Closing the Loop: Breaking the Bottleneck of the Indonesian Plastic Crisis

Marcia Alana Sjarief

Summary

Inadequate infrastructure and a lack of awareness often lead to the pervasive issue of plastic waste from oftentimes mismanaged single-use items. Its multifaceted impacts on Indonesia's waterways and marine ecosystems become a bottleneck to relevant stakeholders and the nation's overall socioeconomic growth. This paper explores the feasibility of a circular economy (CE) model for plastic waste management, incorporating the Life Cycle Assessment (LCA) framework to reduce environmental impact in the value chain. The study also assesses the potential of Extended Producer Responsibility (EPR) as a funding mechanism to support CE implementation in Indonesia, with recommendations for regulatory enhancements and infrastructure investments to overcome current limitations and achieve sustainable national economic growth.

Keywords: Plastic pollution, Waterways, Circular Economy, Lifecycle Assessment, Extended Producer Responsibility

Navigating the Plastic Pollution Crisis in Indonesia's Waterways

With every plastic bottle and bag drifting into our waterways, a planetary emergency is at stake, placing entire ecosystems and global health at grave risk. Like other pollutants, plastic pollution knows no borders–traveling freely across countries, carried by water and air currents, and accumulating in benthic sediments (Borrelle et al., 2020). Global plastic pollution predominantly comprises 88% of macro-plastics from single-use items such as bottles, caps, bags, and straws (OECD, 2022).

In Indonesia, around 7.8 million ton of plastic waste in 2021, but 4.9 million ton is mismanaged–left uncollected, dumped in open sites, or leaking from poorly managed landfills. Approximately two-thirds of mismanaged plastic waste (MPW) originates in rural areas. This is primarily due to insufficient waste collection services and inadequate disposal infrastructure in these regions. This lack of access leads to the direct disposal of waste into waterways, making rivers the primary carriers of plastic waste to the ocean. An estimated 346.5-kilo ton/year of plastic waste enters the marine environment from land-based sources, with two-thirds coming from Java and Sumatra. Rivers transport and release 83% of the annual plastic waste originating from land-based sources, while only 17% comes directly from discarded or washed-off materials in coastal areas. In contrast, only 17% are discarded directly from coastal areas (World Bank, 2021).

Improperly discarded plastic waste degrades into microplastics, which can penetrate living tissues and pose health risks. In marine ecosystems, organisms often ingest microplastics, damaging their digestive systems and leading to potential reproductive issues or death due to toxic substances (Rooswiadji, 2023). These plastics also absorb hydrophobic contaminants, resulting in bioaccumulation in the food chain and affecting marine life and human health. Additionally, microplastics

release harmful chemicals like BPA and PCBs into the water while also forming a "plastisphere," a microbial ecosystem that harbors pathogens and further degrades water quality and impacting aquatic organisms (Alabi et al., 2019).

The Indonesian government has implemented several measures to combat plastic pollution, including the National Action Plan on Marine Debris (2017-2025), which aims to reduce marine plastic waste by 70% by 2025 through behavioural change, leakage reduction, enhanced funding, and rigorous monitoring (UNESCO, 2018). Regionally, Jakarta introduced a ban on single-use plastics in commercial areas in early 2020, leading to a 53% decrease in plastic bag usage within a year. However, small businesses and vendors have exploited regulatory loopholes, with compliance hindered by limited oversight.

Pathway of Plastic Waste and Waterway Contamination

Oil spills at offshore rigs pose a significant Indonesia generates significant amounts of solid waste, with over 66.5 million tons of household waste in 2018 alone. Only 63% of the waste is transported to the final disposal site, with the remaining uncollected. Additionally, around 14% of Indonesia's solid waste is MPW sourced from domestic industries, businesses, consumers, and poor solid waste management infrastructure. A combination of this issue, high population density, increased waste generation in urban areas, and heavy rainfall during monsoon seasons exacerbate plastic pollution in waterways (Lestari & Trihadiningrum, 2019). In addition, socioeconomic factors play a significant role in shaping the behaviour of communities residing near river bodies, where many resorts to illegal dumping and direct disposal due to inadequate access to proper facilities (Salampessy et al., 2019). Other than that, leakage from unsanitary landfills is a critical issue, with only 11% classified as sanitary, and the problem worsens when these landfills are located near waterways (Ramadhan and Sembiring, 2023). The accumulation of pollution from these sources will then be transported to the marine environment.

