

## Sustainability of plastic waste management through voluntary initiatives – a case study in Indonesia

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### ABSTRACT

The plastic pollution crisis has resulted in the establishment of many voluntary plastic waste initiatives in Southeast Asia, where most of the plastic leakage occurs. This study aims to assess the sustainability of four types of voluntary, partly or fully externally funded plastic waste initiatives within Indonesia's current waste management system and anticipate challenges that can arise in the future. The research used the qualitative approach of Strengths, Weaknesses, Opportunities, and Threats, and Internal and External Factors Analysis framework to evaluate the initiatives' techno-economic, socio-cultural, legislative, and environmental sustainability. The results showed that three out of four types of plastic waste initiatives were in the diversification quadrant, and one type was in the survival quadrant. The unfavoured position of the initiatives in the quadrant is mainly due to important regulatory gaps in Indonesia and the lack of a stable funding mechanism. The appropriate strategy for the voluntary plastic waste initiatives to be self-sustainable and a catalyst for sustainable national waste management is to exert pressure on the government to establish an institutionalised and legislated waste management system and endorse a mandatory implementation of the polluter pays principle. Otherwise, improving waste management systems in Indonesia at the macro level could be challenging to achieve.

### IMPACT STATEMENT

Voluntary plastic waste initiatives bridge the current gap between extensive plastic waste leakages into the environment and the need for integrated waste management services, particularly in emerging economies. Since 2014, when the United Nations Environment Assembly (UNEA) first recognized global plastic pollution as an emerging environmental threat, stakeholder engagement on this topic has rapidly evolved. In 2022, the UNEA called for the development of a global plastic governance instrument, which is currently under development. Effective global plastic governance requires a combination of voluntary and regulatory measures to address the plastic pollution crisis. This research aims to shed light on voluntary waste initiatives to initiate a broader discussion regarding the sustainability and effectiveness of voluntary regimes. In addition, it aims to inform policymakers and practitioners about the need for accountability and

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sustainable financing of local waste management systems, supported by well-functioning extended producer responsibility schemes to ensure meaningful progress towards eliminating plastic pollution.

## INTRODUCTION

Indonesia is the largest archipelago in the world, a country that has experienced rapid development with a population of around 270 million people. It has been identified as the second top plastic marine litter polluter in the world (Jambeck et al., 2015); a country where 72 % of plastic pollution originates from its rural areas and small cities (WEF, 2020). The main drivers for plastic pollution, like in other Southeast Asia countries, include poor or non-existent waste management systems, lack of producer responsibility, and lack of awareness by the population for responsible waste disposal (Jambeck et al., 2015). Like neighbouring countries, the informal waste sector dominates the removal of most recyclables, with waste pickers and waste banks, even some functioning as formal waste management structures, recovering roughly 50% of waste (Jain, 2017).

National laws, regulations, and decrees are the basis for managing plastic waste in Indonesia (Table 1), supported by a substantial number of local regulations. The Solid Waste Management Act (No. 18/2008), the Indonesia's Plan of Action on Marine Plastic Debris and the National Action Plan on Circular Economy 2025-2045 (The Government of the Republic of Indonesia, 2018; PPN/Bappenas, 2024) are setting provisions and targets to implement the reduce, reuse, recycle (3Rs) paradigm, aiming for a 70% reduction of ocean plastic by 2025, with gradual targets for specific type of plastic packaging in the retail sector until 2045. According to the Solid Waste Management Act, waste management is defined as a systematic, comprehensive, and sustainable activity that includes waste reduction and handling (Ministry of Environment, 2008). Generated waste goes into the first processing site, namely the Temporary Waste Disposal Facility – *Tempat Penampungan Sementara* (TPS). TPS is a place where waste is transported before it is moved to either the recycling site, processing site, Integrated Waste Processing Site – *Tempat Pemrosesan Sampah Terpadu* (TPST), or 3R Waste Management (TPS 3R) site.

