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The global governance of marine plastic pollution: rethinking the extended producer responsibility system

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The harm caused by marine plastic pollution to the wider environment highlights its importance as a governance issue. The Fifth United Nations Environment Assembly (UNEA) adopted a resolution, "End Plastic Pollution: Towards an International Legally Binding Instrument", which represents a shift towards globalism in the governance of marine plastic pollution. This resolution focuses on the circular economy of plastics and highlights the role of corporations in contributing to a more socially responsible society, thereby increasing emphasis has been placed on the Extended Producer Responsibility (EPR) system that integrates the two factors referred to above. This paper provides a full technical explanation of the EPR system and its implementation in entities such as the European Union, the United States, and China. The challenges faced when integrating the EPR system into international legal instruments for plastic governance were identified, including the different national perspectives, the absence of a supervisor in the public domain, the obscurity of its application, and the lack of supporting measures for the implementation of the system. Therefore, new standards and requirements in the governance of marine plastic pollution and the advantages associated with implementing the full-life-cycle obligations under the EPR system on plastic producers should be fully considered. On this basis, the positioning and implications of the EPR system should be clarified by obligation-oriented regulation and extension-based interpretation. Moreover, the extended and prolonged applicability of the system, including the original sources of marine plastic wastes and considerations of the full-life-cycle of plastics, should be achieved in pursuit of improvements and upgrades in application and complementary policies. If this can be achieved, it is hoped that the goals of protecting human health and controlling plastic pollution can be achieved, contributing to the development of an ocean-based economy and a better world.

KEYWORDS

marine plastic pollution governance, extended producer responsibility, an international plastics agreement, marine environmental governance, full-life-cycle governance of plastics

1 Introduction

Because marine pollution presents a threat to both human health and marine wildlife, it is acknowledged as a serious environmental issue. Marine ecosystems can be damaged by deep-sea mining, surface pollution, crude oil spills, and waste discharges. The issue of plastic waste pollution is one of the most pressing of these concerns. A UNESCO investigation of marine plastic pollution revealed that plastic waste accounts for 80% of all marine pollution, and that by 2050, the weight of marine plastic waste could surpass the weight of all fish in the ocean if it is not controlled (UNESCO, 2022). Marine (plastic) litter, defined as any persistent, manufactured, or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment (UNEP, 2009), is one of the barriers to the successful realization of UN Sustainable Development Goal 14, which calls for the conservation and sustainable use of oceans and marine resources (UNEP, 2018). In terms of severity, Because they are not biodegradable, primary microplastics derived from commercial products and secondary microplastics resulting from the breakdown of large plastic products will simultaneously enter the marine food chain and negatively impact marine ecosystems. This broad range in estimates of plastic input from land to the ocean points to a high level of uncertainty (Harris et al., 2021). Marine plastic pollution is transboundary and widespread, with adverse effects on the marine environment, ecosystems, human health, safety and sustainable development (UNEP, 2022a).

At the Fifth United Nations Environment Assembly in March 2022, states agreed to develop an international legally binding instrument on plastics in an attempt to end plastic pollution. The instrument took into account the full life-cycle of handling plastics, including product material design, manufacturing, disposal, and links to other industries (UN, 2022). The concept of whole-process control is consistent with the non-isolated nature of governance in the context of marine plastic pollution. The instrument fully considered both the fact that seas are connected to land and the inefficiency of the end-of-pipe governance of marine plastic pollution. Additionally, it is vital to consider the inherent relationship and harmony between environmental preservation and economic growth when discussing ocean governance. Regarding the subtopic "governance in marine plastic pollution" within the instrument, producers play a significant role in the "process-oriented" governance of the plastics life cycle because they are the primary drivers of environmental degradation and the main players in the circular economy. Crucially, the plastic industry and plastic products themselves are inextricably linked to the preventive control of plastic pollution. In terms of an environmental protection approach, the Extended Producer Responsibility (EPR) system needs to be reexamined given the shift in the marine plastic pollution prevention paradigm from "decentralization" to "specialization" and from "soft law-based" to "hard law-based". The main problem that this study addressed was how to ascertain the normative positioning of the EPR system in an international plastics agreement and improve its efficacy in the governance of marine plastic pollution. It is envisaged that by methodically presenting the research findings, the environmental governance objective of efficiently reducing plastic pollution will be accomplished, contributing to the development of an ocean-based economy and a better world.

2 Marine plastics governance and the EPR

The main goal of institutional design is to maximize the normative effect and the fairness of the distribution of rights and obligations is used as its evaluation benchmark. It observes social and public problems and suggests methods and strategies for solving them, as well as legislative proposals (Xie, 2005). From this perspective, a system's design has its own unique generative space, theoretical framework, and normative purpose. To establish appropriate boundaries for further use or an expansion of its application, an evaluation of the current system should be paired with an understanding of how the real world functions and its own generative logic. Therefore, to investigate the efficacy and standardization of the EPR system in the governance of marine plastic pollution, we should first reveal the current advances in marine plastics governance and explain the EPR system. Only then can we define the theoretical framework of the system and establish a theoretical and factual basis for the system's methodical application.

2.1 Current advances in marine plastics governance

2.1.1 Changing to a model of global governance

Based on the pursuit of offshore resources by all nations, "marine jurisdiction" has challenged the "freedom of the sea" (Oceans and Law of The Sea, 1998). Under the resource management requirements of nation states, the growth of the marine economy has a corresponding sovereignty attribute, and because of the oceans' natural interdependence, protecting the marine environment also serves as a means of advancing global human interests and determining the direction of multi-party governance and consultation. It is therefore impossible to separate marine environmental governance from the coherence and coordination of the global framework, and regionalism and globalism have a "symmetrical" relationship in which global governance serves as the coordinator of action and regional governance as its component (Adewumi, 2021).

The history of research on plastic pollution demonstrates that the oceans were the first areas where plastic pollution was actually noticed. Subsequently, national awareness of the threats posed by marine plastic pollution has grown (Rochman, 2020), building a foundation for an international agreement. The initial efforts to fight marine plastics focused on the shipping and fishing industries due to their relatively distinct characteristics (Bergmann et al., 2015). The Intergovernmental Working Group on Marine Pollution was formed by the Preparatory Committee for the United Nations Conference on the Human Environment to

investigate matters pertaining to the creation of an ocean dumping convention, in response to a strong demand from several coastal states to regulate ocean dumping. The United States (US) offered a draft convention for review and discussion during this period (Mendelsohn, 1972). Eventually, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972(the London Dumping Convention) became the international framework for the management of marine plastic dumping. It is clear from these developments that the governance of marine plastic pollution as a whole has evolved in a similar way, moving from national to international policy frameworks and back again to national policy refinements. Currently, integrated plastics policies have been developed at national and regional levels, which cover the issues of marine plastics, industry-based policies for sub-area control, and specialized policies for the prevention of marine plastic pollution (Duke Nicholas Institute, 2023). The regulation of marine plastic pollution has formally returned to the mode of integration of global governance frameworks with the request for an international legally binding instrument on plastic pollution. Under the influence of this development, there is anticipated to be a simultaneous realization of a shift in the governance of marine plastic pollution from "decentralized" to "centralized" and from "soft law-based" to "hard law-based".

