Maryland Journal of International Law

Volume 36 | Issue 1 Article 7

The Future of Electronic Waste: Placing Electronic Waste Back in the Hands of the Manufacturers

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I. INTRODUCTION

Electronic waste is considered one of the fastest growing waste categories, growing three to five percent per year in the world.[1] In 2019, 53.6 million metric tonnes (Mt) of electronic waste was generated worldwide, up twenty one per cent in just five years.[2] "Electronic waste" or "e-waste" is described as used electronics that are nearing the end of their useful life, and are discarded, donated or given to a recycler.[3] Products become e-waste when they are no

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1. I.M.S.K. Ilankoon et al., *E-Waste in the International Context – A Review of Trade Flows, Regulations, Hazards, Waste Management Strategies and Technologies for Value Recovery*, 82 WASTE MGMT. 258, 259 (2018).

2. *The Global E-Waste Monitor 2020*, INT'L SOLID WASTE ASS'N, https://www.iswa.org/home/news/news-detail/article/-21c8325490/109/ (last visited Dec. 16, 2020).

3. *Cleaning Up Electronic Waste (E-Waste)*, U.S. ENVTL PROT. AGENCY, https://www.epa.gov/international-cooperation/cleaning-electronic-waste-e-waste (last visited Dec. 16, 2020). E-waste includes electronics such as televisions; desktops; laptops; display monitors; cellphones; iPads, e-readers, and other touchscreen monitors. Products can also include "white goods" such as refrigerators, washing machines, and microwaves. *What is e-waste?*, STEP INITIATIVE, https://www.step-initiative.org/e-waste-challenge.html (last visited Feb. 8, 2021).

longer of value to their users or no longer satisfy their original purpose.[4] These technologies all contain a mixture of toxic substances such as lead and cadmium in their circuit boards; lead oxide and cadmium in monitor CRTs; and PVC cable insulation that release highly toxic chemicals like mercury when burned to retrieve copper from the wires.[5]

These toxic substances create a safety concern since e-waste disposal methods typically include either using landfills or burning.[6] Landfill leachates risks transporting these hazardous substances into nearby groundwater while combustion in an incinerator can emit these toxic gases into the atmosphere.[7] Humans are affected either through direct impact with workers exposed to the toxins firsthand, or through contaminated water and food.[8] Exposure to these chemicals creates long-term health problems with the kidney, nervous system, and brain with further problems like increased birth defects, cancer, and developmental issues for children.[9]

This paper discusses problems within the current management of electronic waste and explains that when analyzing the contributors of e-waste (developed countries,[10] developing countries,[11] and manufacturers[12]), why responsibility of e-waste cleanup and recycling

4. Gitanjali Nain Gill, *Electronic Waste,* BRITANNICA (May 26, 2016), https://www.britannica.com/technology/electronic-waste.

5. Puckett et al., *Exporting Harm: The High-Tech Trashing of Asia*, BASEL ACTION NETWORK (Feb. 25, 2002), at 7, 9, http://svtc.org/wp-content/uploads/technotrash.pdf.

6. Renee Cho, *What Can We Do About the Growing E-waste Problem?*, COLUMBIA UNIV. (Aug. 27, 2018), https://blogs.ei.columbia.edu/2018/08/27/growing-e-waste-problem/.

7. Kiddee et. al., *Electronic Waste Management approaches: An Overview*, 33 WASTE MGMT. 1237, 1238 (2013).

8. Michelle Heacock et. al., *E-Waste and Harm to Vulnerable Populations: A Growing Global Problem*, 124 (5) ENVTL. HEALTH PERSP. 550, 552 (2016).

9. Jayapradha Annamalai, *Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview*, 19 INDIAN J. OF OCCUPATIONAL & ENVTL. MED. 61 (2015).

10. Developed countries are technically and technologically advanced economies with a high human development index (HDI), high per capita income, modern infrastructure, highly developed own industrial production and economy, and a high standard of living. *What is Developed Countries*, IGI GLOBAL, https://www.igi-global.com/dictionary/developed-countries/55588 (last visited Dec. 16, 2020).

11. Developing countries are the countries that have low levels of industrialization, income per capita and standards of living. *What is Developing Countries*, IGI GLOBAL, https://www.igi-global.com/dictionary/developing-countries/7401 (last visited Apr. 21, 2021).

12. Manufacturers in this paper is synonymous with consumer electronics companies which are companies that sell electronic equipment intended for everyday use, most often in entertainment, communications and office productivity. *See Consumer Electronics*,

should be assigned to manufacturers. Part II presents the political, societal, and economic factors of e-waste. First, it describes the economic value within the metals of electronics and how this contributes to a global economy.[13] Second, it outlines the harms improper e-waste disposal has on both environmental health and human health.[14] Third, it discusses the different international efforts made in order to address the issues of e-waste and the inequitable movement of waste from developed to developing countries.[15] Finally, it looks into the different efforts between developed, developing countries and manufacturers to use regulation in order to solve the global e-waste issue.[16]

Part III analyzes how the different contributors supply the increasing e-waste and provide improper management of the waste.[17] This section argues manufacturers should be responsible for e-waste management because manufacturers are best suited to make production decisions to decrease harm from e-waste,[18] can offset the price of recycling to their customers[19] and avoid the tension and animosity that will inevitably arise with countries attempting to carry matters into their own hands.[20] It also explains how to hold manufacturers accountable through Extended Producer Responsibility.[21] Part IV concludes with a summary of why the current e-waste situation is unsustainable and why manufacturers should be held responsible for e-waste management.[22]

II. BACKGROUND

Electronics manufacturers adopt marketing strategies called planned obsolescence, where they rapidly develop new products with more advancements than the previous model and then advertise the new product to tempt consumers to throw away their old electronics

EDUCALINGO, https://educalingo.com/en/dic-en/consumer-electronics (last visited Dec. 17, 2020).

13. *See infra* Part II.A.
14. *See infra* Part II.B.
15. *See infra* Part II.C.
16. *See infra* Part II.D.
17. *See infra* Part III.
18. *See infra* Part III.B.1.
19. *See infra* Part III.B.2.
20. *See infra* Part III.B.3.
21. *See infra* Part III.C.
22. *See infra* Part IV.

for the new commodity.[23] This creates a stream of e-waste that starts with developed countries[24] creating the waste and then shipping discarded electronics to developing countries[25] who typically recycle the parts in hazardous conditions.[26]

The e-waste industry is estimated at $62.5 billion per year stimulating a growing international market.[27] However, this market is generated from developing countries accepting high amounts of hazardous e-waste from the developed countries who are creating the e-waste.[28] Waste disposal gets shipped to developing countries because of the lax domestic processing and environmental regulations in developing countries, who are known for their informal economy.[29] This transboundary movement of electronic waste is justified by economic interests in both the exporting and importing countries.[30]

A. The Value in Electronics

Even with the highly dangerous toxins, poor countries accept the

23. Jeff Turrentine, *At 59 Million Tons, Our E-Waste Problem Is Getting Out of Control*, N. RES. DEF. COUNCIL (July 24, 2020), https://www.nrdc.org/stories/59-million-tons-our-e-waste-problem-getting-out-control.

24. Developed countries refers to countries with major developed economies including United States, France, Germany, Italy, Japan and the United Kingdom. *See, e.g.*, UNITED NATIONS, WORLD ECONOMIC SITUATION AND PROSPECTS 2020, at 165, U.N. Sales No. E.20.II.C.1 (2020).

25. Developing countries refers to countries with developing economies including China, India and East African countries. *Id.* at 166.

26. Cho, *supra* note 6.

27. Press Release, United Nations, UN report: Time to Seize Opportunity, Tackle Challenge of E-waste (Jan. 24, 2019), https://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste#:~:text=The%20world%20produces%20as%20much,the%20commercial%20airliners%20ever%20made.&text=There%20is%20100%20times%20more,a%20tonne%20of%20gold%20ore.