<b>National Law</b>	<b>UU No.18/2008</b> Law on Solid Waste Management	<b>UU No.11/2020</b> Law on Job Creation		
<b>Government regulation</b>	<b>PP No. 81/2012</b> Government Regulation on Management of Household and Household-like Waste	<b>PP No. 22/2021</b> Implementation of Environmental Protection and Management	<b>PP No. 27/2020</b> Management of specific wastes	
<b>Presidential Regulation</b>	<b>Perpres No. 97/2017</b> Presidential Regulation on National Policy management Strategy of Household Waste and Household-like waste	<b>Perpres No. 83/2018</b> Presidential Regulation on Marine Debris Management	<b>Perpres No. 18/2015</b> Presidential Regulation on Income Tax Facilities for Investment in Certain Business Fields and/or in Certain Regions	
<b>Presidential Decree</b>	<b>Keppres No. 61/1993 and No. 47/2005</b> Presidential decree on Ratification of Basel Convention on the Control of the Transboundary Movement of Hazardous Waste and Their Disposal			
<b>Ministerial Regulation</b>	<b>Ministry of Trade Regulation No. 7/2024</b> Import Policy and Regulation	<b>Ministry of Public Works Regulation No. 3/2013</b> Implementation of Solid waste Infrastructure and Facilities	<b>Ministry of Environment and Forestry Regulation No. P. 75/2019</b> Roadmap to Waste Reduction by Producers	<b>Ministry of Environment and Forestry Regulation No. 14/2021</b> Waste Management on Waste Banks
	<b>Ministry of Trade Regulation No. 48/2015</b> General Provisions in the Import Sector	<b>Ministry of Trade Regulation No. 70/2015</b> Importer Identification Number	<b>Ministry of Industry Regulation No.48/2015</b> Requirements for income Tax Facilities.	<b>Ministry Environment and Forestry Regulation No. 6/2022</b> Information System Platform for National Waste Management

Table 1. Updated summary of Indonesia's national waste management regulations, adapted from Ismawati et al., 2022.

The financial resources for municipal waste management services are sourced from public funds and direct payments from households for the waste collection service provided. Financing of waste management relies on the local budget - an annual financial plan for regional governments (Aprilia, 2021). In 2022, the country allocated 0.51 % of its national budget for waste management (Farahdiba et al., 2023). Typically, household payment does not exceed 1-2 USD per month per household (Aaderaa, 2023). Due to gaps in household fee regulations and limited general purchasing power, many cannot afford additional costs. Consequently, household waste is either openly burned in their backyard, buried, or littered into the environment.

To prevent waste generation and increase participation rates in waste management, Indonesia is gradually adopting an Extended Producer Responsibility (EPR) approach, which requires producers to take responsibility for the products they introduce to the market. It currently covers electronic and electrical waste, batteries, plastic packaging, cardboard, glass, and textiles. Some provisions for EPR are outlined in Indonesian legislation and soft law, including the National Action Plan on Marine Plastic Debris and the Roadmap for Waste Reduction by Producers or 'the Road Map' (Ministry of Environment and Forestry, 2019). Given the Road Map is not a binding regulation, it provides an overarching frame for establishing EPR systems; however, to date, the implementation of existing EPR schemes for different waste types varies based on different interpretations of the Road Map. For example, some stand-alone producers channel their responsibility through financial support to selected regional waste management projects. Others, however, such as the Indonesia Packaging Recovery Organisation (IPRO) and the Packaging and Recycling Association for Indonesia's Sustainable Environment (PRAISE), which are comprised of multinational food and beverage companies, like Danone and Coca-Cola and some recyclers, promote a collective producer responsibility scheme. Currently, there is no publicly accessible information about which companies have already submitted their Road Maps.