2.1.2 Emphasizing the circular economy of plastics

The regulation of marine plastics has come under the purview of international law since the London Dumping Convention was established in 1972. In terms of governance objectives, the United Nations Convention on the Law of the Sea (UNCLOS) sets out a general obligation for Parties to "prevent, reduce, and control pollution of the marine environment", and land-based sources, seabed activities under national jurisdiction, dumping and ships are all covered by Parties in their environmental governance. The International Convention for the Prevention of Pollution from Ships and the 1996 Protocol to the London Dumping Convention forbid the discharge of plastics into the ocean on the basis of its primary goal. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (the Basel Convention) regulates the transboundary movement and disposal of plastic wastes. The Stockholm Convention on Persistent Organic Pollutants (the Stockholm Convention) prohibits the production and use of some plastic products. It is evident that there are two categories of international agreements for the governance of marine plastic pollution with regard to the establishment of behavioral targets. The two primary approaches are source governance and end governance. The first involves stringently regulating the manufacturing and use of plastic products, with an emphasis on environmental preservation; the second approach involves cleaning and recycling plastic trash to reduce constraints on the economic operation of the industry. The governing bodies of various parties have also formed the above two types of proposition based on their differences in understanding the objectives of marine plastic pollution control (Cui, 2023). The refinement of the objectives of marine plastic governance is also in a state of competition and divergence.

The establishment of a linear economy for plastics serves as the foundation for the formulation of the aforementioned governance objectives (Ellen MacArthur Foundation, 2016). The United Nations Environment Programme (UNEP) published a report titled "How the World Can End Plastic Pollution and Create a Circular Economy" on May 16, 2023. It goes into great detail about how to create a restorative and regenerative plastic economy that uses reuse, recycling, and the creation of sustainable alternatives as its fundamental components. Pollution of the environment is significantly decreased by the circular economy (UNEP, 2023a). Furthermore, the development of an international agreement on plastic pollution control will be heavily reliant on the transformative trend of the plastics circular economy, according to the Intergovernmental Negotiating Committee on Plastic Pollution (UNEP, 2023b). Consequently, the formulation of objectives for the control of marine plastic pollution should prioritize an understanding of the cyclical economy surrounding plastics, strike a balance between the industry's economic activity and environmental preservation, and employ both source and end-of-pipe governance techniques.

2.1.3 Strengthening corporate social responsibility

There is a need for a shift toward sustainable development of the oceans, but this will be largely dependent on the efficient and cooperative involvement of many governing actors (Chen and Liu, 2023). The primary players in the governance of marine plastic pollution, which is an essential component of global ocean governance, are sovereign states, intergovernmental organizations, and global civil society, which is made up of non-governmental organizations, corporations, scientists, and the general public (especially citizen scientists). Among them, sovereign states and intergovernmental organizations hold the most prominent positions in governing plastic pollution. While the latter act as a facilitator of international cooperation, promote international norms, and offer a platform for deliberation, the former are the primary decision-makers (Cui, 2023). However, global civil society can be considered a "third party force" with specialized or local knowledge and has become a vital source of intellect as the less politicized aspects of environmental governance have garnered increasing attention at the global level (Cui, 2020). Non-governmental organizations, such as the Ellen MacArthur Foundation and Blue Ocean Watch, promote the circular economy of plastics and the sustainable development of the oceans and seas by arranging volunteer opportunities, educating the public, conducting scientific research, and raising awareness. Corporate entities play a pivotal role in the life cycle of marine plastics, encompassing design and production, packaging and distribution, use and maintenance, disposal and recycling of materials and components, reuse (Li and Li, 2020). As producers, distributors, and implementers of national plastics policies, they bear the social responsibility of driving initiatives to mitigate pollution, enhance production processes, encourage recycling, and

reveal pertinent data. Currently, sustainable development and environmental responsibility are the main topics of discussion when it comes to corporate social responsibility (Aslaksen et al., 2021). The application of the EPR system and a full cost recycling system at the national level is also aimed at strengthening the social responsibility of enterprises (Wang and Lin, 2018). Simultaneously, other corporations have pledged to follow the policy of responsibly recycling and reusing product packaging in response to the growing need to address marine plastic pollution. Coca-Cola, for example, has committed to a goal of 100% recyclable product packaging by 2025. Consequently, the diversification of the main regulatory bodies within marine plastics governance demonstrates the trend for strengthened corporate social responsibility.

2.2 Explanation of the EPR

Three trends have emerged in the governance of marine plastic pollution: (1) a shift in the governance paradigm towards a "global framework", (2) an emphasis on the circular economy, and (3) an emphasis on corporate responsibility. These three trends point to the direction of the governance of marine plastic pollution and the reorientation of specific approaches. Specifically, plastics corporations have a significant role in managing the balance between environmental preservation and maritime economic development as a "third-party governance force". The circular economy and the scientific concept of the plastics life cycle require the realization of the compatibility and parallelism of end-of-source and end-of-pipe governance. As a result, businesses that can manage the entire process of product development, sales, and recycling have naturally become the focal point of system design. According to the OECD in 2016, there are more than 400 EPR systems operating globally as environmental policies (OECD, 2016). This is why the EPR system needs to be rethought in the context of developing a single standard for plastics governance. The first step in this process is to analyze the system's original model, which would allow for a timely reconstruction of the system.

"Extended producer responsibility" first appeared as an environmental policy strategy in a report by environmental economist Thomas Lindhqvist to the Swedish Ministry of the Environment in 1990 (Lindqvist and Lidgren, 1990). The goal of the strategy was to transfer waste management accountability from governments and consumers to producers. It was based on an examination of waste recycling and management initiatives in Sweden and other nations (Lindqvist, 2000). This transfer of responsibility was predicated on the recognition that producers possess distinct knowledge and the ability to regulate the production process, which can alter the attributes of the final product (Lindqvist, 2000). Within the conceptual framework of Lindhqvist's study, extended producer responsibility refers to the reduction of a product's overall environmental impact by assuming responsibility for the product throughout its full-life-cycle, particularly during the stages of recovery, recycling, and final disposal (Lindqvist, 2000).