Figure 1. Oil Platform dan Rig Across Indonesia.
Sources : Nugraha et al. 2019

Holistic Approach to Address Plastic Life Cycles

To evaluate the persisting plastic crisis, UNEP's Life Cycle Assessment (LCA) examines products' environmental footprints to advocate a holistic approach to sustainable decision-making. By examining each phase—raw material extraction, design, manufacturing, distribution, use, recovery, and disposal—LCA aims to maximise value and minimise environmental impact throughout the value chain. This optimisation offers cost-saving opportunities, improves efficiency, and reduces ecological footprints.

Figure 2. Life Cycle Approach of Plastic Waste
Sources : UNEP Life Cycle

The LCA approach highlights the environmental, social, and economic impacts across plastic products' entire lifespan, ensuring that improvements in one stage do not lead to unintended negative consequences in others (Jiao et al., 2024). The LCA framework also aligns with circular economy (CE) principles, which focus on minimising waste and maximising resource efficiency by using materials through reuse, repair, and recycling rather than following a linear 'take-make-dispose' model. Implementing CE within the plastic life cycle requires a transformative approach to design, production, and management, ultimately reducing ocean-bound plastic by over 80%, cutting greenhouse gas emissions by 25%, and potentially saving governments USD 70 billion while creating 700,000 jobs by 2040 (UNEP, 2022).

Feasibility of CE in Indonesia

On the contrary, Indonesia still relies on the linear economic model, resulting in excessive resource use and waste, highlighting the urgency to shift to the CE model. It is safe to say that CE implementation in Indonesia is highly feasible, proven by the National Plan for Circular Economy 2025-2045, adopted by the government, outlining a strategic roadmap that targets critical sectors like food and agriculture, electronics, construction, and textile, chosen based on their economic and circularity potential. This plan is synergised based on the 9R framework (Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover) through actions related to revamping policies and regulations, funding and incentives, robust data management, and proper communication and community awareness. This plan aims to increase Indonesia's GDP, create millions of new jobs, reduce waste, and lower GHG emissions (Bappenas, 2024).

There are expected challenges in implementing the national action plan, such as limited public awareness and education on CE practices, inconsistent policies and regulations, and insufficient coordination between local and national governments. Additionally, a significant lack of necessary infrastructure, such as recycling facilities and waste management systems, requires substantial investment. Moreover, there are organisational and cultural resistance challenges as the shift to a CE demands

changes in established practices, which are often met with reluctance. Finally, the local governments also face resource limitations in terms of human capital and finances, hindering their ability to design, implement, and monitor CE problems effectively.

Funding Mechanism Best Practice: Extended Producer Responsibility

In addressing the challenges of CE implementation, the Extended Producer Responsibility (EPR) system can significantly support Indonesia's shift towards CE by focusing on end-of-life product management and holding producers accountable for designing more robust yet sustainable products (OECD, n.d.). This also refers to infrastructure challenges by minimising waste generation right at its source and shifting the financial burden of waste management from local governments to businesses. Additionally, EPR fosters collaboration between stakeholders while raising public awareness of recycling.

EPR brings significant cost savings on the producer's end when implemented across the life cycle value chain. At the raw material extraction stage, the use of recycled content instead of raw materials can reduce procurement costs and protect against price volatility. During production, eco-design strategies help cut material and energy use, simplifying the manufacturing process and costs. Optimising durable, repairable, and recyclable products also decreases material and distribution expenses and consumer replacement needs. EPR also supports product reuse, enabling manufacturers to extend product life and generate revenue in the secondary markets, thus lowering production expenses. Recycling programs encouraged by EPR can provide a steady flow of recycled materials for production, reducing dependency on new resources. Finally, recyclable product design also lowers landfill fees and waste management costs, as EPR discourages incineration and landfill use while benefiting from sustainability incentives.

