entities; however, these may be supported through an intermediary, such as an ESO.

TYPE OF CAPITAL	DEBT
Sources, with Description and Examples	*Venture Debt*:[140] Venture capital businesses may provide debt for high-growth entities. Few investment vehicles or institutions in the six AMS or in ASEAN Region, as a whole, are able (or willing) to provide venture debt to seed or early-growth-stage plastic circularity innovations. One notable exception, Circulate Capital's Ocean Fund, has invested in a number of local businesses in the recovery and recycling sectors in Indonesia, with amounts ranging from several hundred thousand dollars to $5 million. Other venture debt providers include C4D Partners and BIDUK in Indonesia, and inBest Ventures in the Philippines. For information on the role of venture equity alongside debt see the section below on equity.
	Bank Loans (including IFIs): In the six AMS, loans are generally not available for seed and early-growth-stage entities from either local or international commercial banks. These banks are reluctant to lend to start-ups, given their typically poor risk profile, and this generally applies to early-growth-stage plastic circularity innovations. However, once innovations are ready to scale, getting a loan is more likely. Also, commercial banks in Asia are becoming increasingly aware of their corporate social responsibility, including providing finance for businesses that are combatting plastic pollution. For example, in 2019, Swire, ALBA, and Baguio announced a joint venture to manufacture reusable containers made from recycled plastics, and HSBC provided a green loan to help finance the Hong Kong-based facility.[141] IFIs are development finance institutions that have been established by more than one country to support private sector development.
Sources, with Description and Examples	in developing countries. They use their capital to source private funding from capital markets.[142] In the ASEAN Region, their investments in the plastic value chain have primarily comprised extending loans to entities, or investing indirectly through funds that have a plastic circularity investment mandate. One notable example is IFC's provision of $150 million of senior debt through its first-ever blue loan to Indorama Ventures for scaling its PET recycling facilities in five emerging market countries that include Indonesia, the Philippines, and Thailand. ADB and Deutsche Investitions-und Entwicklungsgesellschaft (DEG) have matched IFC's loan to Indorama Ventures with an additional $150 million.

138 ADB (Asian Development Bank). 2020. "Healthy Oceans Technology Innovation Challenge."

139 Zero Waste Living Lab. n.d. "Koinpack is the Winner of the Technology Innovation Challenge on Healthy Oceans – Prevent Plastic Waste."

140 "Venture debt financing is a type of financing often used by early-stage companies that are looking to raise capital but do not yet have a proven track record of generating revenue. Unlike traditional forms of debt financing, venture debt is typically provided by specialized lenders who are willing to take on a higher level of risk in exchange for the potential of higher returns. This type of debt financing is typically used as a complementary method alongside equity financing." (Hayes. 2024. "What is Venture Debt Financing? What Is It and How Does It Work?").

141 Swire Pacific. 2019. "Ground-breaking of New Plastics Recycling Facility Heralds Creation of Closed-loop Economy for Reusable Plastic Containers."

142 OECD (Organisation for Economic Co-operation and Development). n.d. "Development finance institutions and private sector development."

TYPE OF CAPITAL	DEBT
Criteria and Requirements	• Borrowers must have a good credit history, be able to show recurring revenue, and/or provide collateral to secure their loan. • Borrowers must be able to service their loans; however, most business models are not widely understood by retail banks, and interest rates can be prohibitively high.