To better define the type and scope of responsibility, Lindhqvist proposed an initial model of extended producer responsibility that included liability, economic responsibility, physical responsibility, informative responsibility, and ownership. Specifically, "liability" refers to the establishment of responsibility for environmental damage produced by the product in question (Lindqvist, 2000), which may develop throughout the product's life cycle, including the usage and final disposal stages, and the applicable liability limits are defined by legislation. "Economic responsibility" means that the producer bears all or part of the cost of the product at the point of collection, recycling, and final disposal. "Physical responsibility" refers to the producer's organizational accountability for the product and any associated effects. "Informational responsibility" calls for the producer to promptly disseminate information about the product regarding particular environmental factors. "Ownership" is not strictly a form of liability, but means that the producer retains ownership of the product throughout its life cycle, thereby linking the producer to the environmental aspects of the product (Lindqvist, 2000). The original extended producer responsibility model has since evolved and has been applied for the advancement of the waste management industries in several nations.

3 Review of the practice of EPR systems in the governance of marine plastics

Since its inception, the EPR system has been used by a number of countries in their legislation on the recycling and disposal of packaging and the recycling and disposal of solid waste. Currently, the Intergovernmental Negotiating Committee on Plastic Pollution has held three meetings on the development of an international agreement on plastics, and has also invited stakeholders and Committee members to submit written comments (UNEP, 2023c). Simultaneously, the governance of marine plastic pollution is evolving towards worldwide integration, and a consensus on the establishment of guidelines for action depends heavily on national plastics governance expertise. Therefore, to achieve the goal of combining disparate experiences and resolve institutional differences, it is necessary to review the experiences of relevant countries in applying the EPR system in the field of marine plastics governance before discussing the normative content of the system in an international plastic pollution agreement.

3.1 National practice

Due to the complexity of the production process, rather than being a separate piece of legislation, the EPR system is frequently introduced into legislation based on the characteristics of various products on the grounds that it is technically and economically justified. Human activity on land is responsible for 80% of marine pollution, which primarily takes the form of solid waste leaks (COBSEA, 2023). For this reason, the application of EPR to marine plastic pollution at the national level is often incorporated into legislation in areas such as product packaging and waste

management. The purpose of this section is to provide a practical foundation for the application of the EPR system to the governance of marine plastic pollution. To achieve this, a list of national practices in the application of the EPR system will be compiled, using the European Union (EU), which has established a systematic application of the EPR system, the US, which has played a significant role in the drafting of international agreements, and China, which is representative of developing countries, as examples. This will provide a workable foundation for the EPR's implementation in the governance of marine plastics.

3.1.1 The EU: a mature paradigm

The EPR system is the primary policy tool for waste management in the EU. The Waste Framework Directive serves as the overarching directive, and the sectoral directives on radioactive packaging and packaging waste, end-of-life vehicles, waste electrical and electronic equipment, batteries, and accumulators are the essential elements of the two-tier legislative framework. Initially, the EU used the Waste Framework Directive to regulate plastics entering the waste management phase in conjunction with the "extended producer responsibility", rather than creating a special directive on "plastics governance". Subsequently, as one of the EU's main economic activities, packaging manufacturing has become a key environmental issue due to the extensive use of virgin plastics and paper. The EU has regulated the selection, recycling, and reuse of packaging materials, including plastics, with the Directive on Packaging and Packaging Waste. Driven by the European Plastics Strategy for a Circular Economy, the Directive on the Reduction of the Environmental Impact of Certain Plastic Products came into being. The EPR system for plastics has subsequently matured.

The core definition of the EPR under the EU legal framework has been narrowed down to the producer's economic or organizational duty for the waste management phase of the product, which includes collection, transport, recycling, sorting, and disposal. The definition of "producer" has also been changed in line with the regulatory purpose of the directive to achieve a flow-through approach to determine the regulation of EPR. The Waste Framework Directive's basic definition of EPR in the context of plastics governance has been carried over into the Directive on the Reduction of the Environmental Impact of Certain Plastic Products. However, to regulate plastic fishing gear and single-use plastic products, the definition of "producer" was changed to "a manufacturer, filler, seller, or importer established in a Member State, which sells plastic fishing gear or single-use plastic products to a third party." With regard to the specific types of responsibility, the EU has set up economic responsibility, which is mainly in the form of an upfront financial contribution, and organizational responsibility. This refers to the producer's actual management of the product's life cycle, in particular the collection, recycling and reuse process. Producers may fulfill these obligations directly or through groups approved under producer responsibility. Furthermore, producers have a general obligation to report regularly on plastic-containing fishing gear placed on the market and the quantities recovered. Labeling of plastic product composition and the waste management measures adopted are also important. The management and regulatory roles of the government in environmental protection have been reinstated since the establishment of the directive (Ma, 2009).

The specific provisions of the Directive on the Reduction of the Environmental Impact of Certain Plastic Products demonstrates that to manage the plastics life cycle, there is a tendency to expand both the scope of economic responsibility and the application of the EPR for plastics, even though the EU's definition of this responsibility is primarily tied to the waste management stage of plastic products. The EPR for plastics now includes material selection and design. Under this requirement, producers must comply with this regulation by limiting the amount of microplastics in product formulations, meeting the specifications for single-use plastic beverage containers' packaging, and making sure that products contain a certain amount of recycled plastic. Additionally, the coverage of the economic responsibility of plastics producers extends to the costs of establishing specific infrastructure for waste collection and raising public awareness of the hazards of plastics and recycling.

To improve the efficacy of the EPR system, the EU has established a number of auxiliary mechanisms. These include a deposit reimbursement program for the recycling of single-use plastic products, an indirect price structure for the recycling of plastic fishing gear, and a guaranteed recycling quantity. Overall, the EU is committed to using the EPR system to protect the environment. Out of concern for the hazards of waste plastics, the system has been refined to the field of all plastic products, and penalties will be imposed on producers who fail to comply with the provisions of the system to ensure the effectiveness of the system's implementation. This includes the Waste Framework Directive, the Directive on Packaging and Packaging Waste, and the Directive on the Reduction of the Environmental Impact of Certain Plastic Products. The system will be enforced by imposing penalties on producers who fail to comply with the regulations. The Packaging and Packaging Waste Directive is being amended with the purpose of bringing the e-commerce industry into its purview. Overall, the legislative revisions indicate a propensity to impose a stricter obligation on producers.

