**Policy Approaches on E-Waste in the Emerging Economies:
A Review of the Existing Governance with Special Reference to
India and South Africa**

Abstract

The stream of E-waste has observed a considerable intensification in the recent decade rendering its management a major challenge to the contemporary world. Considering the complexities associated with this toxic stream of waste, this paper is an attempt to review the existing E-waste governance in the emerging economies, taking into consideration the evidence and experiences of a number of representative countries. Emerging economies are instrumental in the growth and sustenance of the global economy today. However, certain issues such as the governance of E-waste is yet to be studied adequately in these countries and still remains an unexplored area of research. The BRICS (Brazil, Russia, India, China and South Africa) nations along with South Korea, Taiwan, Indonesia, Turkey, Mexico are considered as representatives of the emerging countries. A systematic literature search has been carried out in Scopus and Web of Science to aid our study. A bibliometric analysis was carried out to situate the research scenario in India and South Africa in particular. We observe that the European Union's landmark WEEE Directive and RoHS Directive have considerable influence on the policies of most of the emerging economies considered for our study purpose. We argue that it is imperative to have a local specific, systematic, organize and stepwise approach towards formulating and implementing the E-waste policies in the respective countries. The fact that, a few representatives from the well-known emerging economies are underrepresented in the E-waste research necessitates adequate attention from the scientific community and policymakers. Overall, it could be concluded that, barring a handful of representative countries, E-waste governance in the emerging economies are yet to be addressed comprehensively both by themselves and the global North.

Keywords: E-waste; Governance; Emerging Economies; Policy; BRICS; Global South

1. Introduction

Electronic waste (E-waste) or waste electrical and electronic equipments (WEEE) is a major pollution concern in the contemporary global environment. According to the estimates by the United Nations University, 44.7 million tonnes of E-waste was generated in the year 2016 alone with a potential for further 17% growth to 52.2 million tonnes by the year 2021 (Baldé, Forti et al. 2017). Such unparalleled growth, particularly during the last two decades, could be attributed to a number of factors such as: 1) rapid technological advancements and innovations, 2) increasing versatility and consumer dependence on electronic equipments, 3) economic growth, 4) strong encouragements for increasing consumption, 5) the descending trend in prices for most electrical and electronic equipments (EEEs), 6) a drastically reduced lifespan of the EEEs among many other such aspects (Borthakur and Govind 2017). Although once widely considered as a problem predominant in the developed economies, E-waste is no longer a concern of the so-called affluent countries alone. The emerging economies and developing countries are in urgent need of workplans and policy interventions to address their ever-increasing E-waste volume and subsequent management crisis. For instance, the East Asian region, especially China, South Korea, Japan and Taiwan, is not only a major consumer of home EEEs, but also has a substantial global share in the production and export of electronic equipments (Lee and Na 2010). In India, another emerging economy from Asia and a major global power, the compound annual growth rate (CAGR) of E-waste is estimated to be 26% with an approximately 10% contribution to the global E-waste generation (Ravindra and Mor 2019). The export of E-waste to these countries by the developed world, widely known as the ‘toxic trade’ of E-waste, further complicates the problem of sustainable E-waste management. Accordingly, it has become increasingly essential to address the E-waste in the emerging economies from its roots so that effective policy and management strategies could be devised and implemented.

Before focussing exclusively on E-waste in the emerging economies, it is imperative to establish the significance of these countries in the present-day world. Today, the emerging economies include one third of the world’s largest twenty-five economies which are crucial for the success of the overall global economy (Xiao, Califf et al. 2013). In the recent past, the emerging economies experienced a much faster growth rate as compared to the developed economies, which resulted in a substantial increase of their share in total foreign direct investment, international

financial markets and world Gross Domestic Product (GDP) in international trade (Radulescu, Panait et al. 2014). The decade from 2001 to 2010 had observed numerous emerging economies experiencing unprecedented growth simultaneously in terms of urbanization and GDP per capita (Rafiq, Salim et al. 2016). Particularly, the Eastern and Southern Asian countries are rising rapidly along with Latin America and Africa bringing new market potentials (Loser 2009). For instance, during the last two decades, China and India experienced remarkable growth and established themselves as two Asian emerging economies which could be drivers of growth in the global South (Banga 2014). The European Commission reports that considering their escalating market potentials and increasing labour force, the emerging economies are anticipated to continue with their growth rather fast¹. Moreover 40% of the global middle-class population today resides in China, India, Russia and Brazil², rendering the emerging world significant in the international arena during the coming decades where an ever-increasing flow of investment and trade is ensured (Loser 2009). The issue of E-waste is a direct repercussion of the growth in the consumer market where, among other commodities, more and more electronic products are being manufactured and traded. The concerns associated with E-waste has already started arising with this market growth in the emerging countries and will continue to be a major cause of concern in the near future.