On top of the national efforts to manage solid waste, since 2015, Indonesia has been experiencing increasing plastic waste initiatives, generally funded by developed economies, e.g., Germany, Norway, corporate plastic industries e.g., Borealis, NOVA Chemicals, Borouge or philanthropists (Stuchtey, 2019; Danielson, 2020). In addition, many start-ups, such as Waste4Change, Rekosistem, and Kibumi, from the technical sphere, have emerged in Indonesia with a focus on addressing municipal waste management. Many of these initiatives focus on the rapid transfer of technology and “know-how” for plastic waste removal from the environment. According to the World Economic Forum, emergent action in Indonesia is related to initiatives that focus on new business models, material innovation, redesign for recycling, waste management and recycling, community and city level partnership, technology-based solutions (e.g., mobile phone apps) and informal recycling sector integration, single-use plastic reduction as well as on enabling activity and research (WEF, 2020).

The Indonesian municipal solid waste management (MSW) system has been the focus of many researchers and has been described in much detail in the literature. Putri et al (2018) looked at plastic waste material flow and compared waste recovery efficiency at source, waste pickers, and waste banks (Putri et al., 2018). Farahdiba et al. (2023) analyse food waste management, including plastics and point out to thermal treatment and refuse-derived fuel (RDF) of MSW (Farahdiba et.al., 2023). The processing of RDF in developed economies contrasts with that in Indonesia, where RDF has, mostly but not always, a positive value. Bagastyo et al. (2023) assessed household attitudes towards waste segregation at source and proposed stronger enforcement regimes (Bagastyo et.al., 2023). Johannes et al. (2021) argued that integrating the informal sector into waste management planning and development is fundamental (Johannes et.al., 2021).

Furthermore, voluntary plastic waste initiatives typically emerged from Western-led corporations with a background in the plastic industry, aid money, or start-up backgrounds, or they evolved from businesses often originating from the local recycling sector. These initiatives usually set up a scheme consisting of household collection, which is sometimes covered by a fee contribution. They sort on-site and further process recyclable material to off-takers and residue to landfill or, recently, more often to cement industries. They process other waste types, such as organics, cardboard, and glass, with organics being the most challenging due to the lack of application options. Such initiatives usually rely on revenue from off-takers for plastics, household fees, and rarely fees collected from local authorities that insufficiently cover their capital and operational expenditure. Therefore, most initiatives rely on funding from third parties.

Plastic credit projects, where individuals, corporate plastic producers, or marketing industries can purchase credits to keep their “plastic neutrality” are increasingly popular across Asia, including Indonesia. Offsetting the plastic footprint requires a standardised measurement system, with accountability from the plastic value chain, including plastic production and legacy plastic remediation. Lee, in her paper (2021), offers her view on standardised plastic credits like the existing carbon and sustainable palm oil systems and argues that such a system could serve as an interim measure for the upcoming EPR schemes (Lee, 2021). Plastic credit initiatives in Asia, as they exist now, are voluntary. They are like unilateral EPRs built on a limited set of criteria and highly exposed to market-based risks (e.g., price calibration vs. prices of recyclables).

Environmentally sound management (ESM) of waste involves a comprehensive approach to handling plastic waste that minimises its negative impact on ecosystems and human health.

This approach encompasses strategies such as reducing plastic consumption and behaviour change regarding waste disposal, as well as implementing efficient waste collection and sorting systems or securing the final disposal in an environmentally sound manner. There is a need to enhance the current legislative framework to move from the various voluntary initiatives like plastic credits to ensure nationwide, upscaled, environmentally sound waste management in Indonesia, which is crucial for minimising plastic pollution.

In Indonesia, many plastic packages are poorly designed for recycling, and there is a lack of environmentally sound recovery options (e.g., downcycling, waste to energy), as well as a shortage of sanitary landfills that follow ESM principles, due to insufficient capital expenditure and operation and maintenance funds (Munawar et al., 2018). This leads to plastic packaging waste being openly burned in communities or leaked into the environment, causing pollution. Furthermore, ESM requires community engagement, strong enforcement of existing waste regulations, and the introduction of new measures, such as closing unsanitary landfills or phasing out non-recyclable single-use plastic packaging and products without sufficient market justification.