3.1.2 The US: a representative of the development of the legislation

The primary characteristic of the EPR system is the transfer of environmental accountability for products to producers farther upstream, with an economic obligation that is intended to outweigh the producer's cost of market entry. For this reason, interest organizations that speak for the American producers of plastics oppose an international plastics agreement and instead advocate for making it harder to recycle other materials, including paper and glass, in an effort to lessen the negative consequences of plastic waste. Due to the traditional view of environmental accountability and the individualistic political culture, the EPR plan was not initially widely applied in the US (Short, 2004). The US President's Council on Sustainable Development's report, "Sustainable America: A New Consensus," states that "Extended

Producer Responsibility" is actually "Extended Product Responsibility," and that everyone involved in a product's life cycle, i.e., designers, suppliers, manufacturers, distributors, consumers, and disposers, are accountable for the product's environmental effects (PCSD, 1996). While such a definition aligns with many interest groups' view of shared environmental responsibility, it also limits the producer's level of accountability, fitting the concept of full life-cycle management of products. Currently, the US application of the EPR system is still based on an understanding of shared environmental responsibility. As defined in the US National Recycling Plan 2021, EPR is a system that places the responsibility for organizing products at the end-of-life stage jointly on the producer and other entities in the product chain (EPA, 2021).

Based on the high priority of environmental protection issues and the urgent need for plastics governance, there is also a general trend towards applying EPR regimes to ensure that plastics are recyclable and reusable in US legislation. The US introduced the Freedom from Plastic Pollution Act on March 26, 2021. This act requires market participants to meet minimum milestones for product or packaging recyclability or reusability by joining a producer responsibility organization (PRO) when the size of the market entity allows it. It also extends producer responsibility to sellers, distributors, and importers of product or beverage packaging. Once they satisfy the requirements of the act, businesses must become a PRO member and reach minimum targets for product or package recycling, elimination, or reuse. For reasons of administrative convenience, the integration of individual producer responsibility into PROs is largely translated into economic responsibility. Specifically, membership fees are paid by producers to the organization on a regular basis to cover the costs of managing and cleaning up their products, as well as covering administrative costs such as ensuring compliance, auditing, and conducting educational activities. Based on this, PROs should create systems for the deposit return and sorting and recycling of beverage containers, as well as public relationships, instruction, and reporting. From the perspective of the bill based on the concept of "Get rid of plastic pollution", it is still up to the producers to set up the corresponding responsibility in the production of products, such as forbidding the provision of disposable plastic handbags and adding visual labels to products. It is evident that the design of the US EPR system is primarily focused on the product recycling stage.

Seven states had passed EPR or comparable packaging laws as of 2023, while more than ten states have proposed EPR packaging laws that will go into effect that year. Overall, it seems that the EPR systems at the federal and state levels of the US are not as complex and strict as the corresponding system in the EU. The US primarily views EPR as a financing mechanism to support recycling programs and shifts the economic responsibility for these programs from the government to the producers to contribute to the realization of a circular economy. Although the application of producer responsibility systems in the US are not as comprehensive as those in the EU, and are mostly set up for economic responsibility, the motivations of the relevant stakeholders are similar. For example, the Plastic Pollution and Recycling Modernization Act in Oregon, US, requires producers of relevant products to join and pay for producer responsibility organizations; and the Maine, US, Act to Support and Improve Municipal Recycling Programs and Save Taxpayer Funds requires producers to contribute to a fund based on the amount and recyclability of packaging associated with their products. The key to the overall agreement among US states on the proposal is how the EPR is applied and the need to strike a balance between industrial economic expansion and environmental conservation.

3.1.3 Asian countries: representative of the beginning of legislation

Asian countries are also rapidly moving forward with the implementation of EPR legislation/plan to mitigate the plastic pollution crisis, in addition to the two actions of actively participating in the negotiation of the text of an international legally binding instrument on plastics and reaching cooperation at the regional level to reduce marine plastic pollution. Philippines passed the "Extended Producer Responsibility Act of 2022" in order to address the huge plastic waste problem in its country. Under the provision of 6.17. of the Act, "extended producer responsibility" is broadly defined as "an environmental policy approach and practice that requires producers to be environmentally responsible throughout the life cycle of a product, especially is post-consumer or end-of-life stage. " The Philippines has built its corporate EPR compliance pathway around the tactic of assigning local businesses the primary responsibility for disposing of plastic wastes in order to achieve its key performance indicators. This entails purchasing materials and wastes back from customers, putting in place specialist recycling systems, disposing of plastic wastes appropriately, and gathering plastic wastes from public spaces. In order to ensure the effectiveness of the system's implementation, the Act also establishes a penalty mechanism whereby the Ministry of Environment and Natural Resources can impose fines on a company if its EPR plan fails to be audited or is found to have fallen short in its fulfillment. China, Singapore, and Vietnam have mostly implemented the operation of EPR systems, in addition to the Philippine legislative model. They have done so by using the current waste management legislation as the policy framework and particular action plans as the implementation assurance. In China, the EPR system began to be absorbed into its legislation, marked by the Law on Prevention and Control of Solid Waste Pollution of the Environment 2004. However, it was not until the success of the pilot work on the EPR for electrical and electronic products in 2015 that China issued a program for the implementation of the EPR in 2016, and initially established an EPR system that integrates the basic meaning, the scope of responsibility and safeguards. Similarly, to Lindhqvist's original concept of EPR, the "EPR" program in China refers to a system that extends producers' resource and environmental responsibility for their products from the point of production to the entirety of the product life cycle, including product design, distribution and consumption, recycling, and waste disposal. China, however, has imposed four behavioral obligations on producers: "use recycled raw materials", "carry out eco-design", "strengthen information disclosure", and "standardize

recycling". Moreover, payment to a fund as a means of fulfilling responsibility is only an alternative to the recycling of the product. However, the program in general seems to be a soft provision that lacks penalties for inadequate fulfillment of the responsibilities and is centrally applied to the four major areas of electrical and electronic products, automotive products, lead-acid batteries, and paper-based composite packaging for beverages.

The Resource Sustainability Act 2019 of Singapore includes a specific provision on producer responsibility schemes (PRS) and required packaging reporting. While the latter serves as the foundation for Singapore's EPR program for packaging waste management, the former lays out the formal requirements for producers to join the PRS. Specifically, the EPR system is primarily implemented by particular actions including plastic product restriction, obligatory packaging reporting, and fees for single-use plastics. Vietnam has established regulations for producers and importers regarding package recycling, waste management, information provision, and other related matters under Decree No. 08/2022/ND-CP. A national action plan on marine plastic litter has been created in Vietnam, with the goal of reducing marine plastic litter by 50% by 2025. In contrast to China, Singapore, and Vietnam, Malaysia's EPR plan is largely industry-driven and funded primarily by obliged parties through the payment of eco-regulation fees, which support waste collection, sorting, recycling, and disposal. Given the system's efficacy, Malaysia launched a mandatory EPR program to create a governance framework with reference to international standards. This framework will contain EPR objectives, roles and responsibilities for all parties involved, an eco-regulation fee structure, and a process for improving products.

