Title: Transboundary Movement of Electronic Waste Under the Basel Convention: Between Legal Shortcomings and Environmental Risks in Developing Countries

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Abstract

This study addresses the problematic issue of the transboundary movement of electronic waste and the severe environmental and health risks it entails, particularly for developing countries that receive increasing quantities of such waste under the guise of "reuse." The research analyses the international legal framework governing this phenomenon, focusing on the 1989 Basel Convention, which serves as the primary reference for regulating the movement of hazardous waste. The study also examines the effectiveness of the Convention in addressing legal loopholes and shortcomings in practical implementation, especially in light of the absence of a unified international commitment. Furthermore, comparative experiences from various countries, including Japan, China, and Ghana, are explored to evaluate national waste management models.

Keywords: electronic waste – Basel Convention – environmental justice – developing countries – illegal transport – extended producer responsibility – environmental pollution

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Introduction

The world has witnessed an unprecedented technological revolution in recent decades, accompanied by a widespread proliferation of electronic devices across various aspects of life. Alongside this expansion, a growing and serious problem has emerged in the form of electronic waste referring to discarded electrical and electronic equipment that has reached the end of its useful life, such as mobile phones, computers, monitors, refrigerators, and others. These types of waste are considered among the most hazardous forms of solid waste due to their content of toxic substances and heavy metals such as lead, mercury, and cadmium. Moreover, they contain valuable materials such as gold, silver, and copper, making them of both economic and environmental concern.

In globalisation, electronic waste has increasingly been transported across borders, often from developed to developing countries, in practices sometimes described as "environmental colonialism." This situation has raised global concern due to the threats it poses to public health and the environment, especially in countries that lack the technical and legislative capacities required to handle such waste safely.

The international response to this phenomenon has been articulated through multilateral agreements, most notably the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. This Convention constitutes the primary global framework for regulating this issue. However, despite its significance, the Basel Convention has faced practical and legal challenges that have hindered its achievement of its objectives. These shortcomings call for a reconsideration of its structure and an update of its enforcement mechanisms.

This context leads us to the central research question:

To what extent have international agreements, particularly the Basel Convention, succeeded in regulating and preventing the illegal transboundary movement of electronic waste and mitigating its health and environmental risks for recipient countries?

Research Objectives

- To clarify the fundamental concepts related to electronic waste and its associated risks, and to analyse the international legal framework governing the transboundary movement of such waste.
- To assess the effectiveness of the Basel Convention in addressing this issue.
- To present comparative experiences from affected countries such as China, Japan, and Ghana.
- To propose mechanisms for strengthening international governance in this field.

Significance of the Study

This research is significant because it focuses on one of the most complex environmental and humanitarian challenges of the modern era, particularly for developing countries. It also aims to fill a knowledge gap in legal studies by providing an in-depth analysis based on recent scientific sources and diverse international experiences.

Methodology

This research adopts a multi-method approach, including the descriptive-analytical method to present and analyse the conceptual and legal framework of electronic waste; the comparative legal method to contrast international texts with selected national experiences in handling electronic waste; and the critical method to evaluate the shortcomings of international agreements, particularly the Basel Convention.

Chapter One: The Conceptual and Legal Framework of Electronic Waste

Given its technical specificity and compounded risks, a precise understanding of the nature and sources of electronic waste is essential. This necessitates an examination of the international legal framework governing its classification and management as hazardous waste.

Section One: The Concept and Sources of Electronic Waste

Electronic devices have become a defining feature of the modern digital era. However, their short life cycle has led to a steady global increase in the volume of electronic waste. According to the *Global E-Waste Monitor 2020*, electronic waste is "all electrical and electronic equipment that has been discarded without the intent of reuse" (Forti et al., 2020).

Electronic waste includes many devices, including mobile phones, computers, televisions, printers, refrigerators, etc. The danger lies in the content of toxic and heavy metals such as lead, mercury, and cadmium, hazardous organic compounds such as polychlorinated biphenyls (PCBs), and valuable materials like gold, silver, and copper (Dhir et al., 2021).