The international commerce together with aspects such as depletion of resources had enforced the E-waste policies/legislation to be altered in several countries (Zlamparet, Ijomah et al. 2017) including in the emerging economies. The E-waste disposal is no longer a concern limited to a single country and thus, needs to be considered as a regional issue, for instance, in the East Asia (Lee and Na 2010). Authors Peng, Tu et al. (2018) argue that efficacious execution of a well-operating E-waste management system necessitates close coordination, collaboration, information sharing, knowledge transfer and conviction among all the actors in the formal and informal sector engaged in the E-waste supply chain structure. At present, the success of the informal E-waste collectors over the formal collectors in the emerging economies could be attributed to the fact that the informal collectors often offer more flexibility, convenience, accessibility and even financial incentives for the E-waste collected (Otto, Kibbe et al. 2018). The formal sector needs to take clue

¹ See: https://ec.europa.eu/knowledge4policy/foresight/topic/growing-consumerism/developing-countries-emerging-markets_en

² *ibid*

from the functioning of the informal sector and there should be greater collaboration between both the sectors for effective E-waste management. Further, there is a dearth of information on the accurate amount of E-waste generated in the emerging economies. A dependable estimation of generation of E-waste is central to the waste management service providers and policymakers to devise a solution to the problem (Araújo, Magrini et al. 2012). Moreover, an appropriate insight of the factors that stimulate pro-recycling behaviours aids in significant understanding for policy-making processes and assists in recognizing the vital touch-points that corporations, governments and grassroots initiatives could explore to address the environmental burdens more successfully (Echegaray and Hansstein 2017). Thus, consumption, disposal behaviour and awareness of the general public should be provided due attention as those attributes are central to any effective E-waste management initiative (Borthakur and Govind 2018).

Considering the complexities associated with the E-waste stream, in this paper, we attempt to review the existing E-waste governance in the emerging economies taking into consideration a number of representative countries. The BRICS (Brazil, Russia, India, China and South Africa) nations along with South Korea, Taiwan, Indonesia, Turkey, Mexico are considered as major representatives of the emerging countries. Further, we particularly focus on India and South Africa, the two BRICS nations, whose E-waste policy initiatives are still at an initial stage and yet to be assessed adequately. We attempt to problematize the E-waste policy concerns in the emerging economies through queries such as: what are the policy approaches currently in place in the emerging economies? How effective these policy responses have been in solving the E-waste problem in a particular country? Is there any difference in the E-waste policy approaches ‘within’ these countries, considering the somewhat similar growth trajectories of these nations which classify them as ‘emerging economies’? We especially focus on the legislative and regulatory measures that are in place in the emerging economies which are indispensable for ensuring effective and responsible E-waste management.

The paper has subsequently been divided into the following sections: Section 2 addresses the context of the study and the methodology involved. Here we described our methods for the search and analysis of relevant literature. We also rationalized our special focus on India and South Africa in this particular section. Section 3 analyses the E-waste governance in the emerging economies taking into consideration the instances of China, Brazil, Russia, South Korea, Indonesia, Taiwan,

Turkey and Mexico. As two countries with relatively lesser attention to their E-waste crisis, section 4 particularly focusses on India and South Africa's E-waste governance. While Section 5 discusses the experiences of these ten countries on E-waste policies from the emerging world in detail, Section 6 concludes the findings of the study.

