E-waste management in emerging markets[1]

Gestión de desechos electrónicos en mercados emergentes

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ABSTRACT

A serious, yet often overlooked environmental danger, E-waste has long been considered an "exportable" problem and wealthier nations have shipped their end of life electronics to poorer parts of the world for decades, ignoring the environmental disasters created and countless lives affected in massive dump sites and informal processing sites in Asia, Africa and South America. Emerging economies such as China, India and Brazil have long represented the final destination for the world's E-waste. Things are however beginning to change as the short term and long term dangers of improperly disposed of electronic waste are starting to become more apparent. This study focuses on the three aforementioned countries and their strategies for combating the E-waste problem. The purpose of this study is to identify the trends and challenges emerging economies face when dealing with the growing global problem of Electronic waste as well as to assess their response both at a national and local level

Keywords: E-waste, Electronic waste, formal recycling, informal recycling, environmental pollution, management.

1 Artículo de investigación

RESUMEN

Un peligro ambiental grave, pero a menudo pasado por alto, son los desechos electrónicos. Estos se han considerado durante mucho tiempo un problema "exportable" y las naciones más ricas han enviado sus productos electrónicos al final de su vida útil a las partes más pobres del mundo durante décadas, ignorando los desastres ambientales creados y las innumerables vidas afectadas en vertederos masivos y sitios de procesamiento informal en Asia, África y América del Sur. Las economías emergentes como China, India y Brasil han representado durante mucho tiempo el destino final de los desechos electrónicos del mundo. Sin embargo, las cosas están comenzando a cambiar a medida que los peligros a corto y largo plazo de la eliminación inadecuada de desechos electrónicos comienzan a ser más evidentes. Este estudio se centra en los tres países mencionados y sus estrategias para combatir el problema de los desechos electrónicos. El propósito de este estudio es identificar las tendencias y los desafíos que enfrentan las economías emergentes cuando se enfrentan al creciente problema global de los desechos electrónicos, así como evaluar su respuesta tanto a nivel nacional como local.

Palabras clave: E-waste, basura electrónica, reciclaje formal, reciclaje informal, contaminación ambiental, administración.

INTRODUCTION

Electronic waste represents a growing environmental problem as consumer electronics become an integral part of daily life around the world. E-waste as it is often referred to, impacts emerging economies disproportionately with adverse effects on society and the health of individuals. And as demand for consumer electronics increases, coupled with a shorter life cycle and low reparability for such products, the problem of E-waste will keep getting bigger. According to the UN's Global E-waste Monitor 2020, electronic waste now represents the fastest growing domestic waste stream (The Global E-waste Monitor, 2020). Due to the complexity of modern electronic equipment and the wide range of materials and technologies used in such products, recycling often proves to be a difficult and costly endeavor with a high environmental cost. In 2019, 53.6 million metric tons of E-waste were generated globally while only 17.4% of those were properly accounted for, collected and recycled (The Global E-waste Monitor, 2020). Unfortunately, the vast majority of e-waste ends

up being shipped illegally from wealthier nations to poorer countries where all materials that can be reused are extracted in makeshift dumps, often directly by burning the electronic devices or using acid bathing. (Abalansa, et. al. 2021). These crude methods are a major source of environmental pollution and pose significant short term and long-term risks for the workers in illegal recycling centers as well as for the members of the surrounding communities and the environment. When improperly disposed of, potential pollutants found in electronic waste - Lead, Cadmium, Mercury, Polyvinyl Chloride and others can cause severe illness such as numerous types of cancers and brain damage (Annamalai, 2015). A study conducted in Guiyu, China, once home of the largest informal E-waste recycling site in the world found that 81% of the children in the city had elevated levels of lead in their blood (Huo, et.al. 2007). And while a massive cleanup operation started in 2013 and most informal e-waste recycling workshops were shut down by 2017, much of the area is still contaminated with dangerous chemicals to this day. The global E-waste problem is often ignored by governments, as it is considered a less pressing environmental issue. However, by disproportionately affecting emerging markets and poorer nations and with no predictable end in sight, electronic waste remains a significant risk for human life and the environment in nations which are often incapable of mitigating its harmful effects.