28. The export of toxic e-waste from developed countries to developing countries is a consequence of global economic forces since hazardous wastes generally follow the path of least resistance, a path of lower costs and lower standards. Nicola J. Templeton, Comment, *The Dark Side of Recycling and Reusing Electronics: Is Washington's E-Cycle Program Adequate?*, 7 SEATTLE J. FOR SOC. JUST. 763, 769–70 (2009).

29. Informal economy is broadly defined as economic activity that is not subject to government regulation or taxation. Emily Benson, *Informal and Green? The Forgotten Voice in the Transition to a Green Economy*, INT'L INST. FOR ENV'T & DEV. 4, 6 (Mar. 2014), https://pubs.iied.org/pdfs/16566IIED.pdf.

30. *See* Erin McIntire, *The International Tribunal for E-Waste: Ending the Race Towards Lethal Fallout*, 5 SEATTLE J. OF ENV'T L. 75, 79 (2015) ("Rich in valuable materials for recovery and recycling, e-waste creates the perfect conditions for a toxic economy in which poor countries labor through exposure to carcinogenic, mutagenic, reproductive and developmental toxins in the name of making a living.").

burden of e-waste in exchange for the precious metals hidden inside the technology.[31] While the chemical composition of e-waste varies by type, age, origin and manufacturer, in 2019, the total value of all raw materials present in e-waste was approximately fifty seven billion dollars.[32] The precious metal content is critical to the economics of recycling processes, with as much as ninety percent of the intrinsic value of e-waste containing gold and palladium content.[33] To obtain the precious materials, an electronics recycler will typically "high-grade" incoming material – "that is skim the most valuable components off the pile and possibly sell them in a store or to specialty brokers."[34] This recovery process, known as urban mining, is linked to resource efficiency and can be a helpful tool to decrease the amount of electronic waste filling landfills.[35] However, obtaining access to these valuable materials is difficult and expensive to separate because it is bound within plastics and mixed with other contaminants.[36] This results in only 17.4 percent of e-waste being collected and recycled, leaving most of the valuable materials dumped or burned.[37] The by-product chemicals from burning and extracting these metals remain in the environment for various periods of time depending on the chemical, which increases the exposure risk for humans and the environment.

31. *See* Puckett, s*upra* note 5, at 12–13 ("Most e-waste will only have positive value in a poor developing country where labor costs might be $1.50 per day and environmental and health standards are lax or not enforced.").

32. Vanessa Forti, et. al., *The Global E-Waste Monitor 2020*, UNITED NATIONS UNIV., at 15 (2020).

33. The StEP Annual Report (2015/2016) estimated the total global gold content of WEEE inventory as 300 tons in 2014, valued at 10.4 billion euros. There is 100 times more gold in a ton of e-waste than in a ton of gold ore. Ilankoon, *supra* note 1, at 260. *See* Alister Doyle, *Emerging Nations Overtake West in Dumping Electronic Trash*, THOMAS REUTERS (Dec. 15, 2013, 2:00 AM), https://www.reuters.com/article/environment-electronics/emerging-nations-overtake-west-in-dumping-electronic-trash-idUSL6N0JR3RC20131215 (finding recycling one million mobile phones alone provides about 24 kilograms ("kg") of gold, 250 kg of silver, 9 kg of palladium and 9 tons of copper).

34. Puckett, *supra* note 5, at 12.

35. Sammani Ramanayaka, *Urban Mining of E-waste: Treasure Hunting for Precious Nanometals*, ECOSPHERE RESILIENCE RES. CTR., UNIV. S RI JAYEWARDENEPURA, at 24 (2019).

36. Such practices include: opening cathode ray tubes with hammers, exposing the toxic phosphor dust inside; cooking circuit boards over open fires to melt lead solder, producing toxic lead fumes…throwing the unwanted, hazardous leaded glass into former irrigation ditches; and dumping pure acids and dissolved heavy metals into nearby rivers. Christine Terada, *Recycling Electronic Wastes in Nigeria: Putting Environmental and Human Rights at Risk*, 10 NW. J. INT'L HUM. RTS. 154, 158 (2012).

37. Forti, *supra* note 32, at 14.

B. Environmental and Health Harms from Electronic Waste

Once the e-waste finds its way to the landfill, it is rarely removed, leaving a mountain of waste waiting to be picked through.[38] Since the components in electronics take a long time to decompose,[39] when e-waste gets to landfills, it contributes to contamination of the surrounding ecosystem over a long period of time.[40] Once the electronics are stripped of value, leaving mostly plastic, they are often burned.[41] Lead particles can be inhaled while still in the air or ingested when it returns to water and soil.[42] Since lead cannot be broken down, it gets converted to other forms which accumulates in the bodies of aquatic and soil organisms, eventually finding its way into humans through consumption.[43] Soils can either come in direct contact with contaminants from e-waste or indirectly through irrigation from contaminated water.[44] These environmental impacts are long lasting and will create externalities for innocent people who were not the producers, nor consumers, of the electronics.

In addition to the health concerns that come from an unhealthy environment, people who live near the landfills and actively work in the e-waste dumps are at a serious health risk.[45] Aside from exposure through a contaminated ecosystem, "exposure to the hazardous

38. Alana Semuels, *The World Has an E-Waste Problem*, TIME (May 23, 2019, 6:27 AM), https://time.com/5594380/world-electronic-waste-problem/.

39. The glass they might contain takes 1-2 million years to decompose. Plastics last forever: a plastic jug lasts 1 million years and plastic bags stick around 20 to 1,000 years. Flimsier metals, like tin can steel, take 50 years to decompose, and an aluminum can takes 200 to 500 years to break down. *See How Long Does it Take Electronic Waste to Decompose?*, SMM INFO. & TECH. CO, LTD. (Nov. 8, 2015, 9:06 PM), https://news.metal.com/newscontent/100080728/how-long-does-it-take-electronic-waste-to-decompose/.

40. *E-Waste & its Negative Effects on the Environment*, ELYTUS, https://elytus.com/blog/e-waste-and-its-negative-effects-on-the-environment.html (last visited Feb. 8, 2021).

41. Unregulated or under-regulated burning is frequently carried out at lower temperatures and releases toxins and small particles that can travel for long distances. Denise Wilson, *Impacts of WEEE (e-waste)*, UNIV. WASH, (2016), https://ewaste.ece.uw.edu/students/impacts-of-e-waste-on-the-environment/.

42. *E-Waste & its Negative Effects on the Environment, supra* note 40.

43. Paul B Tchounwou, et. al., *Heavy Metals Toxicity and the Environment*, 101 EXPERIENTIA SUPPLEMENTUM 1, 16 (2012).

44. Soil can become directly contaminated by (a) effluent or waste products from leaching practices which extract precious metals and other valuable materials from e-waste; (b) coarse particles and bottom ash generated from dismantling, shredding, or burning of e-waste; and (c) leaching of heavy metals not recovered during recycling into underlying soil during disposal. Wilson, *supra* note 41.

45. Heacock, *supra* note 8, at 552.

components of e-waste is most likely to arise through inhalation, ingestion and dermal contact."[46] Workers who typically dismantle and burn waste without protection face an increased risk of injury.[47] There has been a plausible association between e-waste exposure and thyroid dysfunction, adverse birth outcomes, behavioral changes, decreased lung function and adverse changes that can be seen at the cellular level.[48] Specifically for children, exposure to hazardous chemical absorption through their food and water is riskier when compared to adults since children drink and eat more per pound of body weight.[49] Health consequences from e-waste exposure include changes in thyroid function, altered cellular expression and function, adverse neonatal outcomes, cognitive and behavioral changes, and decreased lung function.[50]

C. International Response to Electronic Waste

E-waste being a transboundary issue has led to global attempts to resolve the issues e-waste creates.[51] However, international law requires significant cooperation and coordination between countries with different interests, resulting in unsuccessful agreements. With any treaty or international law, international agreements are voluntary and less strict than a country's own law, creating insufficiencies with respect to reporting, data inaccuracies and not stopping the illegal trade that gets shipped to other countries.[52] While there are agreements for global collaboration, such as the Basel Convention,[53] the lack of enforcement has led some countries to respond to e-waste in their own capacity with their own conventions[54] and waste bans.[55]

46. Kristen Grant et. al., *Health Consequences of Exposure to E-waste: A Systematic Review*, 1 LACET GLOB. HEALTH 350, 351 (2013).