To date, no research has examined the sustainability of current initiatives to address plastic pollution in Indonesia. This research paper evaluates four types of plastic waste initiatives on their sustainability potential. It employed a sustainability framework that entails governance, institutional, socio-cultural, environmental, operational, financial, and economic aspects for its assessment.

## II. BACKGROUND

### Study Area and Initiatives

The study focuses on examining four types of initiatives across Java, Bali, Sulawesi, Lombok, and the Moluccas (Figure 1). The selection of seven initiatives was based on the following criteria: a) all initiatives operate voluntarily; b) are partly or fully funded by external sources, including private or private sector investments, donors, or grants; and c) intend to actively transfer technology as well as “know-how” from developed economies to regions lacking waste management and infrastructure. For some initiatives, partial financial revenues may come from households, sales of recyclables, and local authorities.



Figure 1: Locations of the initiatives examined in the research.

Within the scope of our resources, we studied four types of initiatives: (1) a waste management system established by the initiative with the aim of handing it over to local authorities; (2) waste management systems operated by the initiative; (3) plastic credits; and (4) clean-ups and technology transfer.

A Type 1 initiative focuses on establishing and optimising a waste collection system by engaging households to separate their waste at the source into organic and inorganic fractions. It provides new waste management infrastructure to sort and process recyclables and organic waste, including a behavioral change strategy and cooperation with local authorities operating the initiative. The waste management capital expenses of Type 1 initiative are covered by external donors, while the operational expenses are partly covered by fees from households, the sales of recyclables, local governments and private funds.

A Type 2 initiatives engage in one or more of the following activities: setting up scheduled pick-ups for mixed fractions or plastics-only to be sorted and processed on-site, sourcing material from informal sector structures and/or waste banks, and processing waste at a material recovery facility. The capital expenses for waste management in Type 2 are covered by sources such as external donors, private investments, or loans, while the operational costs are partly covered by household fees, EPR fees, plastic credits, and the sales of recyclables. These initiatives seek for external funding or private investments at different degrees.

A Type 3 initiatives aim to establish plastic credits - a transferable certificate representing the collection of a specified weight of plastic waste that has been recovered or recycled, which would otherwise have ended up in the environment. It then brokers transactions between organisations and end users wishing to purchase these plastic credits to address their 'plastic footprint', and existing formal or informal plastic waste collectors and processors. This initiative taps into the existing supply chain, starting with the informal waste sector, and relies heavily on sales revenues and/or third-party funding.

A Type 4 initiative aims at to perform clean-ups using equipment, such as river litter traps, that prevent plastic waste from flowing into the ocean. This type of initiative conducts frequent clean-ups of waterways, beaches, or the sea through waste collection, using hired workers and volunteers. It involves sorting, processing, and documenting material on-site. Due to the high contamination of collected materials, sales revenue is usually very low, and the initiative relies heavily on third-party funding and volunteering. This initiative relies on philanthropy and private donations.

### **Sustainability assessment aspects**

The assessment of the initiatives in the study is based on the following sustainability aspects, which served as the basis for the questionnaire:

1. Organisational management addressing the strategy and capacity of the initiative.
2. Political/legal aspects that determine the scope of each initiative, and alignment with existing or planned legal and regulatory waste management frameworks and targets.
3. Socio-cultural aspects include the influence of culture on waste generation and management in the household and in businesses; the community and its involvement in waste management; the relations between community groups, looking at gender, age, and occupation (i.e., refers to the inclusion of informal waste sector stakeholders).

4. Environmental aspects focus on environmentally sound waste management, the level of recovery of non-renewable resources; and pollution control.
5. Technical aspects include the performance of applied technology/infrastructure and waste management practices.
6. Financial-economic aspects that pertain to budgeting and cost accounting within each initiative.