THEORETICAL FRAMEWORK

NEGATIVE IMPACT OF E-WASTE POLLUTANTS

Improper disposal of E-waste and its informal recycling is associated with serious adverse effects on human health, both short and long term. Employment opportunities in illegal dump sites attract many workers in poorer nations. Though often aware of the risks involved, poverty forces many to work as dismantlers and burners (the people who burn dismantled electronic devices in order to extract valuable metals). A 2020 study by Amoabeng Nti et. al. found that the elevated levels of particulate matter in Agbogbloshie, Accra, Ghana, the world's largest illegal E-waste dump site was directly correlated with reduced lung function and placed the workers at significant risk of developing chronic obstructive pulmonary disease (Amoabeng Nti et. al. 2020). Unfortunately, as large illegal E-waste dump sites tend to attract a large number of workers, entire communities form around them. And these communities often include a large number of children and pregnant women. Many studies have concluded that pre-natal exposure to heavy metals and other pollutants found at illegal dump sites have a negative impact on fetal development, birth

outcomes and children. A 2018 study conducted at Guiyu, China by Liu et. al. found that children at the dump site had lower cognitive scores that those in the control group and the significantly higher levels of Lead and Cadmium found in their blood was negatively correlated with both cognitive and language scores. (Liu, et. al. 2018). Another study conducted on children living in a village in North Vietnam where E-waste is informally processed found that the higher levels of heavy metals discovered in their blood was associated with DNA damage and potential long term adverse health effects (Ngo, et. al. 2020).

E-WASTE STATISTICS AND TRENDS IN EMERGING MARKETS

China, India and Brazil are leading emerging economies and were chosen for analysis for their similarities regarding the E-waste problem. All three are major producers of electronic waste and have been or continue to be (in the case of India and Brazil), the final destination for electronic waste shipped illegally from wealthier nations which is being processed in most part in informal settings. As the economies of the three nations develop, the domestic use of electronic devices of all types increases and so does the pressure on policy makers to enact legislation aimed at mitigating the problem of a growing amount of electronic waste.

CHINA

The biggest emerging market by GDP is also the world's largest generator of E-waste with more than 10 million tons in 2019. And while the country has been the final destination for electronic waste of the world for the past couple of decades, Chinese authorities have set in place a ban for all solid waste imports which came into effect January 1 2021. The import ban has stopped the flow of E-waste into China from other countries thus allowing the nation to focus its efforts on its own growing electronic waste problem. By implementing legislation that regulates collection and treatment of fourteen types of e-waste (televisions, refrigerators, washing machines, air conditioners, personal computers, range hoods, electric water-heaters, gas water- heaters, fax machines, mobile phones, single-machine telephones, printers, copiers, and monitors), China aims to streamline its E-waste management system allowing it to take advantage of the circular economy and recycle as much of the $23.8 billion USD by 2030 in metals retrievable from e-waste according to Greenpeace East Asia (Greenpeace East Asia 2019). And while the informal E-waste recycling sector has declined dramatically in recent years due to strict governmental control, China still struggles to formally

recycle most of its electronic waste with only 15% of it being officially and legally recycled each year.