47. Heacock, *supra* note 8, at 551.

48. Heacock *supra* note 8, at 552.

49. Chemicals can also accumulate in children's bodies because their immature systems are unable to process and excrete some toxic materials effectually. *Heacock, supra* note 8 at 552.

50. Toxicity levels tested in Guiyu, China, demonstrate that young laborers have enough lead in their blood – 15.3ug/dl, approximately 50 percent more lead than in control sites used in other studies – to cause permanent retardation and brain damage, or possible death. No amount of lead exposure has been considered safe for humans, and even lead exposure less than 10ug/dl will impair a child's cognitive development. McIntire, s*upra* note 30, at 90.

51. *See infra* Part II.C.1., C.2.

52. Forti, *supra* note 32, at 55.

53. *See infra* Part II.C.1.

54. *See infra* Part II.C.2.

55. *See infra* Part II.C.3.

1. Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal (1992)

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is a multilateral agreement negotiated under the United Nations Environment Program beginning in 1988.[56]

The Convention was a response to a public outcry following the discovery of deposits of toxic wastes imported from abroad to Africa and other parts of the developing world.[57] The Convention establishes standards for the transboundary movement of hazardous waste, solid waste and municipal incinerator ash.[58] According to the Basel Convention, e-waste is categorized as hazardous waste when it contains toxic materials such as mercury, lead and brominated flame retardants.[59] In 2002, the Basel Convention was updated to recognize e-waste as an issue. As a result, the Convention included an agreement for environmentally sound management: the prevention of illegal traffic to developing countries and building capacity around the globe to better manage e-waste.[60] While the Convention was designed to regulate transboundary movements of hazardous wastes, it excluded regulation on disposal practices or operations.[61] As a byproduct, there are only general rules and non-binding guidelines

56. *International Agreements on Transboundary Shipments of Hazardous Waste*, U.S. ENVTL. PROT. AGENCY https://www.epa.gov/hwgenerators/international-agreements-transboundary-shipments-hazardous-waste (last visited Dec. 17, 2020).

57. *History of the Negotiations of the Basel Convention*, UNITED NATIONS ENV'T PROGRAMME, http://www.basel.int/TheConvention/Overview/History/Overview/tabid/3405/Default.aspx#:~:text=Law%20in%201981.,The%20Basel%20Convention%20on%20the%20Control%20of%20Transboundary%20Movements%20of,world%20of%20deposits%20of%20toxic (last visited Dec. 17, 2020).

58. *International Agreements on Transboundary Shipments of Hazardous Waste*, *supra* note 56. Exportation of hazardous wastes can only occur when the exporting nation "does not have the technical capacity and the necessary facilities . . . or suitable disposal sites" to dispose of the wastes and acquire prior informed consent from the prospective states of import and transit for the trans-boundary movements of hazardous waste. Rebecca A. Kirby, *The Basel Convention and the Need for United States Implementation*, 24 GA. J. INT'L COMP. L. 281, 292 (1994).

59. *Overview*, UNITED NATIONS ENV'T PROGRAMME, http://www.basel.int/Implementation/Ewaste/Overview/tabid/4063/Default.aspx (last visited Dec. 17, 2020).

60. *Id.*

61. *Warning: The Basel Convention Is Poorly Equipped to Deal with POPs Destruction*, BASEL ACTION NETWORK (BAN) (Dec. 2000), https://www.iatp.org/sites/default/files/Warning_The_Basel_Convention_Is_Poorly_Equippe.htm.

for waste disposal, thereby allowing the illegal e-waste trade to continue and thrive.[62]

2. Bamako Convention (1998)

The shortcomings of the Basel Convention have parties on the receiving end of the waste trade calling for stricter regulation.[63] Frustrated by the failures of the Basel Convention, African nations came together in 1998 to tackle the e-waste market and ban imports of e-waste into the continent through the Bamako Convention.[64] The Bamako Convention resulted in the regulation of known and potentially hazardous wastes, the criminalization of foreign hazardous waste imports into Africa and a limitation of the movement of hazardous waste already located on African soil.[65] The Bamako Convention also uses a similar format and language to Basel but Bamako creates much stronger prohibitions for imports of hazardous waste and it does not accept certain hazardous wastes.[66] Although the Bamako Convention attempted to globally promote Africa's position on e-waste importation, international implementation of Bamako has fallen short due lack of funding and lack of participation from key nations, most of which are resistant to further waste restrictions.[67]

3. Waste Bans and the Return of Waste

Developing countries are tackling the e-waste issues and changing how they accept electronic waste from other nations. In the last four decades, 350 million tonnes of electronic waste were imported to China from different part of the world, resulting in roughly 70 percent of world's e-waste decomposing in China's

62. *Id.*

63. Daniel Jaffe, *The International Effort to Control the Transboundary Movement of Hazardous Waste: The Basel and Bamako Conventions*, 2 ILSA J. INT'L & COMP. L. 123, 126–27 (1995).

64. *The Bamako Convention*, UNITED NATIONS ENV'T PROGRAMME, https://www.unenvironment.org/explore-topics/environmental-rights-and-governance/what-we-do/meeting-international-environmental (last visited Dec. 17, 2020).

65. McIntire, *supra* note 30, at 98.

66. *The Bamako Convention*, *supra* note 64.

67. The United States strongly opposed prohibition, characterizing the transboundary shipment of hazardous waste as a free trade issue and arguing that prohibition would burden individual liberty and conflict with free trade and freedom of contract. Other countries, such as the Netherlands, opposed the ban because they rely on exportation of waste as domestic environmental conditions make safe disposal impossible. Andrew Webster-Main, *Keeping Africa Out of the Global Backyard: A Comparative Study of The Basel And Bamako Conventions*, 26 ENVIRONS: ENVTL. L. & POL'Y J. 65, 82 (2002).

landfills.[68] In mid-2017, the Chinese national government announced that in 2018 it would ban the import of twenty four types of solid waste, including non-industrial plastic waste and electronic waste. China's goal was to gradually stopping all waste imports that could be replaced with domestically recycled materials.[69] Addressing e-waste specifically, China developed domestic policies establishing national e-waste collection systems and recycling infrastructure.[70] Efforts include banning the transboundary importation of e-waste into China, licensing formal recyclers and setting treatment standards.[71] With the ban, China was successful in dropping imports of plastic waste from 600,000 tons per month in 2016 to about 30,000 a month in 2018.[72] Being one of the largest importers of waste,[73] this is an important step for China towards securing a better environment for its citizens. While this has put a stress on developed countries to find a new place to export their e-waste, the China Waste Ban has also inspired other countries to increase their inspections and regulation of waste imports.[74]

D. Regulation of E-Waste

When looking at how to improve the lack of accountability for e-waste, it is important to look at existing laws to see where the responsibility lies. E-waste policies play an important role in setting

68. Natalie W. M. Wong, *Electronic Waste Governance under "One Country, Two Systems": Hong Kong and Mainland China*, 15 INT'L J. OF ENVTL. RES. & PUB. HEALTH 2347, 2347 (2018).

69. Ying Xia, *China's Environmental Campaign: How China's "War on Pollution" Is Transforming the International Trade in Waste*, 51 N.Y.U J. INT'L L. & POL. 1101, 1104 (2019).

70. § 4. China, INT'L ENCY. CYBER LAW 3127684 (C.C.H.), 2020 WL 3127684.