In 2019, the global volume of electronic waste reached 53.6 million tonnes, and it is expected to rise to 74.7 million tonnes by 2030 without effective recycling systems (Forti et al., 2020). Despite these alarming figures, only around 20% of this waste is formally processed. At the same time, the remainder is either disposed of through unsafe methods or transferred to developing countries under labels such as "reuse" (ACE, 2019).

Key factors contributing to the worsening of the problem include:

- The accelerated pace of technological innovation.
- The cost of new devices is lower than that of repairing older ones.
- Consumerism-driven marketing strategies.
- Many countries have limited formal collection and recycling systems (Dhir et al., 2021; ACE, 2019).

Section Two: The General International Legal Framework for Hazardous Waste

The regulation of hazardous waste, including electronic waste, is governed by a set of international environmental legal principles, the most significant of which are:

1. The Principle of Prevention and Precaution: This principle emphasises the need to take proactive measures to protect the environment, even without complete scientific certainty regarding potential harm (UNEP, 2013).
2. The Polluter Pays Principle obliges the party responsible for pollution to bear the costs of preventing or remedying environmental damage. It is firmly established in environmental agreements (Stockholm Convention, 2001).
3. The Principle of Environmental Justice: This principle advocates for an equitable distribution of environmental risks and opposes the imposition of environmental burdens on developing countries resulting from the consumption-driven behaviour of the Global North (Fraley, 2015).
4. The Basel Convention (1989) constitutes the primary legal framework for the transboundary movement of hazardous waste. It obliges parties not to export any hazardous waste without prior notification and the consent of the receiving state (Basel Convention, 1989). Article 4 of the Convention prohibits export to countries lacking adequate environmental capacity, particularly in the Global South.
5. Despite its importance, the Convention has faced several implementation challenges, including:

- Ambiguity in the definition of electronic waste.
- Use of pretexts such as "technical donations" to circumvent the ban.

➢ Limited capacity of developing countries to detect and monitor such shipments (ACE, 2019; Awan et al., 2021).

Chapter Two: The Basel Convention and the Provisions Governing the Movement of Electronic Waste

The Basel Convention constitutes the most important legal framework regulating the transboundary movement of hazardous waste. Therefore, it is necessary to assess the extent to which it addresses the phenomenon of electronic waste and identify the shortcomings in its implementation.

Section One: The Origin and Objectives of the Basel Convention

Following several alarming international incidents, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was adopted in 1989. Chief among these was the 1988 case involving the shipment of toxic waste from Italy to Nigeria, known as the "Koko incident." These events highlighted the absence of an international legal mechanism to regulate and restrict waste movement from the industrialised North to the developing South (Basel Convention, 1989).

The Convention aims to:

1. Limit the generation of hazardous waste and promote its treatment at the source.
2. Prevent the movement of hazardous waste from industrialised countries to developing countries, particularly when the latter cannot manage such waste in an environmentally sound manner.
3. Establish the principle of Prior Informed Consent (PIC), whereby no waste may be transported without prior notification and approval from the receiving state.
4. Provide a legal framework for international cooperation in accidents or emergencies resulting from illegal shipments or waste leakage.

Ratification of the Basel Convention is considered essential for restricting illegal waste trade. Article 9 stipulates that any unauthorised transboundary movement is deemed "illegal traffic," the exporting state must retrieve the waste at its own expense (Basel Convention, 1989).

Section Two: Application of the Basel Convention to Electronic Waste

Despite the importance of the Basel Convention, its application to electronic waste remains fraught with various legal and practical challenges, which can be summarised as follows:

1. **Ambiguity in the Classification of Electronic Waste:**

Electronic waste was not explicitly classified as "hazardous waste" when the Convention was signed, leaving room for divergent interpretations regarding its subjection to regulatory constraints. Subsequently, certain types of electronic waste were included in Annexes VIII and IX, where:

- Annex VIII covers hazardous waste.
- Annex IX covers non-hazardous waste (e.g., equipment intended for reuse).
- This classification created a loophole exploited by some exporters, whereby damaged or semi-functional equipment is shipped to developing countries under the guise of "donations" or "reusable goods" in order to circumvent legal restrictions (Dhir et al., 2021; Fraley, 2015).