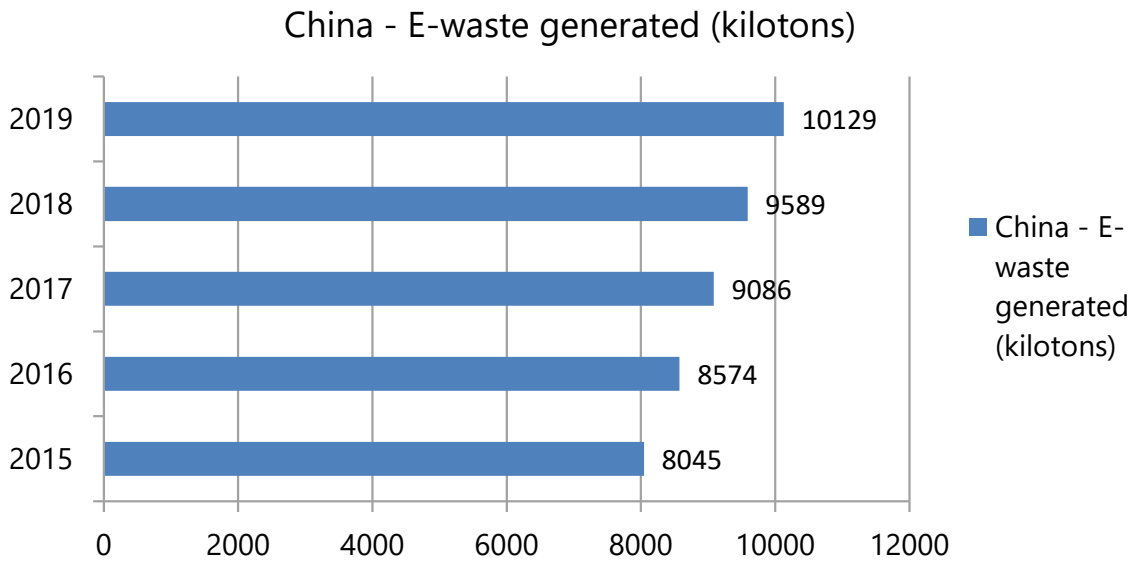

Table 1. Recent trend in E-waste generated in China
Source: data gathered from The Global E-waste Statistics Partnership

INDIA

India is the world's third largest generator of electronic waste, with 3.23 million tons worth. However, as opposed to China, where measures have been taken to curb the informal recycling business, in India, things are not showing signs of quick improvement as over 90% of the country's electronic waste is still being processed in informal settings (R. Turaga et. al 2019). And while the country has passed legislation regarding E-waste management in 2012, with further amendments being added in 2016, little has changed in practice as the laws are rarely enforced and roadside E-waste dumps filled with smoldering electronic parts are still a common site in many places around the country. Compliance is difficult to enforce as the informal recycling sector in India is in direct competition with the formal one when it comes to attracting waste and laborers.

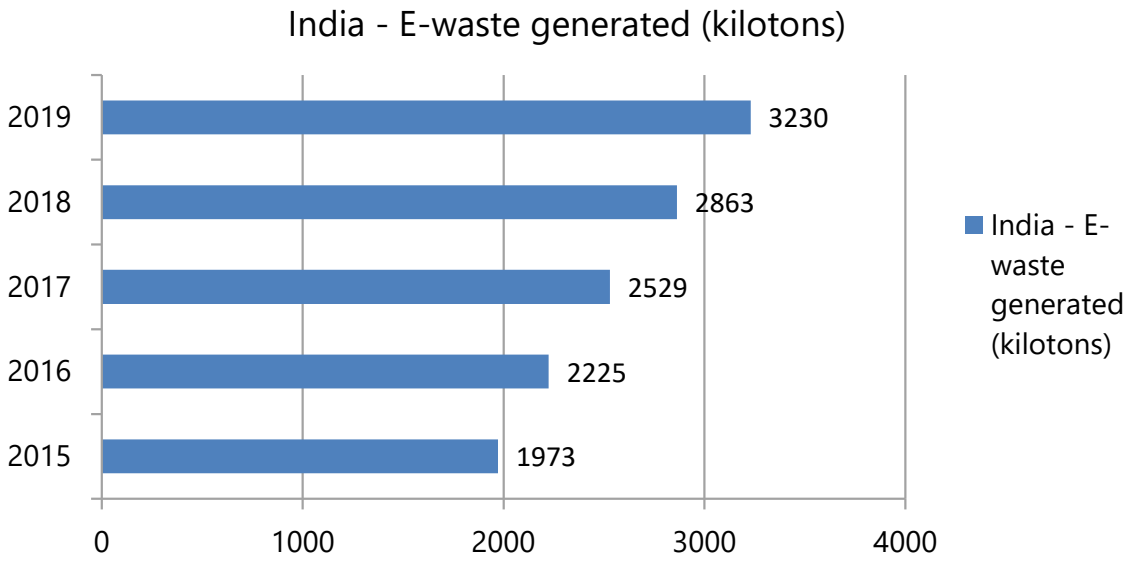

Table 2. Recent trend in E-waste generated in India
Source: data gathered from The Global E-waste Statistics Partnership