71. Wong, *supra* note 68, at 2347.

72. *Data From the Global Plastics Waste Trade 2016-2018 and the Offshore Impact of China's Foreign Waste Import Ban*, GREENPEACE 5 (Apr. 23, 2019), https://www.greenpeace.org/static/planet4-eastasia-stateless/2020/06/9858a41c-gpea-plastic-waste-trade-research-briefing-v2.pdf.

73. China imported 7 million tons of waste plastics and 28 million tons of waste paper in 2016, accounting for more than half of the world's export of waste plastics and waste paper that year. Xia, *supra* note 69, at 1104.

74. *See, e.g.*, *International Policies Affecting Global Commodity Markets*, CAL. DEP'T OF RES. RECYCLING & RECOVERY (Jan. 28, 2020), www.calrecycle.ca.gov/markets/nationalsword/globalpolicies (stating since 2018, Indonesia has required all waste, paper and plastic imports to be inspected); Zafirah Zein, *Thailand to Ban Plastic Waste Imports by 2021*, ECO-BUSINESS (Oct. 17, 2018), https://www.eco-business.com/news/thailand-to-ban-plastic-waste-imports-by-2021/ (reporting Thailand announcing a temporary ban on plastic imports and a plan to ban e-waste and plastic waste imports within two years).

standards to govern the actions of stakeholders who are associated with e-waste in the public and private spheres.[75] Currently, 71% of the world population is governed by national e-waste management laws, up from 44% in 2014.[76] While the international treaties are a starting point for regulating e-waste, it is up to individual countries on how much restrictions they put on manufacturers to allow e-waste to be created and ultimately disposed of. When looking at the different laws in place for developed countries,[77] developing countries[78] and manufacturers,[79] it exposes gaps within e-waste regulation which is a factor that contributes to the uneven distribution of e-waste disposal.

1. Developed Country Laws

Currently, there is no federal law in the United States that mandates the recycling of e-waste or forbids e-waste from being exported to developing countries.[80] The federal regulation involving waste regulation is under the Resource Conservation Recovery Act (RCRA). RCRA is typically unable to adequately regulate waste due to the exemptions and exclusions allowed under the regulation.[81] Under a particularly damaging exemption, large businesses can classify their electronics as a commodity as opposed to waste if their used electronics contain reusable or recyclable components.[82] On June 18, 2014, EPA finalized revisions to the export provisions of the 2006 cathode ray tubes (CRT) final rule which allows the EPA to obtain additional information to better track exports of CRTs for reuse and recycling to ensure safe management of these materials.[83] However, in 2016, the EPA also amended its regulation of RCRA to streamline management requirements for recycling of used CRT and

75. Forti, *supra* note 32, at 53.

76. *Id.* at 26.

77. *See infra* Part II.D.1.

78. *See infra* Part II.D.2.

79. *See infra* Part II.D.3.

80. Cho, *supra* note 6.

81. *See* 40 C.F.R. § 261.4(b)(1) (2004) (providing household exclusion) and 40 C.F.R. § 261.5(f)(3) (2004) (providing exemption for companies producing less than 220 pounds of hazardous waste per month).

82. Used electronics sold to foreign recycling processors before the recycling or disassembly process are also classified as a commodity. Kammy Lai, *E-Waste Regulation Under the RCRA*, GEORGE WASH. J. ENERGY & ENVT'L L. (Nov. 26, 2011), https://gwjeel.com/2011/11/26/e-waste-regulation-under-the-rcra/.

83. *Regulations, Initiatives and Research on Electronics Stewardship*, ENV'T PROT. AGENCY, https://www.epa.gov/smm-electronics/regulations-initiatives-and-research-electronics-stewardship.

glass removed from CRTs.[84]

EPA delegates the primary responsibility of implementing RCRA hazardous waste programs to individual states.[85] Twenty-five states and the District of Columbia have their own electronic recycling laws, varying in approach.[86] Most of these states use a producer responsibility approach, meaning manufacturers pay for the recycling of their e-waste. However, these states differ in their scope of products covered and whether there is a disposal ban.[87] The problem with this framework is that it creates a set of laws where no individual has enough market share to compel manufacturers to design greener or more durable products.[88]

By contrast, the European Union's Restriction of Hazardous Substances Directive represents the entire EU market and thus has the ability to set higher standards for all electronic products sold in the EU.[89] One piece of legislature by the EU is its Directive on waste electrical and electronic equipment (WEEE Directive), which entered into force in February 2003 to create collection schemes in which consumers return their e-waste free of charge in order to increase the recycling of e-waste and/or re-use.[90] Another Directive is on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive) which requires heavy metals such as "lead, mercury, cadmium, and hexavalent chromium and flame retardants such as polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)" to be substituted by safer alternatives.[91]

84. The amendments excluded these materials from the Resource Conservation and Recovery Act definition of solid waste if certain conditions are met. 40 C.F.R. § 261.4(a)(22).

85. *State Authorization under the Resource Conservation and Recovery Act (RCRA)*, U.S. ENV'T. PROT. AGENCY https://www.epa.gov/rcra/state-authorization-under-resource-conservation-and-recovery-act-rcra (last visited Dec. 17, 2020).

86. Jennifer Schultz, *Electronic Waste Recycling*, NAT'L CONF. STATE LEGISLATURES (Sept. 17, 2018), https://www.ncsl.org/research/environment-and-natural-resources/e-waste-recycling-legislation.aspx.

87. *State Legislation*, ELECT. TAKEBACK COAL., http://www.electronicstakeback.com/promote-good-laws/state-legislation/ (last visited Dec. 17, 2020).

88. Cho, *supra* note 6.

89. The laws requiring manufacturers to help pay for recycling resulted in a recycling rate of 35 percent. *Id.*

90. Council Directive 2002/96, art. 9, 2003 O.J. (L 37) 24, 25 (EC).

91. Council Directive 2002/95, 2003 O.J. (L 37) 19, 21 (EC).

2. Developing Country's Laws

When making e-waste laws in developing countries, regulators have to take into account the lack of awareness from end users and lack of incentives from producers to properly manage e-waste recycling. In developing countries, it is hard to create producer responsibility laws due to a deficiency in treatment facilities that are compliant with international standards and a lack of collection infrastructure that channels e-waste to these sites.[92] Developing countries also face the obstacle of adoption of policies from developed countries without taking into context the local political, cultural and socio-economic waste management issues.[93] Moreover, lack of financing and enforceability of these programs present problems since some of them are not legally binding.[94] However, despite these handicaps, developing countries have enabled efforts to strengthen their management of e-waste through legislation.

Across Africa and Asia, for example, there are nineteen countries with legally binding legislation on e-waste, five countries with an e-waste policy but non-legally binding legislation, and thirty one countries with policies in development.[95] India is leading the developing countries in adopting e-waste legislation by creating the E-Waste (Management) Rules in 2016.[96] This rule extends the range of equipment being managed, as well as implements Extended Producer Responsibility (EPR) for producers.[97] Under this rule, the government's role in e-waste management has been more involved to ensure safety, health and skill development of the workers involved in dismantling and recycling operations.[98] Elsewhere in Asia, countries like China are battling regulations within their own borders. For example, Hong Kong is implementing separate regulations on e-waste.[99] In Africa, most countries are aware of the effects of poor e-

92. C.P. Bald, et. al., *The Global E-waste Monitor 2017*, UNITED NATIONS UNIV. 49 (2017), https://www.itu.int/dms_pub/itu-d/opb/gen/D-GEN-E_WASTE.01-2017-PDF-E.pdf.

93. Agamuthu Pariatamby & Dennis Victor, *Policy Trends of E-waste Management in Asia*, 15 J. MATERIAL CYCLES & WASTE MGMT. 411, 411 (2013).

94. Forti, *supra* note 32, at 52.

95. *Id.*

96. G.S.R 338(E), The E-Waste (Management) Rules, 2016, Ministry of Environment, 151 GAZ. INDIA 12, New Delhi, 23 Mar. 2016.

97. *Id.* at 3, ¶¶ (t) and (u).