TYPE OF CAPITAL	EQUITY
Sources, with Description and Examples	*Angel Investors and Family Offices:* Typically, angel investors are individuals who invest their personal wealth in businesses that are in the earliest development stage. The investors may be motivated by their concerns about the environment, and they are willing to invest in unproven business models that cannot get funding from other sources. A family office (FO) is a corporate entity established by a wealthy family to manage its collective wealth, and provide other services to family members, such as tax and estate planning services. Regarding investments in plastic circularity, the motivations of FOs can be quite opaque, and they are influenced by the preferences of individual family members. Globally, little research has been carried out to examine the investments of angel investors and FOs, and, therefore, the extent of their financing for early-stage innovations in plastic circularity is not clear. However, based on conversations with stakeholders in this study, the plastic circularity investments of angel investors in the six AMS have been from about $250,000 to $500,000, although the amounts are often considerably less (particularly in the less developed economies in the ASEAN Region). Although angle investors do not necessarily invest in equity, they often do. Anecdotally, angel investments in the plastic circularity sector has been greatest in Indonesia, and downstream plastic waste collection and sorting services have been of particular interest. However, overall, it appears that such investments have been minimal.
	Venture Capital (VC) Investors, Including Impact VC Investors: VC investors invest in early- and ready-to-scale, high-growth-stage businesses by taking equity or providing convertible debt, and they expect commercial returns. In the ASEAN Region, VC investors are attracted to the opportunities resulting from the region's economic growth, which is driven by strong consumer demand, and the creation of local wealth; however, VC investors have not invested very much in plastic circularity innovations. A subset of VC investors are VC impact investors, which provide financing with the intention of generating positive and measurable social and environmental impacts, as well as earning a return on their investment;[143] however, there have been few VC investors in plastic circularity in the six AMS. Circulate Capital is one investor that specializes in plastic circularity enterprises in the six AMS, and others, such as AC Ventures, Openspace, SOSV, and Katapult Ocean have each made a single investment in the sector in the AMS. IFIs have also provided impact venture capital. In 2020, ADB launched a new venture arm, ADB Ventures. This provides seed, and early-growth-stage capital in emerging economies in Asia to finance technology-driven start-ups, including Circular Economy-themed innovations, and support achieving the United Nations' Sustainable Development Goals. ADB Ventures provides initial seed investments of $200,000, and at a later stage, equity investments of $500,000 to $3 million.[144, 145]
	Corporate Venture Capital (VC): Corporate VCs invest corporate funds directly in start-up businesses, which typically further the corporation's strategic goals (such as increasing the corporation's sales and profits), and/or generating financial returns by investing in businesses that the corporation's management understand better than is the case with typical venture capitalists.[146] In the six AMS, there has been little corporate VC investment in plastic circularity innovations that are start-ups or early-growth-stage businesses. One exception is the Dow Chemical Company's strategic joint ventures with established local firms that are developing high-quality mixed virgin and recycled plastic pellets. Although the company has not invested in start-ups in the six AMS, it has invested in other regions, including East Africa. In early 2022, Dow Chemical Company invested an undisclosed amount in Mr. Green Africa, an early-growth-stage, tech-enabled plastic recycling company in Kenya. Another example is Coca-Cola Amatil, the Australian bottling and distribution company that launched a corporate venture platform called Amatil X in Indonesia in 2019, with the objective of investing in four priority areas: on-demand delivery, distribution optimization, in-store analytics, and sustainable packaging. As of early 2024, Amatil X had not made any investments in innovative packaging businesses in the six AMS.

143 Global Impact Investing Network. n.d. "What is impact investing?"

144 ADB (Asian Development Bank). 2020. "ADB Ventures Raises $50 Million, Exceeding Fund Capitalization Target."

145 See ADB Ventures. n.d. "We invest to scale up climate solutions in emerging Asia."

146 Chesbrough. 2002. "Making Sense of Corporate Venture Capital."

TYPE OF CAPITAL	EQUITY
Criteria and Requirements	• The minimum investment amounts are typically $2 million but may start below $1 million if additional follow-on funding is expected; and more than $20 million for IFIs. • Expected returns for traditional venture capital investments can exceed a 25 percent internal rate of return (IRR); however, impact venture capital investors may accept a lower IRR (around 15 percent). • The optimal term of investment before exiting, such as the sale to a strategic investor or an IPO, is typically 5 years or less; however, impact investors may be willing to accept a longer time horizon, in combination with long-term financing.

Investment activity and practices for the future: Innovators and small businesses typically do not access certain types of capital. They use a combination of grants and loans, or convertible debt and equity, and sometimes in combination with strategic partners that leverage other forms of investment. As stakeholders in the six AMS consider how to increase investment in innovations for plastic circularity, two practices are highly relevant: blended finance and corporate bonds and loans.[147]

Blended finance: Blended finance brings together multiple sources and types of capital to scale innovations and infrastructure. It uses catalytic capital (such as investment capital that is longer term, risk-tolerant, and flexible) from public or philanthropic sources to increase private sector investment in sustainable development.[148] Blended finance also uses a variety of financial instruments to reduce the risk and/or increase the returns associated with a transaction or investment vehicle.