BRAZIL

Brazil, the largest producer of E-waste in Latin America with 2.14 million tons in 2019 is also the final destination for illegal exports of electronic waste from other countries (Souza, 2020). The country is however on the right track when it comes to tackling electronic waste. Federal Decree No. 10,240/20 establishes obligations shared by producers, importers, distributors and traders for recycling household electronic waste. Various NGOs are also active in the field with ABREE - Associação Brasileira de Reciclagem de Eletroeletrônicos e Eletrodomésticos playing a crucial role in promoting and aiding in the proper disposal of household electronic waste. The organization together with its 29 associates representing 96 brands which corresponds to around 85% of the Brazilian market now operates over 1200 E-waste collection points.

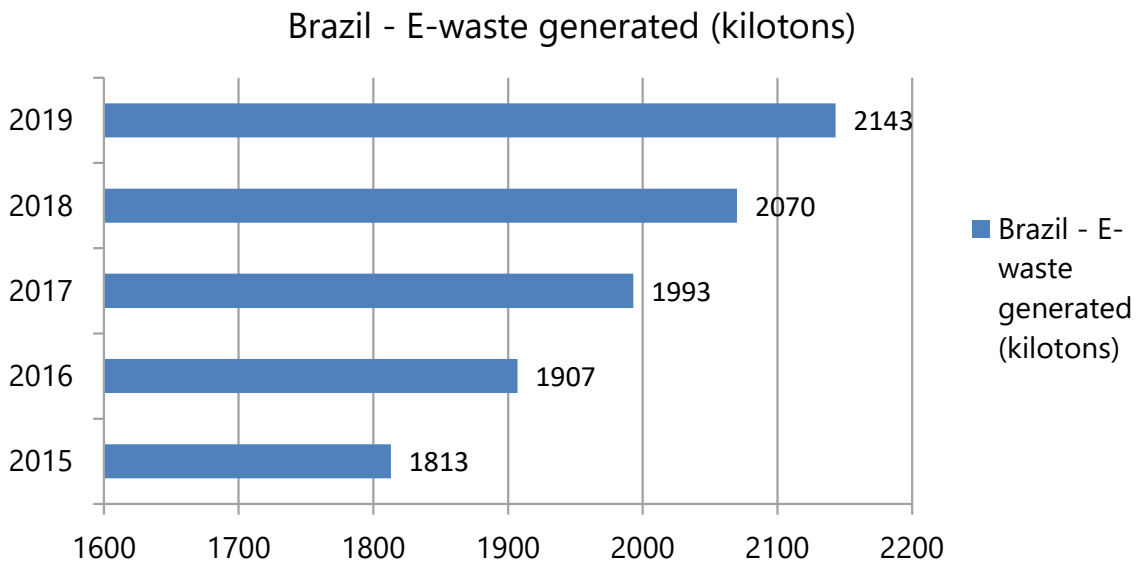

Table 3. Recent trend in E-waste generated in Brazil
Source: data gathered from The Global E-waste Statistics Partnership

METHODOLOGY

A qualitative research method was employed to assess measures and policies that address the problem of electronic waste in emerging economies. We conceptualized a modified framework based on the DPSIR framework (drivers – pressures – state – impact – response) developed by Edith Smeets, Rob Weterings, PeterBosch, Martin Büchele and David Gee. The DPSIR framework has been widely adopted by international organizations such as the European Environment Agency, the Food and Agriculture organization of the United Nations, the United Nations Environment Programme and the Organization of Economic Cooperation and Development due to its capability to provide comprehensive courses of action for combating the negative effects of complex socio – environmental issues. We adapted the DPSIR model to the particularities of E-waste. Unlike many other sources of pollution, E-waste often originates in very different parts of the world. As such, we distinguish between internal and external drivers. E-waste is also a very localized problem, which disproportionately affects a small area. The problem is often ignored at a national level while regional governing bodies are more likely to enact mitigation measures. Our model distinguishes between national and local response.