Although Asian countries have generally accepted the EPR system, these countries still have very basic laws governing the system, including those pertaining to its definition, its application, and the manner in which responsibility is assumed. Asian countries must so keep looking into EPR systems for plastic goods that adhere to international norms.

3.2 Existing challenges

The implementation of the EPR system varies among nations due to disparities in environmental protection awareness, the degree of legislative development, and the sophistication of technological systems. However, a practical analysis of the system's application at the national level revealed a gradual upward trend in its use in the field of plastics governance. According to documents published during the second session of the Intergovernmental Negotiating Committee on Plastics Pollution, the EPR system has been frequently mentioned as a core obligation of countries in the field of plastics governance, such as the establishment of harmonized guidelines for the EPR system and the potential role of the system in the field of waste management and product design (UNEP, 2023d). In this regard, it is important to acknowledge the system's usefulness for plastics governance, while also analyzing the obstacles that now stand in the way of a worldwide agreement on the adoption of the system. This will help establish the best way to structure the EPR system within an international plastics agreement.

3.2.1 Differences in the positioning of the EPR system at the national level

The application of the EPR system at the national level is based on the level of development of the domestic industry and the resulting goals for the governance of plastic waste in the country. These factors need to be considered despite the general agreement among nations regarding the dangers of plastic pollution, including that caused by marine plastics. This has resulted in a differentiated approach to the use of the EPR system in laws pertaining to plastics, general waste management laws, environmental governance policy documents, and strategic plans for the plastic industry (UNEP, 2022b). This divergence is due to differences in the basic orientation of the EPR system in each country when it is applied in practice at the national level.

The fundamental definitions of EPR in the US, China, EU and other countries are very different. "The economic or/and organizational responsibility of the producer of a product at the waste management stage of the product" is how the EU defines EPR. In the US, the term is interpreted to mean "organizational responsibility at the end-of-life stage of a product, shared by all those who are responsible for the environmental management of the product, including designers, suppliers, manufacturers, distributors, consumers and disposers". In China, Lindhqvist's conceptual framework is basically followed, i.e., the EPR system is defined as "a system in which the producer's responsibility for the resources and environment of its products extends from the production link to the whole life cycle, including product design, distribution and consumption, recycling, and waste disposal". Japan, being the first Asian country to implement EPR, has deconstructed the fundamental components of the EPR system by listing the operator's responsibilities in its statute. These include thinking about the design and selection of raw materials, increasing the durability of products, improving maintenance procedures, and collecting or properly recycling things. Similarly, the Korea has established recycling requirements for product manufacturers, importers, and sellers through the implementation of its EPR program in its Act on the Promotion of Saving and Recycling of Resources. In the Philippines, EPR is broadly defined as "an environmental policy approach and practice that requires producers to be environmentally responsible throughout the life cycle of a product, especially is post-consumer or end-of-life stage. "Using Lindhqvist's conceptual framework for EPR as a guide, it can be observed that the definitions of the systems in various countries differ with regard to who holds responsibility, the stage of responsibility, and the components of the type of responsibility. Additionally, there is no single, consistent definition of the EPR system in each nation's practices, and the conceptual descriptions are centered on the three entities.

There are variations in the extent to which the EU, US, China and other countries apply the EPR system. In general, the EU has established a relatively stringent EPR regulatory framework. The Directive on Reducing the Environmental Impact of Certain Plastic Products has brought the framework into the realm of plastics

pollution control, and member states of the EU are now required to incorporate it into their own internal systems. To achieve its ultimate goal of "ending plastics", the EU has expanded the scope of economic responsibility and the applicable stages of plastic EPR. The EPR system has been progressively implemented in the US for product recycling management, but the liability structure is mostly property-based, with the efficacy and transitional character of plastics governance serving as a guide. China's policies about EPR are still at the soft initiative stage and have not been applied to the field of plastics governance. Countries like Singapore, Vietnam, and Malaysia have more generic EPR programs that are comparatively behind in terms of institutional development and implementation.

Therefore, when the EPR system eventually enters into the scope of regulation through an international plastics agreement, it will be necessary to fully consider the reality of the differences in the practices of various countries, and to define its basic positioning. This will harmonize the basic implications and intensity of the application of the extended producer responsibility system, and thus determine the scope of the obligations of the Contracting Parties under the Convention. Therefore, a distinction or compromise should be drawn between mandatory and voluntary application to promote the circular goal of plastic governance under the concept of globalism.

3.2.2 Absence of a governing body in the application of EPR system in the public domain

The key to the effective operation of an EPR system is to visualize and reinforce the existing causal link between the product and the producer, and then to make it a legal obligation of the producer through the institutional design of the sovereign state authority. The EPR system can then be implemented within specific national jurisdictions, and the coordinating framework of regulatory agencies and industry organizations can be used to ensure that plastics producers are held accountable for the handling of plastics products throughout their life cycle. Therefore, the absence of a governing body beyond national jurisdictions may act as a barrier to the establishment of an EPR system within an international plastics agreement, particularly in cases where plastic pollution enters the country by land and ends up in the ocean (Tou and Zhao, 2019). In the event that there is no single entity responsible for the recycling and disposal of marine plastic wastes, efforts to control and clean up the pollution of the marine environment will also be unsuccessful. At the same time, when the country of production or the country where the market is located is a non-state party, because the governance of the transfer of plastic waste from land to sea depends on the domestic policies of the corresponding country, the recycling phase of marine plastic waste requires even more coordination by a unified competent organization.

The absence of a governing body in the application of EPR in the public domain also raises the question of the debugging of the normative core of the system. The implementation of the organizational, economic, and information responsibilities included in the EPR system would occur in a regulatory vacuum. Organizational responsibility lies mostly in the product's post-processing phase. Producers will encounter several challenges in implementing measures, such as collecting, recovering, and recycling plastic waste in the high seas, including issues around technical capability, financial implications, and managerial will. It will also be more difficult to guarantee the practical efficacy of these measures in the event that the relevant institutions fail to coordinate. Economic responsibility requires a dependence on a competent organization for fund management, including the setting of collection criteria, determining the purpose of use, and disclosing the use of funds, whether it is carried out by individual producers or producer-responsible organizations. The responsibility for the provision of accurate information is primarily fulfilled during the product's introduction to the market. This is accomplished by providing details of the product with reference to specific environmental parameters. Using this criterion, it is evident that monitoring the execution of the responsibility for information provision is not feasible given the lack of a capable organization. In the absence of a competent organization in the public domain and the high cost of governance, the basic definition of a "producer" in the EPR system cannot be limited to the coverage of the production process, but also needs to take into account the cross-border circulation of plastic products. Specifically, in Lindhqvist's initial model of EPR, the "producer" is defined primarily as the manufacturer of the product. However, this positioning of the original manufacturer with the emerging trend of plastics governance is no longer possible due to the influence of economic globalization, with the cross-border circulation of plastic products meaning that full life-cycle disposal practices need to be completed in different national jurisdictions. To regulate land-based sources and reduce the creation of marine plastic trash at source, the definition of "producer" will need to be adjusted. This will add regulations at several points along the pathway that plastic products take before entering the ocean. As a result, it is evident from the lack of a governing body that the application of an EPR system will not be simple and that its widespread implementation on a global scale will transcend national borders.