2. Context of the Study and Methodology

Although research on 'E-waste' has observed considerable growth during the past few years, there are a dearth of studies on 'governance' of this specific category of waste. Till now, majority of the studies on E-waste focus on microbial/chemical analysis, recycling, pollution aspects, health impact research, lifecycle assessment and so on (Borthakur and Govind 2017). While research on the policy approaches to address this toxic category of waste takes a backseat, the whole idea of finding solutions for sustainable E-waste management looks impracticable. Further, the available policy studies of E-waste are limited to a few developed countries who serve as a kind of 'benchmark' in E-waste policymaking for developing and emerging countries. The existing policy situation in the emerging economies, which are major centres for market activities in the world today, are largely ignored. Through this study we particularly aim to address this gap in research. We argue that only through addressing such gaps, comprehensive E-waste management could be achieved both at the local and global level.

2.1.Search for Literature and Analysis

2.1.1. Data collection

We began the study by carrying out a systematic literature search in Scopus and Web of Science (WoS) through selected keywords. The keywords identified for the purpose of the study included: 'electronic waste' or 'E-waste' or 'waste electrical and electronic equipment' in the field of 'article title/abstract/keywords' in Scopus and in the field of 'topic' in WoS (which includes article titles, abstracts and keywords). It is important to use a few umbrella keywords in order to ensure a comprehensive search result. All the keywords were separated by an 'OR' for further inclusivity. There are provisions in both Scopus and WoS to narrow down the research results. For instance, both the databases have in-built provisions to classify the research results country-, year- or subject-wise which helps us locate the research papers of our interest. Scopus currently indexes

content from 24,600 active titles and 5,000 publishers, while the WoS covers 8,500 journals across disciplines. It could be expected that, together, these two databases cover most of the peer-reviewed publications on our topic interest. Our search resulted in a total number of 6,226 articles in Scopus and 4,361 articles in WoS (as of August 2019). This includes all the articles published on E-waste which are indexed in these two databases. Based on this overall finding, Figure 1 (Top 10 Countries on E-waste Research in Scopus) has been formulated. The reason behind the greater focus on ‘Scopus’ for constructing the figures throughout the manuscript is that Scopus has a much wider coverage than WoS. Figure 1 shows the top 10 E-waste research producing countries in the world. China, India and Brazil are the representatives from the emerging economies among the top 10 E-waste research producing countries. The research interest of China on the topic is both encouraging and constructive. The available literature illustrates that the emerging economies and developing countries are challenged with both massive volume and management concerns of E-waste. Considering this, more attention from the emerging world is required on this category of waste.

As a part of our literature search, we particularly focussed on the papers that address policies and governance of E-waste. Thus, the original search result was narrowed down to have a look at the policy-relevant articles by using additional keywords such as ‘policy’ and ‘governance’ along with ‘electronic waste’ or ‘E-waste’ or ‘waste electrical and electronic equipment’. After the initial narrowing down of the policy-relevant articles overall, we further organized ‘country-wise’ the original search results in order to concentrate on the countries that we are specifically interested in. Considering the in-built commands already available in these two databases for such classification, it was not a tedious task. Once we segregated the results country-wise, we scrutinized the individual papers (primarily based on their ‘titles’). Apart from China, which has produced over 1500 articles in Scopus-indexed journals, other emerging countries are not producing many research articles on the topic. This made having a look at the individual papers for a particular country and selecting the ones to be considered for this study not exhausting.

Figure 1: Top 10 Countries on E-waste Research

Source: Scopus, 2019

2.1.2. Data Analysis

Once the literatures are shortlisted, an in-depth ‘content analysis’ has been performed to review the existing scenario of E-waste governance in the emerging economies. As a decidedly flexible technique driven either theoretically or empirically, content analysis could be used in the context of an extensive diversity of data sources ranging from textual data and visual stimuli to audio data (Stemler 2015). In this paper, textual data or written texts have been used as the data source for the subsequent content analysis. In the context of content analysis of textual data, Chu (2015: 39) states, “Content analysis, as a research method, features systematic and objective analysis of text data. The unit of analysis in this method usually consists of passages (e.g., words, sentences, and paragraphs)”. Thus, once we classified the articles country-wise, we individually went through each of the article for every country of our interest in order to locate the articles dealing with E-waste ‘policy’ approaches. This was done by considering the titles of the articles and reading the abstract wherever found essential. This was followed by the content analysis of the written text of all the shortlisted relevant articles. As a major part of the emerging economies and due to their significance in the global economy, BRICS nations (Brazil, Russia, India, China