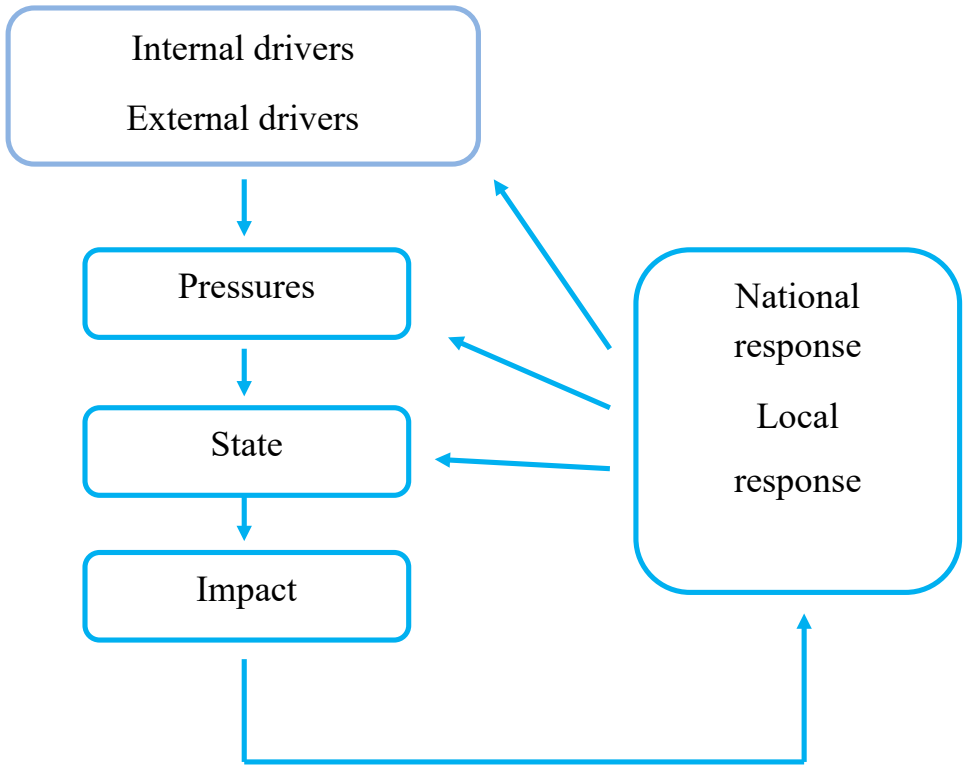

Figure 1. Modified DPSIR model
Source: own work

STUDY AREAS

China, India and Brazil are leading emerging economies and were chosen for analysis for their similarities regarding the E-waste problem. All three are major producers of electronic waste and have been or continue to be (in the case of India and Brazil), the final destination for electronic waste shipped illegally from wealthier nations which is being processed in most part in informal settings. As the economies of the three nations develop, the domestic use of electronic devices of all types increases and so does the pressure on policy makers to enact legislation aimed at mitigating the problem of a growing amount of electronic waste.

DATA COLLECTION

Data was collected via search queries using Google and Google Scholar in order to obtain relevant information that would aid in a comprehensive assessment of all aspects of the modified DPSIR

model. Besides peer reviewed publications, we considered the inclusion of grey literature as well as journalistic sources to be extremely important, as the latter often pain a realistic picture of the realities on the ground as they occur in real time. Example of the search queries used in Google scholar and the number of results can be found below:

- China E-waste – 43.100 results
- India E-waste – 23.700 results
- Brazil E-waste – 9.340 results
- China E-waste policy – 26.400 results
- India E-waste policy – 17.800 results
- Brazil E-waste policy – 7.290 results

A systemic approach was implemented to extract relevant data as it relates to the drivers, pressures, state, impact and response to matters concerning E-waste in the study areas.

RESULTS

- Internal drivers

CHINA

China's rapid economic development and large population make it the biggest consumer of electronic goods in the world. In 2019, 249.253 million USD of electronics were sold in China, nearly double the amount sold in the United States, the country that came in second place (Statia - Revenue of the consumer electronics market worldwide by country in 2019). In 2019, every Chinese citizen generated on average 7.2 kg of E-waste, up from 6.9 kg in the previous year (Globalwaste).