3.2.3 The scope of application of the EPR system needs to be clarified

Examples of the use of EPR systems show that they are often applied to product groups such as electronics, packaging, vehicles, and tires, and they have largely achieved the intended objectives (Shimada and Van Wassenhove, 2019). The success of the EPR system in the traditional product sector has therefore led to the expectation that the system could be extended to other product categories, such as fishing gear, tobacco product filters, textiles, etc (OECD, 2023), thus strengthening the fight against marine plastic pollution. Fishing gear and textiles do not fall into the category of centralized public sector waste collection and treatment by virtue of their product characteristics, and the decentralized nature of their recycling makes them more likely to have a serious impact on the environment, particularly in the oceans. Textiles are prone to releasing micro-pollutants during their use, which can lead to micro-plastic pollution when they enter the ocean through the sewage system, thereby damaging marine ecosystems and affecting human health (Zhang and Wei, 2021). To refine the EPR system's

scope of application, it will be necessary to fully consider the heterogeneity of marine plastic pollution, make good use of the system's potential advantages in plastic recycling and raw material innovation and design, and identify the primary sources of microplastic pollution. This is especially true if the EPR system is to be incorporated into an international plastic waste agreement. For example, industry-specific regulations designed to address marine plastic litter should specifically target the "fisheries" industry. To expand the source control, the further specialized regulation of "textiles", a product prone to producing microplastic contamination, should be considered. However, a suitable EPR system still needs be designed and its effectiveness monitored.

Simultaneously, the type of plastic litter and a country's retail industry are related. For instance, the usage of EPR primarily in the recycling chain has resulted from the plastic crisis produced by styrfoam products in ASEAN countries. The Philippine EPR Act's content is centered on minimizing the amount of plastic products released into the environment without changing how plastic products are currently produced, which is incompatible with the idea of total life-cycle management of international plastics agreements. While Malaysia is still in the voluntary stage, Singapore and Vietnam have more principled EPR laws. Also, some of the provisions of the international plastics agreement have not yet been codified into national legislation. It is also difficult to consider whether the fundamental idea of "full-life-cycle governance" for plastics can be incorporated as part of national policy and globally recognized by all nations.

3.2.4 The lack of support systems for the implementation of an EPR system

The draft resolution on ending plastic pollution, in contrast to the Basel Convention amendment on plastic waste, emphasizes the full-life-cycle governance of plastics, including the design of reusable and recyclable products and materials. This concept of full-life-cycle governance places an emphasis on wider international cooperation in the fields of science, technology, and institution-building (Bai, 2023). The efficacy of an EPR system is positively correlated with the degree of infrastructure or technology development for waste collection, segregation, recycling, and research and development into alternative materials (WWF, 2020). For these reasons, technical assistance agreements between nations have become a crucial component of interregional technical cooperation. The concept of "establishing and operating models of EPR systems based on common principles" is included in the zero draft of the international agreement on plastics, but there are still no provisions for technical assistance between developed and developing countries. The prevention and control responsibilities of developed and developing countries should be distinguished under a "common" framework because developed countries were the first to develop and are typically ahead in terms of waste recycling technology, facilities, and environmental compliance requirements (Wang and Chen, 2022). For this reason, extensive discussions are required regarding the matter of technical cooperation, which would ensure harmonization and justice in the EPR system. The interplay between EPR and other plastics regulatory regimes is also a matter of concern due to the disparities in technological advancement throughout nations. This is mostly because some nations lack the technology necessary to treat plastic waste. Even in cases where producers are charged with handling plastic waste after it has been finalized, they may find it difficult to carry out their organizational responsibilities in the absence of suitable facilities and technologies. Furthermore, in addition to institutional support, technical help must be provided within a reasonable timeframe. In the interim, the Basel Convention's rules on the transboundary movement of plastic waste must be adhered to so that nations that lack technology or are overburdened with plastic waste can collaborate with other nations in the export of plastic waste, subject to specific requirements.

The EPR system was examined with reference to the findings of the national legislation analysis. It was found that both the US and EU legal frameworks have strengthened the EPR system's goal of "improving the environment and the circular economy" by going beyond Lindhqvist's original design. This is reflected in the deposit return system for beverage containers as well as other related policies like financial incentives for environmentally friendly packaging design and a ban on single-use plastics. Whether and how these complementary systems, which have proved to be effective through national practice, are reflected in an international plastics agreement is one of the challenges of the globalist approach to EPR.

4 Rethinking the construction of EPR system in an international plastics agreement

The goals, regulatory bodies, and mode of governance of marine plastic pollution have changed recently. As a result, the regulatory framework for marine plastic pollution needs to be reviewed and updated in light of these changes to ensure that it complies with the new standards and requirements for the governance of marine plastic pollution. The EPR system has yielded good results in plastic recovery, recycling, and other areas, as shown by national practice data. Its implementation aligns with the value orientation of environmental issues under which multiple regulatory bodies share responsibility. However, as demonstrated by the previously mentioned analysis of the EPR system's difficulties in relation to an international plastics agreement, there is a great deal of room for normative discussion and system design with regard to the system's fundamental meaning and positioning, scope of application, regulatory bodies, and supporting systems. Therefore, the ultimate objective of this study was to reconsider how the EPR framework in an international plastics agreement should be constructed to support the plastics recycling industry and maritime environmental governance.

4.1 Institutional orientation: adoption of an obligatory regulatory philosophy

The Fifth United Nations Environment Assembly report on the resolution "Ending Plastic Pollution: Towards an International Legally Binding Instrument" states that while both "binding" and "voluntary" approaches are involved in the establishment of a specific regime, there is general agreement on the fundamental legally binding nature of an international agreement on plastics (UNEP, 2022c). From a practical perspective, there are already some national EPR systems for plastics in operation. At its third conference, the UNEP produced a zero draft of an international plastics agreement that includes both optional and mandatory provisions for the adoption of the EPR system (UNEP, 2023f). While the former encourages parties to set up the system, it also requires the governing body to supply nations with information to facilitate system construction and to guarantee, to the greatest extent feasible, that countries have a common understanding of the system. The latter would force the parties to build EPR systems and operational models "based on common principles" and would make their establishment a mandatory duty.