### III. METHODS

#### Data collection

We used a combination of complementary methods to perform this study. Current research and grey literature on regulatory and operational aspects of plastic waste management in Indonesia were gathered to inform the analysis. In addition, the study obtained information from primary data sources through field observations over a period of time and a total of 52 interviews (7 structured interviews and 45 personal interviews) with different stakeholders from local authorities, academia, initiatives, the informal waste sector, households, and civil society. We conducted structured interviews with representatives of each initiative following a standardised questionnaire, developed based on the six sustainability assessment aspects. The information was gathered through virtual and in-person interviews conducted between the interviewer and the respondents of each initiative. An overview of all questions is provided in Appendix A. During these interviews, respondents were asked to provide scores on a scale from 1 (low) to 6 (high) to define the degree/level to which each initiative meets the sustainability aspects.

The questionnaire was applied individually for each initiative, determining the selection of SWOT factors for each different type of initiative (grouping). SWOT factors selected were the same for each initiative falling under the same group but different to those falling into a different group type. The scope of this work is to assess the sustainability of each different type of initiative.

#### Data analysis

The analysis used to determine the sustainability of each type of initiative followed the Strengths, Weaknesses, Opportunities, and Threats (SWOT) quantitative analysis framework by employing the Internal Factors Analysis System (IFAS) and External Factors Analysis System (EFAS) technique. The SWOT analysis was performed four times, once for each type of initiative grouping. Therefore, the internal and external factors vary for each type of initiative (grouping).

IFAS and EFAS, in this analysis, had an equally important role. The weighting technique was carried out on every factor of SWOT by assigning a weight between 0.00 and 1.00. If the aspect on each factor (internal/external) summed would result in 1. After weighting, a rating was given. This rating indicated the importance level of each aspect (1 = somewhat important; 2 = important; 3 = very important). Then, the weighted score was multiplied by a predetermined rating. The sum of each factor is then summed to know the position of the initiative location in the SWOT quadrant for determining strategy options. Weighting and rating of the internal and external factors were based on internal workshops and the ranking that was provided during the structured interviews.

## IV. RESULTS & DISCUSSION

The application of SWOT analysis provides a comprehensive understanding of the internal and external conditions that influence the effectiveness of plastic waste initiatives in promoting sustainable plastic waste management outcomes in Indonesia. Tables 2-3 present the SWOT outputs for both the internal and external factors analysis of the Type 1 initiative. Similar analysis has been performed for Types 2, 3, and 4 initiatives.

Table 2. IFAS scoring on identified internal factors in SWOT analysis for Initiatives Type 1

Internal Factors		Weight	Rating	Score
<b>Strengths</b>				
S1	Sustainability principles in mission, vision and goals of the initiative exists	0,050	3	0,15
S2	Staffing to realise its vision and mission exists	0,030	2	0,06
S3	Contribution in recovering of plastic waste	0,075	2	0,15
S4	Cooperation/integration with local authorities	0,060	3	0,18
S5	Alignment with national waste management priorities and goals and existing legislation	0,070	3	0,21
S6	Focus on changing the waste management habits of the local communities	0,055	2	0,11
S7	Following a gender sensitive approach	0,030	1	0,03
S8	New waste management infrastructure of sufficient capacity	0,070	2	0,14
S9	Feasibility/baseline studies conducted prior to implementation	0,030	2	0,06
S10	Technical operation follows environmental standards	0,030	1	0,03
Sum		0,500		1,12
<b>Weaknesses</b>				
W1	Insufficient reporting to local authorities	0,055	1	0,055
W2	Low participation by local households	0,075	2	0,15
W3	No focus on changing consumption habits of local communities	0,045	3	0,135
W4	Local communities need to be informed and trained more often	0,070	1	0,07
W5	Competition with the informal recycling sector	0,070	3	0,21
W6	Residues disposed to unregulated landfill sites	0,055	3	0,165
W7	Collection system requires re-design	0,060	1	0,06
W8	Does not sufficiently recover "difficult" to recycle plastics (e.g., MLPs)	0,070	2	0,14
Sum		0,500		0,985