By adopting the EPR system, producers can benefit from resource efficiency using innovative strategies in their value chain operations. They can generate cost savings through reduced operational expenses, compliance fulfillment, and enhanced brand value to access new market opportunities. Moreover, it contributes significantly to job creation at each life cycle stage. Lastly, enhancing supply chain resilience and reducing reliance on imported raw goods strengthens sustainable national economic growth.

The tax subsidy mechanism balances economic and environmental goals using fiscal incentives and penalties to encourage sustainable practices among manufacturers and recyclers to fund EPR systems. This approach imposes taxes on producers who fail to meet environmental standards while providing subsidies to those adopting eco-friendly practices in recycling and manufacturing, motivating ecological innovation and responsibility. An example is Japan's "Design for Environment" (DfE) program, which links eco-design to recycling fees, reducing waste and recycling costs through tax subsidies (Chang et al., 2018). This system ensures fair distribution of financial burdens and benefits, with governments adjusting tax rates based on environmental impact and recycling difficulty to optimise regulation.

Challenges & Opportunities

The EPR system is yet to be implemented in Indonesia due to the issues and concerns related to a lack of awareness regarding waste management options, negative perception of recycled materials, limited capacity of the informal sector, and unavailability of clear guidelines and systems. Without the EPR scheme, CE implementation faces key limitations. First, producers lack incentives to manage product waste, leading to lower recycling rates and limited eco-design. Second, EPR encourages "design for the environment" by holding producers responsible for disposal, promoting recyclable materials, and disassembly-friendly designs. Third, waste management costs fall on municipalities, straining budgets and reducing effectiveness. Fourth, complex or hazardous materials risk improper disposal, increasing pollution. Fifth, EPR supports secondary material markets, reducing dependency on raw resources. Next, tracking and monitoring under EPR improve transparency and progress measurement toward CE. Lastly, EPR provides necessary guidance for consumers on responsible recycling and disposal, enhancing awareness. Without EPR, achieving full CE goals becomes more challenging and less efficient.

While some CE activities can occur without EPR, the system plays a critical role in aligning incentives, establishing accountability, and creating the infrastructure needed to support a fully functional circular economy. The World Bank has made sufficient recommendations for the accelerated implementation of EPR, tailored to the conditions of Asia-Pacific Economic Cooperations (APEC).

The three phases can be a stepping stone for Indonesia to initiate its EPR implementation.

Phase I focuses on awareness and foundation building. This can initiate educational programs on recycling, responsible consumption, and principles to enhance