The decision to implement the EPR system in this manner was based on how sovereign states are conceptually understood to participate in global environmental governance. The conventional "absolute sovereignty" and the integration of global environmental governance have come into conflict during the creation of international environmental law (Wang and Xu, 2023). Routes for recourse within the framework of environmental rights has been subject to fragmentation and incoherence, while the value orientation of considering the common interests of the international community has broadened the "duty of environmental protection". The foundation of this mandatory regulatory system is the state's sovereignty to accept the duty to be bound, which is the basic concept of international law and serves to safeguard humanity's common interests (Mo, 2023). To ensure that environmental governance is not harmed, a state can reduce the amount that its own internal environmental issues impact on other nations when it is subject to mandatory environmental rules. In keeping with the holistic approach to the full-life-cycle governance of plastics, design of an EPR system within an international plastics agreement that takes the form of mandatory regulation will effectively contribute to the consistency of countries' understanding of plastic pollution and regulatory actions. By providing a foundational framework for coordinating national efforts, the EPR system can encompass the full life-cycle of plastic products, from design to recycling, and can significantly improve the efficacy of plastics governance.

However, if a voluntary approach to regulation is chosen, the extent and mode of implementation of the EPR system will differ significantly between nations, making it difficult to establish a meaningful global linkage. This will put more pressure on the governance of plastic waste in public spaces and make it difficult to forecast how local environmental issues will affect other nations. Simultaneously, the voluntary method would reduce the likelihood of national restrictions favoring economic development and environmental protection, and the shared responsibility burden may impede the claim of national sovereignty over issues. Despite the fact that the EPR system's obligation-based regulation can effectively realize the construction of a common responsibility framework for plastic governance, it is still impossible to ignore the actual disparities in the economic and technological development of various nations. The obligation-based regulation's limited-term commitment scheme can be used to realize the construction of "common but differentiated" responsibility. Therefore, developing countries would be permitted to fulfill the agreement's obligation to establish an EPR system domestically in a gradual and phased manner based on their unique circumstances, which is in line with the overarching goal of an international plastics agreement.

4.2 Institutional connotations: applying an expansive interpretative approach

The prerequisite for reaching agreement on a regime within the international framework is that countries also have a relatively uniform understanding of its basic content. The main barriers to the specialization of the EPR system, as stated in the submissions of the Member States following negotiations at the third session of the Intergovernmental Negotiating Committee on Plastic Pollution, are the ambiguity surrounding the system's specific content, the lack of consistency in the standards for defining the term "producer", and the ambiguity surrounding the forms of liability (UNEP, 2023g). This conclusion was consistent with the findings of the studies from individual countries on the fundamental definitions of the EPR system that were previously highlighted. For this reason, the content of the EPR system will be determined by considering the following three factors: the forms of liability, the breadth of the subject matter covered by the system, and the system's level of coverage.

First, the EPR system's original goal and the features of plastic governance must be taken into account while evaluating the system's coverage phase. Based on the goals of the environmental governance policy at the time, Lindqvist provided a model for the establishment of the EPR system. The model emphasizes an examination of the environmental impacts of products at the "recovery, recycling, and final disposal stages" as well as the transfer of "responsibility for waste organization" between producers and the government. Consequently, the majority of the early EPR applications were centered around waste management. Since the 1970s, the rate of plastic production has grown faster than that of any other material. It is estimated that 75 to 199 million tons of plastic are currently found in our oceans. The transboundary nature of marine plastic debris raises the cost and difficulty of pollution governance. The presence of microplastic pollution in marine environments has intensified the demand for treatment technologies and management strategies. Consequently, by implementing an EPR system that covers the entire product design chain, the pressure for developing end-of-pipe plastic treatments could be successfully relieved, and the degree of environmental pollution could be decreased. To manage marine pollution at its source, it is also necessary to involve the product design stage in the raw material selection process. This means that producers must be held accountable for fulfilling their end of the life

cycle, which includes product design, circulation and consumption, recycling, waste disposal, and waste management to attain results more effectively.

Second, regarding the system's scope, it is necessary to conduct a value chain analysis of plastics production and identify the accountable parties in the critical stages of the plastics distribution process. Because they are affordable, lightweight, moldable, and long-lasting, plastics are used in a wide range of industrial processes, goods, and packaging (Bishop et al., 2020). Due to their extensive uses in industrial processes and wide market circulation, plastics are distributed among various producers. To achieve continuity and full coverage of the primary responsibilities and maximize system utilization, a full-life-cycle understanding is required to identify the main bodies in each link of the production chain. To provide countries with guidance when designing particular systems, the exhaustive definition of "producer" found in US and EU legislation can be adopted. This method is comparable to focusing on the production chain and includes "designers, suppliers, manufacturers, distributors, and disposers".

Finally, the entire strategy should incorporate organizational, economic, and informative responsibilities as forms of accountability. Specifically, economic responsibility should be the minimum standard, and the responsibility for providing information should be established to serve the needs of post-regulation and environmental governance. Because organizational responsibility is frequently associated with the accountable parties and processes at the waste management stage within nations (i.e., government agencies or business associations in charge of the recycling management system) it need not be an internationally imposed standard.

The adoption of the commonly named "expansive interpretation path" means that the reality of the plastics production process should be taken into account. The "producer" should not be automatically identified as "the producer," and the fundamental concept of the full-life-cycle governance of plastics production should be taken into account, with the result that the system cannot be understood simply as a tool for the management of plastics wastes. The economic, informative, and/or organizational responsibility of plastic product designers, suppliers, manufacturers, distributors, and disposers for product design, distribution and consumption, recycling, and waste disposal can be referred to as the basic definition of the EPR system. A common understanding of EPR can serve as the foundation for its adoption within a minimal framework, and each country can be permitted to enhance the system in accordance with its unique circumstances.

4.3 Scope of the regime: covering products that become sources of marine plastics

Academics and industrial practitioners have reached a consensus regarding the environmental risks posed by plastic waste, with research confirming that the oceans are the final destination for plastic debris (Auta et al., 2017). The terminology "including marine plastics" in the zero draft of the international plastics agreement embodies the fundamental concept of plastics source management, and integrated land-and-sea management serves as a successful model for reducing the sources of marine plastic waste. China, the EU, Russia, Japan, and other countries have indicated that international agreements on plastics should concentrate on the governance of plastic waste, including marine plastic waste, as indicated by the comments submitted by the negotiating members at the third session of the Intergovernmental Negotiating Committee on Plastic Pollution (UNEP, 2023g). Expanding the product categories covered by the EPR system has become a global trend, with the aim of reducing the impact of plastics on the marine environment. Toys, sporting goods, cigarette filters, fishing gear, and other plastic products are now included in the product categories that should be regulated, in addition to plastic containers and packaging (Tasaki and Matsumoto, 2023). The EPR system should be expanded to include items sourced from marine plastic to address the issue of marine plastic pollution. Nevertheless, there are still two areas in which careful system design is required.