98. Ministry of Environment, *E-waste (Management) Rules, 2016*, INDIA ENV'T PORTAL (Mar. 23, 2016), http://www.indiaenvironmentportal.org.in/content/426933/e-waste-management-rules-2016/.

99. It is legal for Hong Kong to import or act as an entrepot for second-hand EEE and e-waste if an import license is obtained in Hong Kong. Moreover, the equipment imported to

waste management, however, very few countries have any formal policies specific to e-waste.[100] Most of these programs involve approaches to integrate the informal sector into official management structures and establish takeback schemes, EPR, and Producer Responsibility Organizations (PROs) schemes.[101] In Latin America, seven out of the twenty one countries implemented e-waste regulations, most of which operate at the local level.[102]

3. Manufacturer's self-regulation

While most manufacturers' e-waste regulation is regulated through producer responsibility laws set by the country they operate in, self-regulation efforts can advance manufacturing electronics to be as minimally environmentally damaging as possible. Some manufacturers made voluntary commitments to manage used electronics in an environmentally sound manner and to restrict exports of used electronics that they collect for recycling.[103] Though some companies are more persuaded to reduce waste due to the rising price of raw materials and metals, others recognize the role they need to take to protect the environment and how their products have an effect on the environment.[104] To avoid the implementation of regulatory EPR mandates, some manufacturers in the United States started to set up voluntary takeback programs that charge an end-of

Hong Kong can be shipped to other countries, including China, with no waste permit required from Hong Kong authorities. Wong, *supra* note 68, at 2349.

100. In Nigeria, the EPR took off with formation of the E-waste Producer Responsibility Organisation of Nigeria (EPRON), a non-profit organization set up by electrical and electronic producers in Nigeria. In Ghana, Technical Guidelines on Environmentally Sound E-Waste Management for Collectors, Collection Centers, Transporters, Treatment Facilities and Final Disposal have been developed and are being enforced. Forti, *supra* note 32, at 70.

101. Bald, *supra* note 92, at 60.

102. This includes Bolivia, Chile, Colombia, Costa Rica, Ecuador, Mexico and Peru. *Id.* at 66.

103. As of 2020, there are over 900 facilities in over thirty countries that are R2 certified. *Find a Recycler*, SERI, https://sustainableelectronics.org/recyclers (last visited Dec. 17, 2020).

104. One company taking initiative includes Sprint through their Buyback program. Sprint accepts any mobile device regardless of carrier or condition and offers customers a financial incentive of up to $300 per eligible device. Sprint then tests and sorts them. Most of these "old phones" are functional and in demand, so Sprint cleans, refurbishes and updates the software so they can be reused. This approach has helped Sprint avoid a billion dollars in cost, since the majority of these pre-owned, certified devices are redistributed through equipment warranty and insurance claims. Philip Fava, *Recycling E-Waste: How One Company Gets It Right*, FORBES (Nov. 13, 2012, 8:32 AM), https://www.forbes.com/sites/philfava/2012/11/13/recycling-e-waste-how-one-company-gets-it-right/?sh=29e688e92b94.

life fee to consumers.[105] However, other retailers, such as Best Buy, will take back most brands of most electronics for free and then aim to refurbish old electronic components and parts into new products.[106]

While manufacturers will have to follow laws and policies regardless of voluntary efforts, some of the policies created help manufacturers to electively make better decisions with their products. Specifically, as of 2009 in the United States, the EPA created a Responsible Recycling (R2) and e-Stewards certification program with electronics manufacturers, recyclers and other stakeholders that allows electronics recyclers to obtain certification that they are voluntarily adhering to environmental, worker health and safety, and security practices.[107] As of December 2015, more than 550 U.S. electronics recycling facilities were certified to one or both of these standards.[108] Also, under government influence, "extended producer responsibility" policies are created where e-waste responsibility can be assigned either individually, where producers are responsible for their own products, or collectively, where producers in the same product type or category fulfill the responsibility for end-of-life management together.[109] Implementing these policies incentivizes manufacturers to consider environmentally-designed products and how to minimize end-of-life problems with their products.[110]

105. For example, major electronics manufacturers, such as Dell, Hewlett Packard and IBM have set up voluntary programs where they charge consumers a $20 to $30 fee for taking back the product. Beverley Thorpe, et. al., *Extended Producer Responsibility*, CLEAN PROD. ACTION 9 (2004), https://www.cleanproduction.org/static/ee_images/uploads/resources/EPRtoolkitColourFinal.pdf. Hewlett-Packard and Dell have also adopted company policies that ban exports of nonworking electronics to developing countries. Linda Luther, *Managing Electronic Waste: Issues with Exporting E-Waste*, CONG. RES. SERV. 9 (Sept. 27, 2010), https://fas.org/sgp/crs/misc/R40850.pdf.

106. Best Buy reported it had collected two billion pounds of electronics and appliances since the program launched in 2009. In 2019, the company handled nearly one million devices through its trade-in program, according to the sustainability report. However as of current, Best Buy has suspended this program due to COVID-19. Colin Staub, *Best Buy and Others Halt E-scrap Collection Due to Coronavirus*, E-SCRAP NEWS (Mar. 26, 2020), https://resource-recycling.com/e-scrap/2020/03/26/best-buy-and-others-halt-e-scrap-collection-due-to-coronavirus/.

107. *Manual of Policies and Procedures for R2 Standard Development*, SERI (June 14, 2019), https://sustainableelectronics.org/wp-content/uploads/2021/02/8.-SERI-Manual-1.pdf.

108. U.S. ENVTL. PROT. AGENCY, 530-R-16-008, Implementation Study of the Electronics Recycling Standards: R2 and e-Stewards® (2016), at 1.

109. Bald, *supra* note 92, at 49.

110. *Extended Producer Responsibility*, ORG. FOR ECON. CO-OPERATION & DEV, https://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm (last visited Feb. 8, 2021).

III. ANALYSIS

There is limited scholarship discussing in depth the issues of e-waste and the specific relationship developed countries, developing countries and manufacturers have to e-waste. When looking at how different actors play a role in contributing to e-waste, not one specific entity can be blamed for the vast amounts of e-waste accumulated and each has the incentive to recycle e-waste. However, when trying to mitigate the e-waste problem, manufacturers have the most influence at the beginning of electronic production and can also most effectively reuse their own products to create new ones. Due to the competitive advantage e-waste recycling can bring to a country, manufacturers are best suited to recycle e-waste since their incentive will be based on corporate responsibility for the products they create.

A. Current Relationship to Electronic Waste

The movement of e-waste typically starts in developed countries and then gets shipped to developing countries in order to take advantage of their informal collection systems, which result from less stringent environmental laws. Though in 2019, most of the e-waste was generated in Asia (24.9 megatons (Mt)), this changes when looking at waste produced per capita.[111] The causes of e-waste boil down to manufacturers making the products and consumers using the products, but eventually getting rid of them to use a manufacturer's newest invention. These interactive relationships create a global, systematic movement of e-waste: manufacturers make the waste[112] and developed countries use the waste,[113] leaving developing countries to clean up the waste.[114]

1. Manufacturing Companies

Companies have the greatest influence over product design and marketing decisions because they oversee design and market strategies of the products that eventually become e-waste. There is a trend set by these companies that makes the manufacturing of devices inexpensive, but makes it difficult, inconvenient or costly to repair the devices to incentivize new purchases.[115] While consumers are the

111. The continent that generates the most in kg per capita is Europe at 16.2 kg per capita in 2019. Forti, *supra* note 32, at 13.

112. *See infra* Part III.A.1.

113. *See infra* Part III.A.2.

114. *See infra* Part III.A.3.