Table 3. EFAS scoring on identified external factors in SWOT analysis for Initiatives Type 1

External factors		Weight	Rating	Score
<b>Opportunities</b>				
O1	New jobs are created in the community	0,060	2	0,120
O2	Recyclable materials to the market are of better quality creating the chance to generate higher income from sale	0,120	2	0,240



External factors		Weight	Rating	Score
O3	Financial resources are secured for the continuation of the initiative	0,110	2	0,220
O4	Integration of the IRS in the formal waste management system	0,090	1	0,090
O5	Scalable operational model in terms of capacity	0,060	1	0,060
O6	Informs the development of new regional legislation	0,060	2	0,120
Sum		0,500		0,850
<b>Threats</b>				
T1	Capital costs and costs of operation depends in majority upon external donors	0,200	3	0,600
T2	Lack of funds allocated internally to address sustainability aspects beyond the immediate implementation	0,050	2	0,100
T3	Inefficient collection scheme may create negative backlash from households	0,050	2	0,100
T4	Existing legislation does not ease implementation of the initiative (e.g., legislative gaps to implement high recycling targets)	0,100	3	0,300
T5	Operation of the initiative will be handed to local government that has limited capacity (technical and other)	0,100	3	0,300
Sum		0,500		1,400

The sustainability position of each type of initiative in the IFAS-EFAS quadrant (See Figure 2) was determined by calculating values on the x-axis and y-axis, referring to the total value of each factor.

$$X = \text{Strength} + \text{Weakness} \quad Y = \text{Opportunity} + \text{Threat}$$

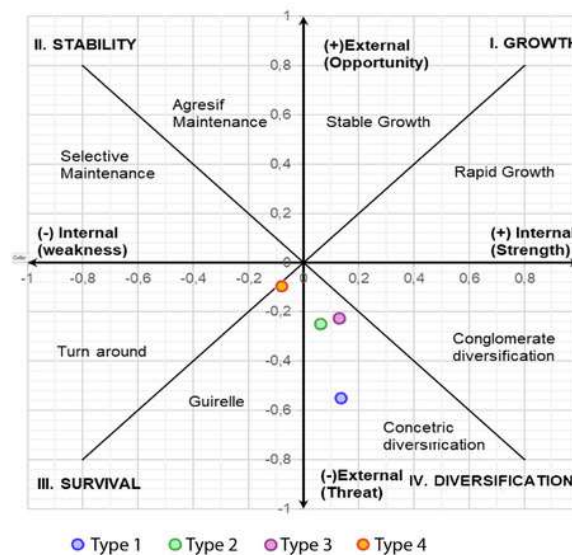


Figure 2: Results of the IFAS-EFAS analysis in quadrant positions for the four types of initiatives.

Quadrant I, means that the situation is very advantageous because the initiative has the opportunity and strength to deliver sustainability in managing plastic waste. An aggressive strategy may be adopted in such a case. Quadrant II means that the initiative has the opportunity to overcome internal weaknesses immediately. Minimizing internal problems may become the

best strategy to solve them. However, in our case study, none of the types of different initiatives were positioned in either quadrant I or II.

The summative analysis of the Type 1 initiative falls under quadrant IV that means that this type of initiatives are characterised by stability and has the potential to grow further once internal and external weaknesses have been addressed. While this type of initiative is aligned with the national waste management priorities, goals and existing legislation, it prompts competition with the informal waste sector, and the disposal of residual waste to unregulated land-fill sites, undermining the potential stability and growth. However, the biggest external threat is the lack of capital and operational costs which depend mostly on external donors. The external threats are also linked to the gaps in the existing legislation, which does not ease the implementation of the Type 1 initiative. In addition, if such operations are handed over to the local government, the threat remains around limited technical know-how and other capabilities to secure a continued and adequate service to the communities.