In the six AMS, reducing credit risk has been central in the innovative use of blended finance, which has facilitated access to capital for businesses seeking smaller investments. For example, Circulate Capital's Ocean Fund benefits from a partial credit guarantee of up to $35 million from the US International Development Finance Corporation (DFC). This guarantee reduces the credit risk of loans, and it allows the fund to make investments that it might otherwise decline. The Ocean Fund is one of the few impact funds or venture capital firms offering debt financing to growth-stage plastic circularity entities in the ASEAN Region. Notably, one of its investments in Indonesia has been in Prevented Ocean Plastic Southeast Asia (POPSEA), a joint venture between a local recycling company and a broker based in United Kingdom, which has helped to scale its waste collection and recycling operations across the country. In 2022, USAID's leading program to combat ocean plastic pollution, Clean Cities, Blue Ocean, gave a grant to POPSEA for the purchase of aggregation equipment for its new facility in Semarang, Java. This grant is expected to increase the potential returns on investment for the providers of private capital.

Thematic corporate bonds and loans: Several emerging market businesses in the plastic value chain have raised significant sums by issuing bonds in international or domestic debt capital markets. The proceeds from these bonds must be applied either to a specific project, or in the borrowing company's operational portfolio in a manner that is designed to have a measurable impact on one or more sustainability- or climate-related metrics. In these transactions, increasing plastic circularity is the common goal such as through investing in additional recycling capacity or increasing the use of recycled material.

147 A third mechanism on the horizon, plastic credits, may play an increasingly important role in the future.

148 Convergence. n.d. "Blended Finance."

Appendix 5. Selected Financing Criteria for Plastic Circularity Investments

DBS Foundation Social Enterprise Grant Program Qualifying Criteria

To qualify for consideration in the program, a social enterprise must:

- Be registered in Singapore; China; Hong Kong, SAR, China; India; Indonesia; or Taiwan, China.
- Have a viable business model, sales tractions, and a proven track record in sales and profitability.
- Offer an innovative solution to tackle critical social or environmental issues.
- Have a strong business plan to scale operations, impact, and reach (for example, leverage technologies and platforms).
- Implement a framework to measure and track key metrics, such as growth, finances, reach, and impact indicators.
- Have strong leadership and team experience, with a clear commitment to building a sustainable business for impact.

Ending Plastic Pollution Innovation Challenge

Participants are assessed using five separately weighted criteria:

- Viability and local potential (such as a locally tailored solution with demonstrable potential to reduce plastic pollution) – 35 percent.
- Innovativeness (such as a new idea to solve plastic waste) – 20 percent.
- Sustainability and scalability (operational and financial stability combined with the ability to scale and be replicable in other contexts) – 20 percent.
- Impact (with respect to SDG 1: no poverty, SDG 5: gender equality, and SDG 10: reduced inequalities) – 10 percent
- Diversity and complementarity of the submitting team – 15 percent.

Appendix 6. Selected Venture Debt Providers and Their Products

COMPANY	COUNTRY	INDICATIVE LOAN PRODUCT
C4D Partners[149]	Indonesia	Convertible debt, debt with a revenue share, or debt with other types of incentives Investment range: $200,000 to $1 million, with an average tenor of 5 years
BIDUK[150]	Indonesia	Customized, uncollateralized, cash flow-based loans of $10,000 to $150,000 for a usual term of 3 to 12 months, with 18 months as the maximum
inBest Ventures[151]	The Philippines	For corporations with at least a 2-year track record, $100,000 to $300,000 in growth capital as a conventional loan, venture loan (with flexible terms), mezzanine investment, and/or equity with a tenor ranging from 3 to 7 years. $20,000 to $80,000 in short- to medium-term liquidity loans

Source: Company websites, 2023

149 C4D Partners. n.d. "Capital 4 Development Partners."

150 Biduk Indonesia. 2021. "Revolutionizing Financing for Small and Growing Businesses in Indonesia". Biduk Indonesia. 2022. "Biduk's Unique Value Proposition."

