

Research Article

Cite this article: Rucevska I, Ch. Tsakona M and Wermter B (2024). Sustainability of plastic waste management through voluntary initiatives: A case study in Indonesia. *Cambridge Prisms: Plastics*, 2, e33, 1–9 <https://doi.org/10.1017/plc.2024.33>

Received: 23 May 2024
Revised: 06 September 2024
Accepted: 01 October 2024

Keywords:

waste management; plastics pollution; plastic waste recycling

Corresponding author:

I. Rucevska;
Email: Ieva.Rucevska@grida.no

Sustainability of plastic waste management through voluntary initiatives: A case study in Indonesia

Ieva Rucevska¹ , Maria Ch. Tsakona^{1,2} and Benedict Wermter³

¹GRID-Arendal, Arendal, Norway; ²Qgreen, Melissa, Attica, Greece and ³Veritas Edukasi Lingkungan Foundation, Surabaya, Indonesia

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 recognised 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 sustainable financing in local waste management systems, supported by effective 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 recovery of most recyclables, with informal waste workers and waste banks, some even 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

© The Author(s), 2024. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.



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

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

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.

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 (Aadaraa, 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 multi-national 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, Borealis 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 (SWM) 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 SWM (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 addressing plastic pollution in Indonesia. This research paper evaluates four types of plastic waste initiatives based on their sustainability potential. It applies a sustainability framework

encompassing governance, institutional, socio-cultural, environmental, operational, financial and economic aspects for its assessment.

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.

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 behavioural change strategy and cooperation with local authorities. 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.

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 external funding or private investments to varying degrees.

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 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.



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

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.

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 using a

standardised questionnaire, developed based on the six sustainability assessment aspects. Information was gathered through virtual and in-person interviews conducted between the interviewer and the respondents from 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 to which each initiative meets the sustainability aspects.

The questionnaire was applied individually for each initiative, determining the selection of SWOT factors for each type of initiative (grouping). The SWOT factors were consistent for initiatives within the same group but different for those in different groups. 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.

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 and 3 present the SWOT outputs for both the internal and external factors analysis of the Type 1 initiative. Similar analysis was performed for Types 2, 3, and 4 initiatives.

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.

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

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. Minimising 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 landfill 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 Types 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 Types 2 and 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 Types 2 and 3 initiatives are better positioned than the Type 1 initiatives in financial terms. Types 2 and 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.

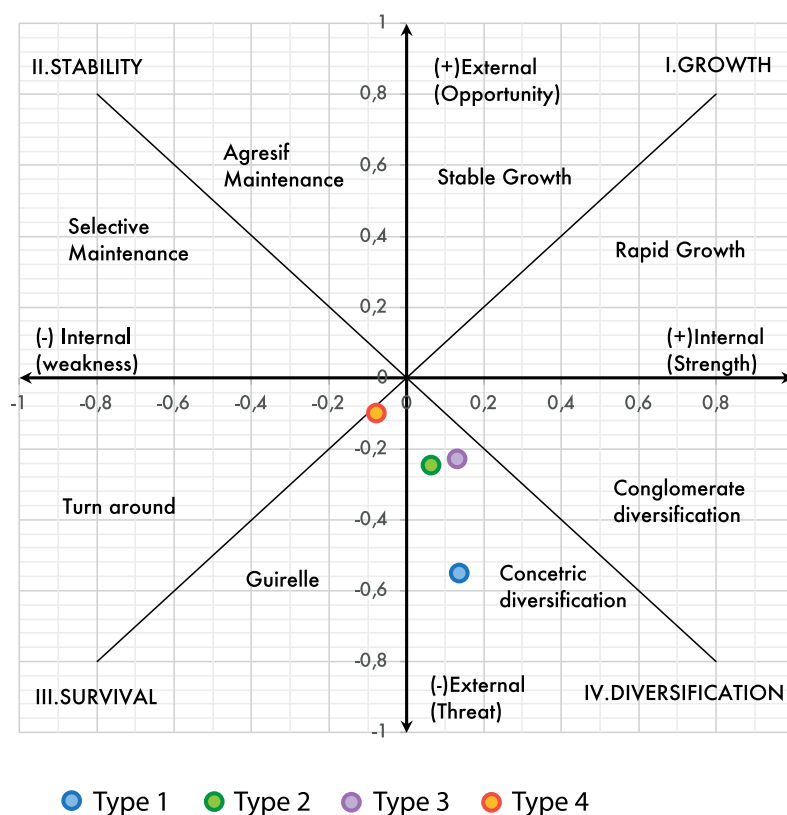
The summative analysis of the Type 4 initiative finds itself in quadrant III. This outcome could be explained by internal strengths and weaknesses, and external opportunities and threats being evenly scoped. Type 4 initiative contributes to recovering plastic waste from the environment and can recover difficult-to-recycle material but the capital cost and operational cost depends largely

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

Internal factors		Weight	Rating	Score
Strengths				
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 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
Weaknesses				
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 redesign	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 internal factors in SWOT analysis for Initiatives Type 1

External factors		Weight	Rating	Score
Opportunities				
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
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
Threats				
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

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

upon external donors and private investments and cannot secure continuation of operations in the future if the funding dries out.

Future perspectives

The internal and external threats identified in the SWOT analysis contextualise the current situation and help in developing 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 raise

awareness 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 as 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 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 multilayer plastics (MLPs). Therefore, the utilisation of proven, technoeconomic, sustainable, and environmentally sound solutions 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 ensure that 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.

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.

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. Prioritising 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.

Open peer review. To view the open peer review materials for this article, please visit <https://doi.org/10.1017/plc.2024.33>.