The summative analysis of Type 2 and 3 initiatives is also in quadrant IV, which could be explained by threats scoring considerably higher than internal strengths, weaknesses and external opportunities. By its nature, the Type 2 and Type 3 initiatives demonstrate strong outcomes in recovering plastic waste, aligned with national waste management priorities and goals and existing legislation. The scoring of opportunities demonstrates that Type 2 and 3 initiatives are better positioned than the Type 1 initiatives in financial terms. Type 2 and Type 3 initiatives show potential to deliver recyclables of better quality to the market and generate income from the sales of material. By doing so, it can secure financial resources for future operations. However, financial security is based on a fluctuating market of recyclables, and, in addition, the existing legislation does not ease the sustainability of operations.

The summative analysis of the Type 4 initiative finds itself in quadrant III. This outcome could be explained by internal strengths and weaknesses, and external opportunities and threats being evenly scoped. Type 4 initiative contributes to recovering plastic waste from the environment and can recover difficult-to-recycle material but the capital cost and operational cost depends largely upon external donors and private investments and cannot secure continuation of operations in the future if the funding dries out.

## V. FUTURE PERSPECTIVES

The internal and external threats identified in the SWOT analysis contextualise the current situation usefully and help provide strategies for stakeholder engagement and collaboration, shaping legislation, securing finances, and improving the performance of environmentally sound waste management practices.

**Stakeholder engagement and collaboration:** Direct engagement with households in communities is required to increase their participation in waste management and increase knowledge about the high risks of environmental impacts of mismanaged waste and the dangers of open burning. Households should be informed about responsible consumption of single-use plastics in a context-specific manner, focusing on waste prevention, as well about waste management options and their personal role in it. This long-term effort should be institutionally supported and should not be a burden to the communities. Initiatives should engage with the informal waste sector as the backbone of SWM in Indonesia. In addition, initiatives should lower barriers to integrating the informal waste sector within the structure of the initiatives by providing easy access to apply for work and providing incentives for the informal waste sector to work

on standard contracts with social benefits. Finally, it is important for stakeholders to enhance interaction with local government and establish regular communication, cooperation, and accountability.

**Regulatory interventions:** The initiatives should take the opportunity to contribute to designing a sustainable financial framework nationwide by advocating for the government to establish an institutionalised and legislated waste management system, where producers are responsible for the end-of-life phase of products in a transparent, holistic, and systematic manner. It includes enhancing nationwide mandatory frameworks, such as Extended Producer Responsibility (EPR) regulations, environmental compliance, and reporting to local authorities. An unregulated and scattered system may further increase the misperception of efficiency and finally hinder the development of accountable and reliable waste management. The “polluter pays” regime should also put legitimate demand to find solutions on difficult to recycle plastics, such as multi layers plastics (MLPs). Therefore, the utilisation of proven techno-economic sustainable applications for managing MLPs and a ban on specific packaging is urgently needed.

**Sustainable financing:** The initiatives should help stakeholders design some aspects of financial mechanisms nationwide. A mandatory “polluter pays” regime should be designed so that producers bear the waste management costs of plastic applications put on the market, without passing these costs on to the consumer. This regime should contribute to a sustainable financing mechanism that complements public funding, investments, and household contributions. Meanwhile, the initiatives should increase the sales of recyclables by expanding the existing collection networks and securing high-quality recyclable materials.

**Environmentally Sound (Waste) Management (ESM):** ESM encompasses a comprehensive approach to plastic waste management by following the waste hierarchy or 3R (reduce, reuse, recycle) approach in an environmentally sound manner. All types of initiatives, regardless of their profile, should perform in line with these principles. Therefore, it is necessary to build community capacity to participate in the overall waste management to reduce risks of open burning or open littering, as well as to avoid and reduce waste generation and especially hard-to-recycle materials. This also entails strategies to find alternative consumption models, e.g. reuse models and deposit return systems, following the waste hierarchy. The final disposal of material – especially the cascading of material into applications of minor quality – could be an option to elaborate with off-takers and informal recyclers. Finally, the initiatives must be secure if the actual process during collection and on-site management during sorting and final disposal matches ESM standards. As per this research, the final residue disposal utilised by the plastic waste initiatives was unregulated dumpsites.