115. Syed Faraz Ahmed, *The Global Cost of Electronic Waste*, THE ATLANTIC (Sept. 29,

people responsible for turning a manufacturer's product into waste, manufacturers contribute to the issue when they create their products. Ultimately, decisions about longevity, durability and reusability of a product are placed in the manufacturer's hands.[116] The raw material put into the technology is processed by these companies and it is up to the manufacturers to choose how they source their material and how easy it is to extract later on.[117]

2. Developed Countries

"Developed nations inevitably produce more hazardous substances, due in large part to the development process itself, which involves heavy industrialization in order to achieve capitalistic economic progress."[118] Nine of the top ten e-waste producing countries in the world, including the U.S. and multiple countries in Europe, create upwards to sixty two pounds per capita of e-waste.[119] When waste containing hazardous contents require special treatment beyond being dumped into landfills, it becomes more economical to load the waste onto ships and trains for transport beyond the boundaries and jurisdiction of those places in which they were produced or collected.[120] Historically, "exporting electronic waste to developing countries has been one way in which the industrialized world has avoided having to deal with the problem of expensive disposal and close public scrutiny at home."[121] With only twenty percent of e-waste recycled,[122] there is a huge market of untapped economic value in the precious metals of e-waste that countries like

2016),
https://www.theatlantic.com/technology/archive/2016/09/the-global-cost-of-electronic-waste/502019/.

116. *Basic Information About Electronics Stewardship*, U.S. ENVT'L. PROT. AGENCY, https://www.epa.gov/smm-electronics/basic-information-about-electronics-stewardship (last visited Feb. 11, 2021).

117. *Id.* ("Source reduction is important in manufacturing as environmentally preferable electronics will use less materials overall, use more recycled materials and be more durable and recyclable.").

118. Laura A.W. Pratt, *Decreasing Dirty Dumping? A Reevaluation of Toxic Waste Colonialism and The Global Management of Transboundary Hazardous Waste*, 21 TEX. ENV'T. L.J. 147, 153 (2011).

119. Vijayalaxmi Kinhal, *Highest E-Waste Generating Nations in the World*, WORLDATLAS (Apr. 25, 2017), worldatlas.com/articles/highest-e-waste-generating-nations-in-the-world.html.

120. Suthipong Sthiannopkaoa & Ming Hung Wong, *Handling E-waste in Developed and Developing Countries: Initiatives, Practices, and Consequences*, 463–64 SCI. TOTAL ENV'T 1147, 1147 (2012).

121. Puckett, *supra* note 5, at 11.

122. Cho, *supra* note 6.

the U.S. should take advantage of.

3. Developing Countries

Even though developing countries create some e-waste, most of it is shipped by developed countries, with an estimated twenty three percent of developed countries' e-waste getting shipped to developing countries each year.[123] Developing countries' relationship with e-waste is typically an economic one represented through an informal economy. What makes a developing country informal is the fact that they often lack comprehensive or mechanized solid waste management systems, leaving the waste pickers to informally collect, sort and repackage materials for recycling by hand.[124] Even though informal waste picking activities "take place outside official channels, unlicensed and untaxed" in many countries, it is a significant contributor to their national economy.[125] These unofficial channels provide an incentive for developing countries to transport the waste they produce into the developed countries. Even though these countries' citizens are exposed to the harmful effects of e-waste, they are willing to accept the waste in order to receive economic benefits.

B. Assigning Future Responsibility to Manufacturers

To answer the question of who should pay for the costs of e-waste, one needs to look at who is better at offsetting the costs with the benefits. While developed countries may be able to avoid the responsibility of storing the e-waste and environmental damage if developing countries had responsibility, the developed countries give up the opportunity of economic revenue that they would get from proper recycling. Inversely, if the developed countries are held responsible for e-waste, it takes away an industry that plays a huge part in a developing country's economy but then allows for less damage to their environment and health. Seeing these conflicting viewpoints, manufacturers should be responsible for e-waste management. Manufacturers are in the best position to deal with e-waste because the waste created comes from their products and manufacturers will be incentivized to make production decisions to

123. Knut Breivik et al., *Tracking the Global Generation and Exports of e-Waste. Do Existing Estimates Add up?* 48 ENV'T SCI. & TECH. 8735, 8739 (2014).

124. Benson, *supra* note 29, at 21.

125. *Id.* at 22.

decrease the impact of e-waste[126] and can offset the cost of those decisions to consumers.[127] Additionally, manufacturers can best handle e-waste because it will decrease political tensions between countries since those countries would no longer have to make decisions on e-waste that impact other countries.[128]

1. Manufacturers are Best Suited to Make Production Decisions to Decrease Harm from E-waste

Since manufacturers dictate what materials go into their products, how the product is ultimately built and how easily a product can be repaired, they can minimize e-waste impacts by making more sustainable choices before the product becomes waste. Due to several design choices, manufacturers have created a cycle where it costs more to repair a product than to completely replace it.[129] For older products, manufacturers use software updates on newer models of smartphones and computers, subtly pressuring consumers to buy new devices to get the optimal electronic experience.[130] Simultaneously, producers end support for older models or the operating systems that run on them.[131] In this phenomenon known as "repair prevention,"[132] repairs can often be more expensive than replacing the item entirely, thereby causing mostly working electronics to be thrown away and ending up in the landfills of developing countries.[133] While this strategy allows manufacturers to gain increased profit from the purchases, environmental and health harms are not considered in this

126. *See infra* Part III.B.1.

127. *See infra* Part III.B.2.

128. *See infra* Part III.B.3.

129. Manufacturers also made more complex designs for their products while also restricting repair information to only authorized repair centers. Emily Matchar, *The Fight for the "Right to Repair"*, SMITHSONIAN MAG. (July 13, 2016), https://www.smithsonianmag.com/innovation/fight-right-repair-180959764/.

130. In March 2020, Apple Inc. agreed to pay up to $500 million to settle litigation accusing it of quietly slowing down older iPhones as it launched new models, to induce owners to buy replacement phones or batteries. While Apple denied wrongdoing, attributing the problems mainly to temperature changes, high usage and other issues, they settled the case. Further Apple apologized and lowered the price for replacement batteries from $79 to $29. Johnathan Stemple, *Apple to pay up to $500 Million to Settle U.S. Lawsuit Over Slow iPhones*, REUTERS, (Mar. 2, 2020, 10:59 AM), https://www.reuters.com/article/us-apple-iphones-settlement/apple-to-pay-up-to-500-million-to-settle-u-s-lawsuit-over-slow-iphones-idUSKBN20P2E7.

131. Ahmed, *supra* note 115.

132. Matchar, *supra* note 129.

133. *Id.*

business model.[134]

To combat this system, the "Right to Repair" movement has been advocated for worldwide. In the United States, the Public Interest Research Group campaigns for consumers and small businesses to receive access to parts, tools and service information in order to repair products.[135] The Public Interest Research Group has pushed Right to Repair legislation in twenty states and has succeeded in applying this to auto-repairs, however, it has been less successful with other electronic products.[136] Conversely, the Right to Repair movement has been successful in the European Union, requiring by 2021 all "electronic displays, fridges, washing machines, dishwashers and lighting products" placed on the EU market to meet minimum repairability requirements in order to extend their lifetime.[137] For other electronics, the European Commission announced plans to extend the 2021 right to repair coverage to phones, tablets and laptops.[138]

This idea of repair prevention includes tactics such as digital locks or copyrighted software to prevent consumers or independent repair retailers from making changes or repairs.[139] Manufacturers should allow independent retailers to repair devices, creating job opportunities[140] and ultimately decreasing the turnover rate of electronics. Manufacturers argue that opening repair to anyone is a safety concern because "poorly trained service centers could ultimately jeopardize the safety of consumers and the public in general."[141] However, advocates for Right to Repair assert "right-to-repair laws could make devices safer by allowing consumers to

134. Matchar, *supra* note 129.

135. *Right to Repair*, U.S. PUB. INT. RES. GRP., https://uspirg.org/feature/usp/right-repair (last visited Dec. 17, 2020).