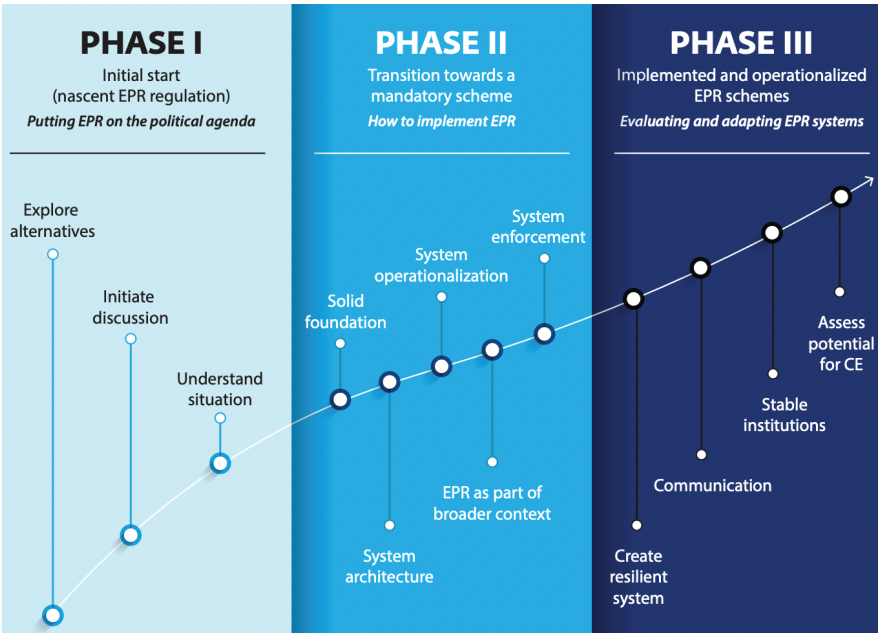

Figure 3. Recommendations for Accelerating EPR Implementation Based on APEC Context
Sources : World Bank, 2022

public awareness, leading to increased recycling rates and reduced waste. Next, stakeholder collaboration among governments, industries, and communities can analyse successful international EPR models, engage key stakeholders, and identify priority waste types.

Phase II involves establishing a regulatory framework and piloting EPR projects. A comprehensive framework should define producer responsibilities, financial obligations, and enforcement mechanisms. This can include tax breaks or subsidies for compliant companies and stricter penalties for non-compliance. Pilot EPR projects in high-waste areas can help refine the approach, especially for small and medium-sized businesses. Aligning with Indonesia's National Action Plan for Circular Economy will further support sustainable resource management.

Phase III shall focus on institutionalisation and continuous improvement. Public-private partnerships between local governments and businesses can develop waste infrastructure and recycling facilities, sharing costs and responsibilities. A central authority should oversee EPR implementation, complemented by public awareness campaigns encouraging responsible waste disposal. Routine evaluations and monitoring will address emerging challenges, ensuring alignment with CE goals and enhancing resource recovery nationwide.

Moreover, relevant laws and regulations can be applied to assist the implementation of EPR. First, Law No. 18 of 2008 on Waste Management provides a foundation for waste reduction, reuse, and recycling but lacks specific EPR provisions; expanding this law to assign end-of-life responsibilities to producers, especially for complex waste like electronics and packaging, could improve alignment with EPR. Next, Law No. 40 of 2007 on Limited Liability Companies (CSR requirements in Article 74) mandates Corporate Social Responsibility, particularly in resource-intensive sectors, which indirectly supports circular economy practices; requiring end-of-life management for high-waste industries like electronics and textiles could enforce producer responsibility. Fourth, the Ministry of Environment and Forestry's Ministerial Regulation No. P.75/MENLHK/SETJEN/KUM.1/10/2019 requires companies to create waste reduction roadmaps, especially in packaging and retail, promoting reusable and recyclable packaging; stricter requirements, timelines, and penalties could enhance its effectiveness. Finally, Law No. 11 of 2020 on Job Creation (Omnibus Law) streamlines waste management by easing permitting for recycling businesses, which could be leveraged by offering incentives for circular practices, such as tax breaks for eco-friendly designs.

Conclusion

With many efforts to minimise the environmental impact of plastic waste in water bodies by maximising the reuse and recyclability of products, implementing the CE approach and adopting LCA principles can enhance resource efficiency, yet challenges in regulation enforcement, public perception, and infrastructure gaps remain significant. Through the implementation of the EPR system, this funding mechanism enables producers to be accountable, hence addressing the mentioned drawbacks and improving national economic performance by enhancing the resilience of supply chains, reducing dependency on raw material imports, and raising awareness on responsible consumption.

Resilience Development Initiative

Disclaimer

The views expressed in this op-ed are those of the author or authors of this article. They do not necessarily represent the views of RDI, its editorial committee, or the mentioned speakers' affiliation.