151 InBEST Ventures. n.d. "Who we are."

Appendix 7. Perceived Barriers and Supportive Policies to Drive the Development of Plastic Circularity in the Six AMS

CATEGORY	PERCEIVED BARRIERS	SUPPORTIVE POLICIES
Alternative Materials	For bio-based and biodegradable materials: • Lack of technical expertise to develop and/or implement domestically. • Competition from large-scale and technically sophisticated producers • Lack of indigenous materials (such as agriculture- or aquaculture-derived materials) • Commercial scalability not viable due to issues with supply, technical performance, and/or relative cost	• Adoption of international standards for bio-based and biodegradable materials • Consumer labeling standards and guidance • Point-of-sale tax on most commonly littered plastics. • Bans of materials (such as bans of plastic bags and straws, and of oxo-biodegradable products) • Green Public Procurement Policy with preference given to alternative material, eco-design, recycled material over pricing. • Incentives/tax breaks for businesses using preferred alternatives. • Eco-modulated EPR fees
Redesign	Designs that involve alternative materials or refill/reuse: • Barriers such as lack of technical expertise to develop products using alternative materials, and lack of the requisite reverse logistics for refill/reuse innovations. • Designs for recycling or composting • Lack of the requisite SWM infrastructure such as segregation, collection, and processing facilities that can accept or maximize the value or impact of redesign	• Promotion and adoption of guidelines for acceptable recycling/composting designs • Consumer labeling standards and guidance • Adoption and enforcement of segregation-at-source policies • Incentives or tax advantages for designs (such as tethered caps) or business models that demonstrate the ability to reduce litter
Refill/Reuse	• Customer inconvenience and/or price sensitivity limits adequate buy-in/demand. • Lack of the requisite reverse logistics infrastructure impedes scalability	• Policies promoting water bottle refill stations in public spaces. • Inclusion of refill/reuse to meet EPR compliance. • Policies that subsidize or encourage investment in shared collection and washing infrastructure
Services to producers and waste generators	• Inadequate commercial demand • Relevant standards lack transparency/rigor	• Appropriately structured EPR regimes and reporting requirements
Operational Platforms	• Low barriers to entry • Highly fragmented market with no dominant technology or platform • Customer inconvenience and/or the perception that it duplicates a municipal service limit. • Inadequate buy-in/demand	• Policies that adopt and promote the selected operational platform(s) to support municipal collection, and align with EPR data reporting compliance, as required
Digital Mapping	• Unproven commercial application, especially where the participation of a large informal sector presents implementation challenges. • Possible competition from large technology companies (Big Tech)	• Mandated corporate ESG reporting requirements (for example, the EU's Corporate Sustainability Reporting Directive)

CATEGORY	PERCEIVED BARRIERS	SUPPORTIVE POLICIES
Recycling	• Inadequate quantity/quality of feedstock • Insufficient demand for recycled material, except for some high-value plastic-derived polymers • Price is uncompetitive when compared to the price of the virgin equivalent. • Collection is viewed as an activity with poor returns. • The existing technologies for sorting have several well-established players with high technology-related barriers to entry	• Source segregation. • Pay-as-you-throw (PAYT) • EPR for packaging • Design guidelines and requirements for recycling. • Recycled content mandates • Green Public Procurement Policy • Recognition of informal collectors and integrating them into municipal services
Recovery	• Inadequate demand reflects the absence of consumer buy-in • Existing separation technologies for sorting have several well-established players, with high technology-related barriers to entry. • Additional capacity development required	• Advanced disposal fee or tax on the most littered items (SUPs and other products) to create funds for street cleaning, litter prevention, and so on • For illegal dumping and littering, and failure to comply with public cleaning laws, charge fines and impose consequences (such as canceling the business license of repeat offenders)

Appendix 8. Summary of Selected SWM and SUP Policies

LEGEND	✔ - Enacted	(✔) - Future/Planned or partial enactment	↻ - Considering	✖ - Not yet considering	✔ - Priority for innovative solutions

POLICY	CAMBODIA	INDONESIA	MALAYSIA	PHILIPPINES	THAILAND	VIETNAM
Segregationat Source	✔	✔	✔	✔	✖	✔
Material Ban: Bag Ban/Tax	✔	↻	✔	↻	✔	✔
Use Ban: SUP	↻	(✔)	↻	↻	✔	(✔)
Waste Import Bans	✖	✔	↻	✖	(✔)	(✔)
EPR for Packaging	✖	✔	(✔)	✔	↻	✔
Preferred Procurement	✖	✖	✖	✖	✖	↻
Tax Incentives/ Tariff Rebates	✖	✖	✖	✖	✔	↻
Recycled Content Allowances	✖	✔	✔	✔	✔	✔
Recycled Content Mandates	✖	✔	↻	✖	✖	↻
Material Bans (Oxo-degradable)	✖	↻	✖	✖	✔	✖

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June 2024