136. *Id.*

137. European Commission Press Release QANDA/19/5889, The New Ecodesign Measures Explained (Oct. 1, 2019).

138. Paola Rosa- Aquino, *Fix, or Toss? The 'Right to Repair' Movement Gains Ground*, NY TIMES (Oct. 23, 2020), https://www.nytimes.com/2020/10/23/climate/right-to-repair.html.

139. Matchar, *supra* note 129.

140. *See* Henrik Riisgaard et. al., *Local Circles in a Circular Economy – the Case of Smartphone Repair in Denmark*, 5 EUR. J. SUSTAINABLE DEV. 109, 115 (2016).

141. Nathan Proctor, *Here's How Manufacturers Argue Against Repair*, U.S. PUB. INT. RES. GRP (July 1, 2019),
https://uspirg.org/blogs/blog/usp/here%E2%80%99s-how-manufacturers-argue-against-repair.

quickly replace failing parts or update buggy software."[142] Repairs could potentially result in damage to a replacement component if mishandled and to other components within a device that may have been functioning properly beforehand.[143] To fix this issue, manufacturers could simply make repair models more accessible and implement simpler designs that can be fixed without a device specific manual.[144] While the choice to repair a device is ultimately left to the consumer, manufacturers should make that choice more approachable.

2. Manufacturers Can Offset Costs to Consumers

Manufacturing companies are best suited to offset increased recycling costs and the cost of environmental regulation to their customers through higher pricing of their products.[145] On top of the normal costs associated with shipping goods from one place to another, unaccounted costs of e-waste trade include harm to workers and the environment and these costs increase when hazardous waste is moved from countries with relatively strong worker and environmental protections to countries with weaker protections.[146] These costs come from the price of hazardous waste training, protective equipment and health care, which would introduce compliance or liability costs but would eliminate the hidden costs that are currently being passed to developing countries.[147] When producers bear these recycling costs of their products, those costs are passed to consumers and offset through higher prices.[148] These costs can be minimized through the free market where producers compete with

142. Louise Matsakis, *Security Experts Unite Over the Right to Repair*, WIRED (Apr. 30, 2019, 9:15 AM), https://www.wired.com/story/right-to-repair-security-experts-california/.

143. Mike Wuerthele and Malcolm Owen, *Editorial: Arguing Over iPhone 'Right to Repair' is Good, but a Solid Middle-Ground is Needed*, APPLEINSIDER (May 6, 2019), https://appleinsider.com/articles/19/05/06/editorial-arguing-over-iphone-right-to-repair-is-good-but-a-solid-middle-ground-is-needed.

144. Matcher, *supra* note 129.

145. One argument for assigning liability to manufacturers is loss distribution under strict products liability. Manufacturers are in the best position to distribute the losses from injury since they can test the product, evaluate its potential for harm, and then insure against that harm, passing on the insurance costs through increases in the product's price. Alden D. Holford, *The Limits of Strict Liability for Product Design and Manufacture*, 52 TEX. L. REV. 81, 82–83 (1973).

146. Jennifer Chen, *The Efficiency and Management of the International Trade in Electronic Waste: Is There a Better Plan Than a Ban?*, 21 N.Y.U. ENVTL. L.J. 142, 155 (2014).

147. *Id.*

148. Jeremy Knee, *Guidance for the Awkward: Outgrowing the Adolescence of State Electronic Waste Laws*, 33 ENVIRONS ENVTL. L. & POL'Y J. 157, 164 (2009).

one another to offer lower prices to consumers, including recycling costs.[149] A producer who can minimize recycling costs possesses a competitive advantage in the electronics marketplace which would create incentives for other manufacturers to have better recycling practices.[150]

To make the process of recycling through manufacturers effective, the consumers need to play a part to provide the material recycled and further, producer responsibility laws will need to require electronics manufacturers to provide responsible and free of charge disposal options at all stages of their products' life cycles.[151] Requiring consumers to bring back old electronics to the manufacturing recycling centers may not happen though if disposal options are not convenient or if there is a lack of education on e-waste disposal.[152] Improving these issues are goals under environmental regulation in order to decrease the long-term costs of environmental and health harm, however, regulation has a separate set of costs.[153] Not only is there a cost to implementing policies, but there are economic consequences in terms of increased unemployment and increased prices for recycling factories.[154] However, under Extender Producer Responsibility, there is an opportunity to integrate the previous informal waste pickers from developing countries into formal jobs.[155] Manufacturers can offer

149. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-10-626, CONSIDERATIONS FOR PROMOTING ENVIRONMENTALLY SOUND REUSE AND RECYCLING (2010).

150. *Id.*

151. Nick Raffaele, *IDump: How the United States Should Use Disposal Bans to Legislate Our Way Out of the Electronic Waste Crisis*, 39 WM. & MARY ENVTL. L. & POL'Y REV. 483, 485 (2015).

152. When citizens are more informed about how waste picking can affect their health and create long-term environmental effects, they can make a more educated choice on their behavior. Ida Ferrara & Ysé Serret, *Household Behaviour and the Environment Reviewing the Evidence*, ORG. FOR ECON. CO-OPERATION & DEV., at 11 (2008).

153. Environmentally-sound, end-processing technologies require a higher investment cost compared to pre-processing technologies, as well as a large amount of tonnage to operate the processes economically and a medium to high level of training to educate the workers. Christine Terada, *Recycling Electronic Wastes in Nigeria: Putting Environmental and Human Rights at Risk*, 10 NW. J. INT'L HUM. RTS. 154, 158 (2012).

154. Due to the shortfall in raw materials, recycling factories in China have suffered from incredible price hikes—eight months after the announcement of the foreign waste ban, the price of waste steel had increased by forty percent, and wastepaper by almost sixty percent. Xia, *supra* note 69, at 1153.

155. Agnes Bünemann, et. al., *EPR Toolbox: Know-how to Enable Extended Producer Responsibility for Packaging*, PREVENT WASTE ALLIANCE, 85 https://prevent-waste.net/wp-content/uploads/2020/11/PREVENT-Toolbox-interactivePDF_2020lowres.pdf (last visited Feb. 10, 2021).

formalized jobs, encouraging collectors who have been working informally to apply for jobs.[156] Though this may take away some of the incentives employees had under their informal system of waste picking, this is the tradeoff for a healthier environment and healthier citizens.

3. Assigning Responsibility Decreases Political and Economic Tensions Between Developed and Developing Countries

By having manufacturers be responsible for e-waste, the relationship between developed and developing countries through e-waste should no longer be strained. The current system of e-waste involves trade relations between developed and developing countries which creates the opportunity for increased animosity between the countries since the externalities are not distributed equally.[157] The movement of e-waste from developed to developing countries allows developed countries' citizens to benefit from the electronic products, leaving developing countries' citizens subjected to untouched piles of waste and exposure to environmental and health hazards. With developing countries already fighting back on receiving hazardous waste from developed countries,[158] developing countries may reconsider future trade agreements with developed countries, thereby putting the entire international trade economy at risk. In order to avoid this, manufacturers can take over the responsibility of e-waste, saving international trade from crumbling due to increased animosity over e-waste.

Furthermore, more electrical goods will need to be produced as more developing countries become more prosperous.[159] There will be

156. *Id.*

157. *See, e.g.*, Hannah Ellis-Petersen, *Treated Like Trash: South-East Asia Vows to Return Mountains of Rubbish from West*, The GUARDIAN (May 27, 2019), https://www.theguardian.com/environment/2019/may/28/treated-like-trash-south-east-asia-vows-to-return-mountains-of-rubbish-from-west (reporting that in May 2019, the president of the Philippines threatened to sever diplomatic ties with Canada if the government did not agree to take back 69 containers containing 1,500 tons of waste that had been exported to the Philippines in 2013 and 2014). Canada said the waste exported to the Philippines between 2013 and 2014, was a commercial transaction done without the government's consent and has been sitting in the Philippines ever since. *Id.*

158. *See supra* Part II.C.3.