INDIA

India, with its large population and sprawling IT sector, is the third largest market for electronic good, trailing China and the United States. 2019 saw 48.197 million USD worth of electronics sold in the country (Statia - Revenue of the consumer electronics market worldwide by country in 2019). The E-waste generated per capita by Indian citizens in 2019 was on average 2.4 kg, up from 2.2 in 2018 (Globalwaste).

BRAZIL

Brazil, the mous populous country in Latin America is the world's fourth largest consumer of electronics with 48.014 million USD of devices being purchased in 2019 (Statia - Revenue of the consumer electronics market worldwide by country in 2019). In 2019, it generated 10.2 kg of E-waste per capita, up from 9.9 kg in 2018 (Globalwaste).

- External drivers

CHINA

Instated at the end of 2017, China's waste import ban practically ended the inflow of electronic waste into the country. The ban sent shockwaves across the global recycling industry with China previously representing the biggest destination for numerous types of waste, much of which was represented by E-waste (Brooks et. al. 2018).

INDIA

India represents a final destination for a lot of foreign E-waste which is often introduced illegally into the country. The informal recycling sector is a thriving business in the country, with nearly 95% of electronics being processed at illegal sites (Recycling of e-waste in India and its potential 2019).

BRAZIL

Brazil continues to be an attractive destination for illegal shipments of electronic waste. Regarding illegal E-waste shipments bound for Brazil, Ana Angélica Alabarce, head of Ibama's Technical Unit in Santos stated in an interview published in April 2021 by the Brazilian newspaper CartaCapital that "The African continent has always been the target of these traders. Mainly, as an electronic waste deposit. Now, they are turning to Brazil" (Carta Capital)

PRESSURES

The pressures that emanate from E-waste, and especially E-waste that is not properly processed (the vast majority) are not unique to any country or region in the world. Pollutants from improperly handled E-waste have long term negative consequences on the environment and human health while also representing a burden for national healthcare systems well into the future. According to a study published in the Lancet by Kristen Grant and colleagues, there is a significant correlation between exposure to pollutants found in electronic waste and spontaneous abortions, reduced birthweight and DNA damage (Grant et. al. 2013).

STATE

Electronic waste is a major cause of environmental pollution. As in the case of affected humans, the effects are both short term and long term. A 2014 study conducted by the Indian environmental research and advocacy organization Toxic Links at Loni and Mandoli, two areas in the Indian state of Uttar Pradesh known for their status as informal E-waste processing sites revealed high levels of contaminations with heavy metals in both the soil and water samples analyzed. When compared to the control sample of soil, the levels of zinc and chromium were six times higher in the Mandoli area while the highest level of lead found in a sample was 102 times higher (Sinha et. al. 2014). A 2004 study conducted at the notorious Guiyu illegal processing site in China discovered Polybrominated diphenyl ethers level in the air were almost 100 times higher than normal levels (Deng et. al. 2007).

IMPACT

The overall impact of electronic waste on the environment, human health and the economy ranks it amongst one of the most important, if often ignored sources of pollution on Earth. Proper recycling however can yield impressive results, recover precious and sometimes difficult to find materials as well as reduce pollution. Ferrous and non-ferrous metals can be recovered and reused, as well as glass that is often reused as part of asphalt mixes and other construction materials. China, India and Brazil lag behind other nations when it comes to recycling and reusing electronic waste.

RESPONSE

NATIONAL RESPONSE IN CHINA

After a long time as the final destination for numerous types of waste from across the world, China has decided to put an end to its undesirable status by enacting a waste impost ban which covers a large number of solid waste products, including plastics and electronic waste materials. The laws governing solid waste have been revised in 2020, making them even stricter and stetting bigger penalties for noncompliance. The new regulations require waste generator to implement solid waste management systems along with instruments to facilitate the traceability of such waste (The National Law Review, 2020).