## VI. LIMITATIONS OF THE STUDY

The Type 4 initiative primarily focuses on remediation activities, such as removing littered plastic waste from the environment. This contrasts with other initiatives that focus on plastic waste management. This limitation may hinder efforts to compare the four types of initiatives, although this is not the main scope of the paper.

Structured interviews were limited to seven, which might not be sufficient to justify the SWOT analysis results provided that this is the main and only data collection method used. To overcome this limitation, the research was enriched with a vast number of personal interviews and field visits. Furthermore, the in-depth understanding of the local context and status

of initiatives under the research of one of the authors of this paper, who has operated in Indonesia for many years, enhances the credibility of the research results.

## VII. CONCLUSIONS

Plastic waste management must be integrated into a comprehensive solid waste management system to combat plastic pollution effectively and achieve sustainable outcomes. This pioneering research on assessing the sustainability of plastic waste initiatives serves as a key starting point for broader dialogues and discussions regarding the effectiveness of different voluntary regimes. Urgent attention is needed on accountability, sustainable financing, and the development of a well-functioning EPR and ESM to ensure meaningful progress towards eliminating plastic pollution. Presently, voluntary plastic waste initiatives in Indonesia create uncertainty about their ability to minimise plastic leakage into the environment due to limited accountability of plastic waste management at the national scale. Reliance on external funding creates risks in securing the financial resources the initiatives largely depend on. Prioritizing the establishment of a mandatory “polluter pays” regime through regulatory tools such as EPR should be a priority strategy to secure essential financial resources alongside public and household funding.

### **Author contribution statement**

All authors equally participated in the conceptualization, implementation, and analysis of this research.

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### **Conflict of Interest Statement**

The research team declares that Benedict Wermter, a contributor to this study, has partly investigated some of the selected initiatives during previous journalistic assignments. The research team avoided competing interests by evaluating those initiatives with other researchers.

### **Ethics Statement**

This research has been conducted within GRID-Arendal’s policy frameworks covering code of conduct, procurement, and personal data management policy that is in line with the General Data Protection Regulation (GDPR).

### **Data availability**

The data that support the findings of this study are available on request from the corresponding author ([Ieva.Rucevska@grida.no](mailto:Ieva.Rucevska@grida.no)).

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Appendix A: Profiles and topics of interviews included in the questionnaire

Profile	Question topics
Institutional profile	Sustainability principles in the mission of the initiative; internal capacity to realize the vision and mission; cooperation with local authorities (e.g., province, regency, subdistrict, village); integrated reporting and monitoring by local authorities; and third-party audits.
Political/legal profile	Compatibility with waste management priorities and goals set in national policies; compatibility with existing national legislation; gaps in existing legislation; the initiative as a vehicle in stakeholder consultation to develop new regional legislation or soft law (e.g., new draft bills, amendments).
Socio-cultural profile	Participation of householders in the initiatives; household consumption and waste management practices; awareness and training activities for local communities; job opportunities for the local community; inclusion of the informal waste sector and/or their representatives; formalization of work opportunities in the informal waste sector; gender profile.
Environmental profile	Plastic pollution leakages; environmental inspections; environmentally sound waste management of technical operations; environmentally sound waste management of residue disposal (e.g., access to sanitary landfills); plastic waste reduction measures.
Technical profile	Utilization of existing infrastructure and practices; new equipment; equipment capacity; feasibility (techno-economic) study at the design phase prior to implementation; establishment of a plastic waste collection system; recovery of plastic waste.
Financial-Economic profile	Waste management capital expenses (CAPEX); waste management operating expenses (OPEX); producer responsibility; support from local authorities; household payments; private investments; external donors; interaction with the plastic waste market; financial sustainability.

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