159. This is already occurring with developing economies, led by China and India, accounting for nearly 90 percent of the 750 million people that went online for the first time between 2012 and 2015 according to data from the International Telecommunication Union. Press Release, United Nations, IER - New Digital Era Must Ensure Prosperity For All, United Nations Says, UNCTAD Press Release PR/2017/033 (Oct. 2, 2017).

more e-waste when more people are able to afford these technological gadgets, "which will either have shifted to a new set of developing countries or more countries will have to participate in the disposal of the trade."[160] Without manufacturer responsibility, this will only further the tensions of figuring out where the e-waste can go. Assigning manufacturers responsibility of e-waste will shift this discussion to be made between manufacturers and a country, and away from individual countries having to coordinate with each other.

As previously stated, the value of metal leftover in electronic waste can produce a substantial economic incentive to recycle the electronics.[161] While it seems like a country who experiences environmental and health harms from managing e-waste would want to avoid it, developing countries continue to accept e-waste in order to reap the economic benefits.[162] Developing countries' economic relationship with e-waste is typically represented through an informal economy.[163] While some associate an informal economy with lost revenue, unfair competition, low productivity, human rights abuses and environmental degradation, others, mostly the developing countries themselves, associate it with entrepreneurship, flexibility and resilience.[164]

Informal waste management operations achieve a net benefit while formal waste management operations have a net cost since the countries with informal systems are more oriented towards productive use of waste materials to create revenue instead of focusing on environmental and health impacts.[165] Informal recyclers with cheaper operating costs will always be willing to pay more for waste than formal recyclers' prices because their return will be higher since they are restricted by regulations.[166] Therefore, if responsibility

160. Jennifer Joines, *Globalization of E-waste and the Consequence of Development: A Case Study of China*, 2 J. SOC. JUST. 1, 12 (2012).

161. *See supra* Part II.A.

162. *Id.*

163. Benson, *supra* note 29.

164. Martha Alter Chen, *Working Paper: Rethinking the Informal Economy: Linkages with the Formal Economy and the Formal Regulatory Environment*, U.N. DEP'T ECON. & SOC. AFFAIRS, U.N. Doc. ST/ESA/2007/DWP/46 (2007).

165. Research shows that the informal sector saves the authorities money, mostly due to avoided collection and disposal costs (€14 million per year in Lima, €12 million in Cairo, and €3.4 million in Quezon City). *Id.*

166. Research in Delhi has found that informal recyclers will pay double than formal recyclers' prices for hard disks and mobile phones, and three times the amount for computer processors. Kate Lines & Ben Garside, *Innovations for Inclusivity in India's Informal E-waste Markets*, INT'L INST. FOR ENV'T & DEV. (Dec. 2014),

for e-waste is placed in the hands of developing countries, developing countries would have little incentive to switch to a formal market. By placing responsibility in the manufacturer's hand, it forces developing countries to move away from an informal market which will benefit their people and environment tremendously.[167] Additionally, if manufacturers want to outsource their recycling of e-waste, they can always employ and make agreements with developing countries to help recycle their waste, but in a sustainable manner.[168]

C. How to Hold Manufacturers Responsible through Extended Producer Responsibility

Responsibility of e-waste also cannot rest solely in the hands of manufacturing companies. Though some manufacturers have taken the initiative to voluntarily manage their products, overall, most manufacturers will need regulatory oversight to guide manufacturers into being responsible for their electronics.[169] Since international law and treaties are less enforceable, individual countries will be responsible for creating these regulations and can adopt strategies from other successful countries.[170] One successful strategy is shifting responsibility to manufacturers through Extended Producer Responsibility (EPR).

EPR essentially treats electronic equipment manufacturers as polluters who are required to take financial responsibility for the entire life cycle of their hazardous products, including the take-back, recycling and proper final disposal of their old and obsolete products.[171] Since manufacturers have the greatest influence over

pubs.iied.org/pdfs/17266IIED.pdf.

167. Work in the informal economy is either excluded from, or effectively beyond, the reach of social security schemes, safety, health, maternity and other labour protection legislation. Also, since unregistered enterprises do not pay taxes or benefits to workers, it deprives the government of public revenue which means limited ability for improvement of things like infrastructure, education and health systems. International Labour Office, International Labor Conference, Mar. 25, 2013, ILC.103/V/1, 3.

168. *See Sustainable Materials Management (SMM) Electronics Challenge*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/smm-electronics/sustainable-materials-management-smm-electronics-challenge (last visited Dec. 17, 2020).

169. *See supra* Part II.D.3.

170. This can create problems in places like the U.S. where currently there is no federal law addressing e-waste so manufacturers would be subjected to regulations on a state-by-state basis which could create inconsistent results in regulation. Cho, *supra* note 6.

171. Zelalem Tesfaye Bogale, *E-Responsibility: E-Waste, International Law and Africa's Growing Digital Wasteland*, 18 U.C. DAVIS J. INT'L L. & POL'Y 225, 242 (2011).

product decisions, EPR creates an incentive for companies to make smarter production choices since they will be responsible for the product's end result and less toxic products would be cheaper and easier for manufacturers to recycle and reuse.[172] Switzerland served as a role model in implementing EPR as it was the first country in the world to have a formal system to manage e-waste.[173] Their e-waste management system has extensive nationwide coverage, with more than 500 collection centers set up by manufacturers across the nation.[174] The presence of multiple levels of independent controls prevents free riding and helps to maintain quality and environmental standards by the recyclers, while also preventing illegal imports and exports of e-waste.[175]

One critic of EPR is that if e-waste can be cheaply disposed of abroad, like the current e-waste system, producers under EPR will choose that option.[176] Implementing a trade ban or tariff system would use domestic measures to put disposal responsibility on those receiving the waste.[177] A ban would force manufacturers to recycle the waste domestically, and if a tariff system considered the cost of proper disposal, it would incentivize producers to design products with lower hazardous content to minimize the tariff.[178] Another critic of EPR is sorting the waste by brands would create a high transaction cost and therefore decrease a manufacturer's incentive to make smarter designs impracticable.[179] This is rebutted by the fact that that costly recycling programs encourage manufacturers to privatize the program in order to decrease their cost.[180] Manufacturers recycle the products themselves if they think they can do it more efficiently than municipalities and other program actors.[181] This outcome is highly

172. "The closer the system gets to direct reuse, i.e., the perpetuation of its original purpose, the larger the cost savings should be in terms of material, labour, energy, capital and the associated externalities, such as greenhouse gas emissions, water, or toxic substances." Harald Wieser & Nina Tröger, *Exploring the Inner Loops of the Circular Economy: Replacement, Repair, and Reuse of Mobile Phones in Austria*, 172 J. OF CLEANER PROD. 3042, 3042 (2018).

173. Yamini Gupt & Samraj Sahay, *Review of Extended Producer Responsibility: A Case Study Approach*, 33 WASTE MGMT. & RS. 595, 604 (2015).

174. *Id.*

175. *Id.*

176. Chen, *supra* note 146, at 184.

177. *Id.*

178. *Id.*

179. Knee, *supra* note 148, at 172.

180. *Id.*

181. *Id.*

advantageous since with manufacturers' resources and the incentive to be efficient, manufacturers would remove program burdens from less willing and less capable actors and place them onto manufacturers with a large stake in the program's efficiency.[182]

IV. CONCLUSION

The current management of electronic waste is unsustainable and creates a toxic environment in vulnerable countries who accept the e-waste due to relaxed environmental regulation. The international community has attempted to fix this problem, however the lack of enforcement of international policies makes it easy for countries to avoid their obligations to make electronic disposal safe for others. While individual countries attempted to address the lack of international efforts by creating legislation on e-waste regulation, the limited laws passed allows manufacturers to avoid responsibility for e-waste. Rather than developed or developing countries being solely responsible for e-waste, implementing Extended Producer Responsibility will allow manufacturers to effectively manage e-waste. Assigning e-waste management to manufacturers allows the world to keep its dependency on electronics, while making sure the disposal of those electronics is done in the safest way possible.

182. *Id.*