2. **Supplementary Agreements and Clarifications:**

In 2006, the parties to the Convention adopted Interpretive Decision VII/2 to clarify that electronic waste not directly usable without repair is to be considered waste subject to the Convention's provisions. Furthermore, the *Basel Technical Guidelines on E-Waste* (2015) provided practical guidance for implementing the Convention in electronic waste.

3. **Obstacles in Monitoring and Compliance:**

Recipient countries face technical and legal difficulties in verifying the contents of shipments, particularly in the absence of advanced laboratories or testing equipment. In many instances, shipments are unloaded at ports in developing countries without practical inspection and transferred directly to second-hand markets or informal dismantling sites (ACE, 2019; Awan et al., 2021).

4. **Evasion of the Convention Through the Grey Market:**

A widespread phenomenon known as the "grey market" for electronic waste has emerged, in which damaged products are sold as second-hand goods and illegally shipped across borders. Some companies exploit ports in countries with weak regulatory oversight as transit points such as the Port of Cotonou in Benin and other ports in West Africa making traceability and accountability increasingly difficult (Awan et al., 2021).

5. **The Need to Amend the Convention:**

Numerous experts and environmental organisations have recommended explicitly including electronic waste among the hazardous materials covered by the Convention. They have also called for stricter controls on so-called "reuse" shipments, especially after studies confirmed that more than 60% of exported equipment is either non-functional or beyond practical repair (Forti et al., 2020).

Chapter Three: Health and Environmental Risks of Transboundary Electronic Waste

The harms associated with electronic waste are not limited to technical or economic dimensions; instead, they have profound implications for human health and the environment, particularly in countries where such waste is processed through unsafe methods.

Section One: Health Risks of Electronic Waste

Electronic waste poses a growing health risk, particularly in developing countries where such waste is received and often processed using rudimentary methods without preventive systems or personal protective equipment. End-of-life electronic devices contain a range of toxic substances that have direct adverse effects on human health, including:

- **Lead (Pb)**: Used in the internal soldering of electronic circuits; it causes damage to the nervous system, especially in children (ACE, 2019).
- **Mercury (Hg)**: Found in light switches and flat-screen displays; it can lead to neurological and immune disorders and quickly enters the food chain (Forti et al., 2020).
- **Cadmium (Cd)** is present in batteries and printed circuit boards. It accumulates in the kidneys and bones, causing osteoporosis and renal failure (UNEP, 2013).
- **Polybrominated diphenyl ethers (PBDEs)**: Used as flame retardants in plastic casings; they are linked to hormonal disruptions and congenital abnormalities (Dhir et al., 2021).

A study conducted in areas near electronic waste dismantling sites revealed that residents particularly children suffer from elevated levels of heavy metals in their blood, increasing the likelihood of developing chronic illnesses such as cancer, liver and kidney diseases, and respiratory conditions (*Cobalt Exposure Study*, 2021).

In Ghana, research has shown that workers at manual dismantling sites are daily exposed to delicate particulate matter resulting from the open burning of cables and plastics. This exposure leads to pulmonary fibrosis and heightened rates of chronic poisoning (Awan et al., 2021).

Section Two: Environmental Harms of Electronic Waste

The threat posed by electronic waste is not limited to human health; it extends to endangering entire ecosystems. This danger is attributable primarily to improper disposal methods, particularly open burning, landfilling, or unregulated dismantling.

1. **Soil and Water Contamination**:

Heavy metals and hazardous chemicals from electronic waste leach into the soil, eventually contaminating groundwater. This is particularly prevalent in many African and Asian countries where waste is buried without treatment or oversight (ACE, 2019). Elevated arsenic, chromium, and lead concentrations have been detected in groundwater samples near electronic waste disposal sites (*Characterization of E-Waste*, 2021).

2. **Air Pollution**:

Open burning of cables and plastics is one of the most significant sources of air pollution associated with electronic waste. This practice releases:

- **Dioxins**: Highly persistent carcinogenic compounds.
- **Furans**: Harmful to the respiratory system and liver.
- **PM2.5 particles**: Fine particulate matter penetrating deep into the lungs and entering the bloodstream, leading to cardiovascular and respiratory diseases.
- Reports by the World Health Organization indicate that residents living near electronic waste burning sites suffer from high rates of acute respiratory infections, skin conditions, and eye diseases (WHO, 2018).