Author

Marcia Alana Sjarief
Institut Teknologi Bandung

Supervisor

Maya Larasati
Programme Officer
Resilience Development Initiative

Almira Hanifa
Research Officer
Resilience Development Initiative

References

Alabi, A. O., Kehinde, O., I., Oluwaseun, A., & E, A. O. (2019). Public and Environmental Health Effects of Plastic Wastes Disposal: A Review. *Journal of Toxicology and Risk Assessment, 5*(2). https://doi.org/10.23937/2572-4061.1510021

Bappenas. (2024). Peta jalan & rencana aksi nasional ekonomi sirkular Indonesia 2025–2045. Jakarta, Indonesia: Ministry of National Development Planning.

Borrelle, S. B., Ringma, J., Law, K. L., Monnahan, C. C., Lebreton, L., McGivern, A., Murphy, E., Jambeck, J., Leonard, G. H., Hilleary, M. A., Eriksen, M., Possingham, H. P., De Frond, H., Gerber, L. R., Polidoro, B., Tahir, A., Bernard, M., Mallos, N., Barnes, M., & Rochman, C. M. (2020). Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science, 369*(6510), 1515–1518. https://doi.org/10.1126/science.aba3656

Chang, X., Wu, J., Li, T., & Fan, T. (2018). The joint tax-subsidy mechanism incorporating extended producer responsibility in a manufacturing-recycling system. Journal of Cleaner Production, 210, 821–836. https://doi.org/10.1016/j.jclepro.2018.10.300

Lestari, P., & Trihadiningrum, Y. (2019). The impact of improper solid waste management to plastic pollution in Indonesian coast and marine environment. *Marine Pollution Bulletin, 149,* 110505. https://doi.org/10.1016/j.marpolbul.2019.110505

Jiao, H., Ali, S. S., Alsharbaty, M. H. M., Elsamahy, T., Abdelkarim, E., Schagerl, M., Al-Tohamy, R., & Sun, J. (2024). A critical review on plastic waste life cycle assessment and management: Challenges, research gaps, and future perspectives. *Ecotoxicology and Environmental Safety, 271,* 115942. https://doi.org/10.1016/j.ecoenv.2024.115942

OECD. (2022). *Global plastics outlook: Economic drivers, environmental impacts and policy options.* OECD Publishing. https://doi.org/10.1787/de747aef-en

OECD. (n.d.). Extended producer responsibility and economic instruments. Retrieved from https://www.oecd.org/en/topics/sub-issues/extended-producer-responsibility-and-economic-instruments.html

Ramadan, A. H., & Sembiring, E. (2023). Potential of Plastic Waste Leakage to Environment in Indonesian Final Disposal. *IOP Conference Series Earth and Environmental Science, 1257*(1), 012001. https://doi.org/10.1088/1755-1315/1257/1/012001

Rooswiadji, T. A. (2023). *MENGENAL MIKROPLASTIK, SI KECIL NAN BERBAHAYA. WWF* Indonesia. https://www.wwf.id/id/blog/mengenal-mikroplastik-si-kecil-nan-berbahaya

Salampessy, M. L., Febryano, I. G., & Widhyastini, I. G. a. M. (2021). Community perception on the utilization of natural resources in the Cisadane Watershed. *IOP Conference Series Earth and Environmental Science, 739*(1), 012007. https://doi.org/10.1088/1755-1315/739/1/012007

UNESCO Office Jakarta. (2018). Marine debris in Indonesia: Toward a national action plan [PDF]. Retrieved from www.unesco.or.id/publication/SC_Retreat/4_MarineDebrisIndonesia.pdf

United Nations Environment Programme (UNEP). (2022). How can the life cycle approach curb the plastic pollution crisis? Retrieved from https://www.unep.org/news-and-stories/story/how-can-life-cycle-approach-curb-plastic-pollution-crisis

World Bank. (2021). Plastic waste discharges from rivers and coastlines in Indonesia. Marine Plastics Series, East Asia and Pacific Region. Washington, DC: World Bank.

World Bank. (2022). The role of extended producer responsibility scheme for packaging towards circular economies in APEC. Washington, DC: World Bank.