First, a list of product categories for the EPR system for plastics should be established. The analysis of the difficulties faced by the EPR system demonstrated that when creating a list of product categories, consideration should be given to the primary constituents of marine plastics as well as the efficacy of managing the sources of marine microplastics. Examples of such industries and sectors include the textile industry and the fishing industry. Specifically, fisheries regulations should focus on the recycling and management of fishing gear and ropes. According to studies, between 46 and 70% of the floating plastic in the oceans consists of fishing gear and rope (IUCN, 2021). Textile regulations should focus on the reduction, reuse, and recycling of textile waste. Also, consider specialized regulations for primary microplastics to reduce the use and consumption of hazardous substances in consumer products. For instance, the EU takes another major step to protect the environment by adopting measures that restrict microplastics intentionally added to products (Cosmetics, personal care products, detergents, etc.) under the chemical legislation REACH. The new rules will prevent the release to the environment of about half a million tons of microplastics (EU, 2023).

Second, competent organizations for governance in high seas should be established to prevent the EPR system from being ineffective when the end-of-life of plastic products occurs in the public domain. More specifically, the primary regulatory body might be an institutional entity created by an international plastics agreement. This is related to UNEP's Regional Seas Programme in terms of action measures. To support the plan for collecting marine plastic waste and the upkeep of land-based waste treatment facilities, the economic responsibility of plastic producers could be further developed into a financial mechanism for the governance of plastic waste pollution in nations with maritime areas. The institution established by an international plastics agreement can be effectively given organizational responsibility because they will be in charge of overseeing and putting into practice the procedures for collecting marine plastic waste and managing it in conjunction with coastal nations. This interfaces with the "Requirements for Non-Sea Disposal of Plastics" required by Annex V of the 1973 International Convention for the

Prevention of Pollution from Ships (MARPOL), whereby marine plastic debris, once collected, is subsequently disposed of in port and terminal reception facilities (Vince and Hardesty, 2018).

4.4 Institutional support: supporting the implementation of full-life-cycle governance

The focus of the EPR system for plastics on the full-life-cycle of plastics determines that it cannot rely on a single system to accomplish its governance goals. The EPR system itself only defines the concept of a "producer" and details the stages of use and disposal that are covered by their "responsibility" to complete the basic institutional framework. However, two components of the system's supporting architecture must still be taken into consideration for the EPR system to function as effectively as possible. First, to create an EPR system, the system's design must be coordinated with that of the various links in the plastics value chain. Second, it is necessary to complete the provisions for national cooperation in transnational governance of plastics, so as to reconcile the disparities in the technical aspects of plastic waste control that exist across different countries.

Product design, distribution, and consumption, recycling, and waste disposal are used as process controls in the various links in the plastics value chain. Initially, a list of raw materials that are prohibited and a list of corresponding product categories should be established during the product design stage. Additionally, manufacturers will be encouraged to develop innovative technologies and use recyclable raw materials. The government may also establish a system of subsidies to encourage manufacturers to actively participate in environmental control. Manufacturers should label their products with the raw materials that they use to provide relevant information for disposal and recycling. Second, a deposit return mechanism that matches the circulation and consumption stages should be devised (OECD, 2019). For example, for fishing gear and beverage bottles with lids, a refundable advance deposit system should be established, and the return operation should be conducted through a specially designed system to include consumers, which would increase the recycling rate of specific products. Third, appropriate recycling criteria should be established. Only waste management indicator requirements, waste management procedures that could result in hazardous material emissions and releases, and a list of hazardous emissions and releases that need to be regulated are mentioned in the text of the annex to the zero draft of the current international plastics agreement. To meet this aim, standard rules for the recovery and recycling of plastic waste should be developed by the International Organization for Standardization (ISO) and then a comprehensive management document that integrates recycling standards, methodologies, and processes could be published. In conclusion, it is imperative to build a unified database during the waste disposal phase to oversee the recovery of plastics. This will provide fundamental data for assessing and optimizing the system's performance, as well as modifying the quantum of particular payments for the producer's economic accountability based on environmental outcomes. All of these measures should be seen as an extension of the system of collective responsibility to improve the effectiveness of governance.

Technical assistance and transfer are essential to ensure that developing nations and countries that lack plastic waste treatment technology can grow their internal capacity to meet national cooperation provisions on transboundary plastics governance. Because building a technology base takes considerable time, a phased program could be adopted. Technology exchange and cooperation on plastics recycling technologies can be conducted, while also giving due consideration to linking to the relevant provisions of the Basel Convention on transboundary movements of wastes. The timeliness and safety of plastic waste disposal can be ensured by articulating standards and procedures for the export of plastic waste before completing capacity building. Through the National Plan, the aforementioned phased plan should be communicated to the international organization that sets plastics agreements. To secure funding for technical support and training, national cooperation provisions could also be connected to the financing program of an international plastics agreement. To create minimum nationally harmonized standards for the application of the EPR system and to serve as a reference for the improvement of national legislation and implementation policies, all of these measures should be established as annexes to an international plastics agreement.

5 Conclusion

The EPR system has been used in environmental governance since its establishment in 1990 and has produced results in particular areas at the national level. There is considerable urgency in addressing the issue of plastic waste due to its detrimental effects on the environment, particularly marine contamination. The circular plastics economy also forces producers to assume corresponding governance responsibilities. With the development of globalization, plastic EPR systems have been developed. At the same time, the EPR system has already been used extensively for plastics in national settings. The implementation of the EPR system therefore has the potential to significantly improve the governance of plastic pollution, particularly where it affects the marine environment. However, it should be clear that even if the EPR is included in the content of an international plastics agreement, it should be subject to an objective test of the international community's practice, and it should be ensured that this is in line with the laws and needs of the international community (Gu, 2012). Because the EPR system effectively connects the environment and the economy, it remains to be seen if following the theoretical development and promotion of the principle of international cooperation, its efficacy in particular national jurisdictions can be realized at the universal national level and beyond national jurisdictions. Although this paper provides guidance on the fundamental positioning, basic meaning, scope of application, and supporting systems of the EPR system, the value and mission of environmental governance cannot be fully dependent on the operation of a single system, and the

maintenance of human health and global ecosystems should become an overall mission that is constantly adhered to, ensuring the construction of a better world and the ultimate goal of an ocean-based economy.

Author contributions

JZ: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing. DL: Formal analysis, Investigation, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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