3. **Biodiversity Loss**:

Specific chemical substances released from electronic waste impact organisms within food chains, especially fish and birds, causing reproductive and hormonal disruptions. Mercury is among the most dangerous of these substances; in aquatic environments, it transforms into methylmercury a highly toxic compound that bioaccumulates throughout the food web (UNEP, 2013).

4. **Climate Dimension**:

Primitive waste burning, especially in open-air settings, contributes to the emission of greenhouse gases such as carbon dioxide and methane. These emissions exacerbate global warming and undermine efforts to combat climate change (Forti et al., 2020).

Chapter Four: Evaluating the Effectiveness of International Agreements and National Experiences

Given the limitations of international legal texts, it becomes essential to compare national experiences in managing electronic waste to identify successful practices, uncover deficiencies, and propose more effective legal solutions.

Section One: Limitations of International Agreements in Addressing the Movement of Electronic Waste

Although the Basel Convention represents the primary global legal framework for regulating the movement of hazardous waste, its practical application, particularly regarding electronic waste, reveals several weaknesses that compromise its effectiveness:

1. **Legal Ambiguity in the Classification of Electronic Waste**:

Specific electronic devices are categorised as "reusable equipment," a designation that is often exploited as a pretext to bypass legal restrictions. The ACE (2019) report indicated that more than 60% of shipments labelled "technical donations" consist of non-functional or completely broken devices.

2. **Lack of Unified International Commitment**:

Major countries like the United States have yet to ratify the Basel Convention, placing themselves outside its formal obligations. This allows companies operating within such jurisdictions to export waste to countries that are environmentally unprepared to manage it (Forti et al., 2020).

3. **Weak Monitoring Systems in Developing Countries**:

Recipient countries often suffer from inadequate infrastructure and a shortage of trained personnel, which hampers inspection and verification processes at import points. Furthermore, corruption and smuggling undermine the practical enforcement of the Convention (Awan et al., 2021).

4. **Illegal Trade and Grey Markets**:

United Nations reports indicate that illegal shipments of electronic waste account for approximately 25% of global trade in this sector. Ports in African countries are often used as "transit hubs" to obscure the origin of the waste or alter its declared destination (Basel Action Network, 2017).

5. **Lack of an Effective Enforcement or Deterrence Mechanism**:

The Convention lacks a binding punitive mechanism for countries that violate its provisions or engage in illegal transboundary waste movement. This weakens its legal authority and, in some contexts, renders it a symbolic instrument.

Section Two: Comparative International Experiences in Managing Electronic Waste

Several countries have adopted diverse approaches to managing electronic waste by limiting exports or improving treatment and recycling mechanisms.

1. **China's Experience**:

For many years, China was among the largest recipients of electronic waste globally. However, in 2018, it enacted a comprehensive ban on importing most categories of electronic waste through its "National Sword Policy."

This policy led to:

- A reduction of imports by over 90% within a single year.
- The waste redirection flows to other countries, such as Malaysia and Ghana.
- The stimulation of domestic recycling industry development (*An Overview of E-Waste Management in China*, 2021).

2. **Japan's Experience**:

3. Japan has implemented a rigorous system for managing electronic waste since the enactment of the *Home Appliance Recycling Law* in 2001. This law requires both producers and consumers to bear the costs of recycling.

Key features of the Japanese model include:

- The use of identification codes for electronic devices enables tracking.
- Municipal councils should be involved in collecting and delivering devices to recycling centres.
- Public-private partnerships to develop advanced technologies for the separation and recovery of rare metals (Dhir et al., 2021).

3. **Ghana's Experience**:

4. Although Ghana is one of the countries most affected by electronic waste imports, it has initiated several reform measures, including:

- The adoption of a dedicated *Electronic Waste Management Act* in 2016.
- The imposition of import levies on electronic devices to finance waste treatment programmes.
- Establishing the *Accra Integrated E-Waste Recycling Facility* will help manage waste through cleaner technologies (Awan et al., 2021).

However, significant challenges persist, most notably the prevalence of informal dismantling sites such as the infamous *Agbogbloshie* area, where devices are openly burned to extract metals without environmental or health regulation.