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

Acknowledgement. The research team acknowledges Jane Fischer, the coordinator of the Indonesian Waste Platform in Bali, for her support in Indonesia, as well as Swati Singh Sambyal, GRID-Arendal officer in India, Miles Macmillan-Lawler, Chief Scientific Officer, GRID-Arendal, Mochamad Septiono of GRID-Arendal, Dr. Eleni Iacovidou, Senior Lecturer in Environmental Management at Brunel University London and Yuyun Ismawati of the Nexus 3 Foundation for taking the time and effort to review the paper and for providing their constructive feedback, valuable suggestions, and insightful comments.

Author contribution. All authors equally participated in the conceptualisation, implementation and analysis of this research.

Financial support. This research was financially supported by the Norwegian Agency for Development Cooperation (NORAD).

Competing interest. The research team declares that Benedict Wermtner, 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).

References

- Aadaraa S (2023) *CLOOC Project*. Presentation. Avfall Norge.
- Aprilia A (2021). *ASEFSU23 Background Paper – Waste Management in Indonesia and*. Jakarta: Challenges and Way Forward.
- Bagastyo AY, Anggrainy AD and Maharani Wiguna Hidayat Liang MS (2023). Assessment of attitude and participation level among the households and local merchants toward single-use plastic waste management: A case study in Balikpapan municipality, Indonesia. *Case Studies in Chemical and Environmental Engineering*, 7, 100361. <https://doi.org/10.1016/j.csee.2023.100361>.
- Danielson J (2020) Leave No Trace (Report). Retrieved from <https://hasiruda.la.in/wp-content/uploads/2020/12/Leave-No-Trace.pdf>
- Farahdiba AU, Warmadewanthi IDAA, Fransiscus Y, Rosyidah E, Hermana J and Yuniarto A (2023). The present and proposed sustainable food waste treatment technology in Indonesia: A review. *Environmental Technology & Innovation*, 32, 103256. <https://doi.org/10.1016/j.eti.2023.103256>.
- Ismawati Y, Septiono MA and Proboretno N (2022) Country Situation Report. Plastic Waste Management and Burden in Indonesia (Report). Retrieved from https://ipen.org/sites/default/files/documents/ipen-2021-indonesia-v1_law.pdf
- Jain A (2017) Waste Management in ASEAN Countries: Summary Report (Report). Osaka: United Nations Environmental Programme. Retrieved from http://www.rrcap.ait.ac.th/Publications/Waste_Management_in_ASEAN_Countries_Summary_Report.pdf
- Jambeck JR, Geyer R, Wilcox C, Siegler TR, Perryman M, Andrady A, Narayan R and Law KL (2015). Plastic waste inputs from land into the ocean. *Science*, 347 (6223), 768 –771. <https://doi.org/10.1126/science.1260352>.
- Johannes HP, Kojima M, Iwasaki F and Edita EP (2021). Applying the extended producer responsibility towards plastic waste in Asian developing countries for reducing marine plastic debris. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 39 (5), 690 –702. <https://doi.org/10.1177/0734242X211013412>.
- Lee MKK (2021). Plastic pollution mitigation – Net plastic circularity through a standardized credit system in Asia. *Ocean & Coastal Management*, 210, 105733. <https://doi.org/10.1016/j.ocecoaman.2021.105733>.
- Ministry of Environment and Forestry of the Republic of Indonesia Roadmap for Waste Reduction by Producers., Pub. L. No. Decree No.P75/MENLHK/SETJEN/KUM NUMBER. 1/10/2019 (2019). https://nicholasinstitute.duke.edu/sites/default/files/plastics-policies/112021_N_2019_The_minister_of_environment.pdf
- Ministry of Environment Act of the Republic of Indonesia Number 18 Year 2008 Regarding Waste Management., IDN-2008-L-84427 (2008). https://natlex.ilo.org/dyn/natlex2/r/natlex/fe/details?p3_isn=84427
- Munawar E, Yunardi Y, Lederer J and Fellner J (2018). The development of landfill operation and management in Indonesia. *Journal of Material Cycles and Waste Management*, 20 (2), 1128 –1142. <https://doi.org/10.1007/s10163-017-0676-3>.
- PPN/Bappenas (2024) Peta Jalan Pengelolaan Susut dan Sisa Pangan dalam Mendukung Pencapaian Ketahanan Pangan Menuju Indonesia Emas 2045. (Policy). Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional (PPN/Bappenas). Retrieved from <https://lcdi-indonesia.id/wp-content/uploads/2024/07/Peta-Jalan-SSP-2045.pdf>
- Putri AR, Fujimori T and Takaoka M (2018). Plastic waste management in Jakarta, Indonesia: Evaluation of material flow and recycling scheme. *Journal of Material Cycles and Waste Management*, 20 (4), 2140 –2149. <https://doi.org/10.1007/s10163-018-0753-2>.
- Stuchtey M, Dixon B, Danielson J, Hale J, Wiplinger D and Bai P (2019) Project STOP: City Partnerships to Prevent Ocean Plastics in Indonesia. Retrieved from URL: <http://journals.openedition.org/factsreports/5409>
- The Government of the Republic of Indonesia (2018) Indonesia's Plan of Action on Plastic Debris 2017–2025. https://maritim.go.id/konten/unggah/2018/03/NAP_Marine_Plastic_Debris_Indonesia_Summary.pdf
- World Economic Forum (2020) Radically Reducing Plastic Pollution in Indonesia: A Multistakeholder Action Plan National Plastic Action Partnership (Insight Report). Retrieved from <https://weforum.ent.box.com/s/3dx0h6h3iyab847msnx7iw62kjt5myu>

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 realise 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; formalisation of work opportunities in the informal waste sector and 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) and plastic waste reduction measures
Technical profile	Utilisation 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 and 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 and financial sustainability