REGIONAL RESPONSE IN CHINA

With drastic measures put in place at national level, previously enacted regional laws such as the 2006 Zhejiang Solid Waste Pollution Prevention and Control Regulations and the Hong Kong Product Eco-Responsibility (Regulated Electrical Equipment) Regulation, L.N. 143, became obsolete.

NATIONAL RESPONSE IN INDIA

Indian legislation regarding waste in general and electronic waste in particular is lax, provides numerous loopholes and is rarely enforced (Chaudhary 2018). The Ministry of Environment, Forest and Climate Change of India enacted a set of E-waste management rules in 2016. In theory, the rules make it difficult for informal E-waste processers to operate and try to channelize E-waste processing towards the formal recycling sector. However, anecdotal evidence suggests that the enacted set of rules have made little impact on the informal E-waste recycling sector.

REGIONAL RESPONSE IN INDIA

The South Delhi Municipal Corporation has partnered with a private corporation in order to develop an online E-waste disposal platform. The partnership ensures that all electronic equipment gathered following collection requests received on the platform will be properly recycled (Livemint). Two NGOs from Bangalore, Saahas and Environmental Synergies in Development have launched the bE-Responsible initiative, aimed at aiding citizens to properly dispose of electronic waste. According to their website, the initiative has so far collected and properly disposed of 108 tons of E-waste, has prevented 643 kg of toxic metals from ending up in landfills and has recovered 7561 kg of metals.

NATIONAL RESPONSE IN BRAZIL

The National Solid Waste Policy enacted by Brazil in 2010 laid the groundwork for municipal and state governments to manage waste flows with an emphasis on recycling and reusing materials when possible. However, legislation aimed specifically at electronic waste came in the form of Federal Decree No. 10,240/20 which establishes obligations shared by producers, importers, distributors and traders for recycling household electronic waste (Santos 2020).

REGIONAL RESPONSE IN BRAZIL

Numerous regional and local laws and regulations are in effect in various regions and municipalities in Brazil:

- Sao Paulo Recycling, Management and Disposal of E-Waste, Law 13576/2009
- Sao Paulo Licensing for Waste Management Facilities in Reverse Logistics Systems, Decision 120/2016/C
- Santos Collection and Disposal of Waste Electronic Equipment, Act No. 2.712, 2010
- Rio Grande do Sul Solid Waste Policy, Law No. 14528/2014
- Manaus Management of Waste Electronic Equipment (WEEE), Law No. 1705/2012
- Espirito Santo Takeback and Recycling of Products Containing Heavy Metals, Law 9163/2009
- City of Lins Collection, Reuse and Recycling of Electronic Waste, Law 5332/2010

CONCLUSIONS AND DISCUSSION

Electronic waste is an often ignored global problem that disproportionately affects emerging markets and poorer countries around the world. Technological advance and the world's growing dependency on electronic devices will only result in more E-waste being produced in the future. The three countries analyzed in this study are powerful global economies but only two of them, China and Brazil seem preoccupied to mitigate the harmful effects of E-waste, especially when it

is being illegally imported into their countries and processed in an illicit manner. China seems to have made the biggest progress, not only by passing and enforcing strong legislation but also by cleaning up its former informal dump sites, which have hosted the world's scrap electronics for years. The Brazilian authorities are also acting on the matter with many municipalities taking things into their own hands and not entirely relying on a single national policy. India is lagging behind, with a lot of E-waste still being imported from abroad by taking advantage of lax regulations and legal loopholes. The informal recycling sector is still thriving in the country, with no indication that things will change for the better in the near future. Ever since the Chinese solid waste import ban has been enacted, the ever growing problem of global E-waste is trying to find new homes, mainly in poor countries where lack of regulations, corruption, poverty and inaction will allow it to harm countless lives. Wealthier nations, preoccupied as they are by environmental issues, should start realizing that Earth is a planetary ecosystem and exporting an environmental problem doesn't mean it goes away.

We strongly suggest that emerging economies take strong and rapid action to stop the influx of E-waste into their countries as well as set up comprehensive measures and policies to aid in the proper recycling and reusing of electronic waste, a strategy that is sure to bring along numerous benefits in a world ever more dependent on finite and difficult to obtain resources.

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