Conclusion

The illegal transboundary movement of electronic waste represents one of the most pressing environmental and humanitarian challenges of the modern era, due to its multifaceted implications for public health, environmental sustainability, international justice, and economic equity between nations. This study has demonstrated that electronic waste is not merely "used goods," but instead delayed toxic bombs transported from the industrial North to the developing South under the pretext of "reuse," violating fundamental environmental and human rights principles.

The Basel Convention constitutes an important step toward regulating the movement of hazardous waste. However, its effectiveness in addressing the challenges of electronic waste remains limited in terms of implementation, interpretation, and deterrence. Comparative experiences, particularly in China and Japan, highlight that strong political will and robust national legislation can significantly reduce the harm caused by such waste. Meanwhile, other countries, such as Ghana and Sri Lanka, bear environmental and health costs due to weak regulatory capacities and inadequate legal frameworks.

The evidence gathered from studies and official reports reveals that the shortcomings lie not only in the international agreements themselves, but also in the absence of genuine international solidarity and in the environmental justice gap between exporting and importing countries.

Key Findings and Recommendations

Based on the foregoing analysis, the following key findings and recommendations can be drawn:

- Electronic waste is among the most hazardous forms of contemporary waste due to its toxic components and destructive health and environmental effects, particularly when mismanaged in developing countries.
- The 1989 Basel Convention constitutes the primary international legal framework for regulating the movement of hazardous waste, including electronic waste; however, it suffers from legal loopholes that undermine its effectiveness.
- The major loophole lies in the concept of "reuse," which is frequently exploited to circumvent export bans, thereby leaving illicit channels open for the shipment of non-functional equipment.
- The absence of unified international commitment especially from non-signatory states such as the United States weakens global environmental governance and results in fragmented and selective application of the Convention.
- The health impacts of electronic waste are scientifically documented and include lead and mercury poisoning, pulmonary fibrosis, liver disease, and reproductive disorders, particularly in populations living near informal dismantling sites.
- Environmental damage includes contamination of water, soil, and air and increased emissions of greenhouse gases, making the management of electronic waste a global environmental issue with a climate dimension.
- Some countries' experiences (e.g., Japan and China) demonstrate the effectiveness of strict national frameworks in limiting the phenomenon. In contrast, the damage persists in countries lacking appropriate legislation or regulatory enforcement, such as Ghana and Sri Lanka.

- The current international legal framework is insufficient and must be supported by stronger enforcement measures and financial and

technical cooperation from industrialised countries towards developing nations.

➢ Ethical and environmental responsibility is shared among producers, consumers, and states. It requires activating the Extended Producer Responsibility (EPR) principle and involving the private sector in sustainable solutions.

Based on the overall findings, the following key recommendations are proposed:

✓ Strengthening the Classification of Electronic Waste as Hazardous:

✓ The Basel Convention should be amended to explicitly classify electronic waste as hazardous, regardless of its potential for reuse. A unified and precise definition must be adopted to close the exploited loopholes.

✓ Criminalising Illegal Exports through Effective Sanction Mechanisms:

✓ An international punitive system should be incorporated within the Convention or through an annexed protocol. This would allow for fines or sanctions on countries or companies engaging in illegal transboundary movement of electronic waste.

✓ Ensuring Actual Pre-Shipment Verification:

✓ Mandatory double-check mechanisms should be enforced, requiring exporting countries to conduct physical audits of devices prior to shipment. Reliance on visual inspection or paper-based classification alone should no longer be accepted.

✓ Capacity Building for Developing Countries:

✓ Technical support must be provided to developing countries to help establish waste testing laboratories and finance environmentally sound recycling programmes. These countries must also be empowered to reject suspicious shipments without being subjected to political or commercial pressure.

✓ Enhancing Transparency Through Tracking Technologies:

✓ Digital technologies such as blockchain should be adopted to enable end-to-end tracking of electronic devices from the point of export to their final treatment, ensuring transparency, traceability, and accountability.

✓ Implementing Extended Producer Responsibility (EPR):

✓ Electronics manufacturers must be held accountable for contributing to the costs of recycling and environmentally sound disposal of their products, even beyond the borders of the manufacturing countries.

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