and South Africa) have been one of our major focuses of attention. Analysing the E-waste policies of the BRICS countries are not only vital to these respective countries alone but also have the potential to influence the global policy processes. In the current world, the BRICS group exerts great influence, with the World Bank estimating that the BRICS countries accounts for about 42% of the total world population, incorporates over 30% of the world land coverage, and contributes over 20% of the gross world product (Shen, Shuai et al. 2017). Apart from these five countries, South Korea, Indonesia, Taiwan, Turkey and Mexico were our focus countries as representatives of the emerging world. The purpose of selecting these countries is to provide a comprehensive overview on the E-waste governance scenario in the emerging economies across continents. We believe that together, these ten major representative and indicative countries from the emerging market economies have the potential to provide substantial insights on the current E-waste governance approaches and possible way forwards.

2.2.Why India and South Africa in particular?

There a number of reasons for providing special attention to India and South Africa. Firstly, research on E-waste management and policy has primarily focused on certain geographical areas. For instance, although India shares almost similar anxieties associated with E-waste as that of China, the research and policy attention on the country are still inadequate (Borthakur and Singh 2017). South Africa, unfortunately, has received almost no attention although it is considered one of the rapidly emerging markets. This is evident from Figures 2-5. While India still has observed a near-constant growth in E-waste research (Fig. 2) producing 94 research articles on the topic in 2018, South Africa (Fig. 4) has produced maximum 11 articles in one individual year. Considering the rapid intensification of the E-waste problem, the universities in both the countries are yet to focus adequately on the topic. For instance, as compared to the research institutes/universities in China, India's attention on the topic looks largely deficient. The Chinese Academy of Sciences in China alone produced more than 500 research publications on E-waste during the last decades (Scopus, 2019). The research institutes and universities in both India and South Africa are far behind in this context, although all three countries are representatives of emerging economies with a sizable market to influence the global E-waste stream. Secondly, approaches towards E-waste

management and policies in India and South Africa are very recent which makes a review and assessment of the current scenario interesting and has the potential to provide important insights.

Figure 2: Year-wise Distribution of E-waste Research in India from 2004 to 2018

Source: Scopus, 2019

Figure 3: Affiliation-wise Distribution of E-waste Research in India from 2004 to 2018

Source: Scopus, 2019

Figure 4: Year-wise Distribution of E-waste Research in South Africa from 2006* to 2018

Source: Scopus, 2019

Figure 5: Affiliation-wise Distribution of E-waste Research in India from 2006* to 2018

Source: Scopus, 2019

*The first paper on E-waste from South Africa was recorded in the year 2006 in Scopus while in India, it was recorded in 2004.

3. E-waste Governance in the Emerging Economies

3.1.China

The People's Republic of China is one of the leading E-waste producing countries in the world with a projected 15.5 and 28.4 million tonnes to be produced in the year 2020 and 2030 respectively (Qu, Wang et al. 2019). For quite a few years, the government of China has been conscious about the environmental concerns associated with E-waste and consequently, had issued a range of environmental regulations, standards, laws, practical norms and guidance connected with the production of electronic equipments and management of E-waste (Yu, Williams et al. 2010). Especially during the past two decades, the environmental and human health impacting properties of E-waste had encouraged China to ratify and execute a series of legislation and policies (Guo, Wang et al. 2018). The country's primary inspiration behind their current E-waste legislation has been motivated by the economic considerations accompanying the reuse of secondary materials and recycling of obsolete electronics in addition to the harmful constituents of E-waste (Salhofer, Steuer et al. 2016). Many explicit and apposite regulations and laws have been introduced in China during the past decade (Yu, Williams et al. 2010). The government of China has adopted a very thoughtful approach which opts for a stepwise regulation of E-waste taking into consideration the policies for the electronics industries along with the outcome of the domestic economy on the recovery stage (Guo, Wang et al. 2018). Further, not only confining itself to the introduction of the administrative regulations alone, the experiences of the developed countries are studied by the Chinese government, it explored the extended producers' responsibility (EPR) systems, and thus, aimed to formulate an in-depth mechanism for the formal E-waste processing through market-oriented means such as the direct fund subsidy and others (Wang, Gu et al. 2017).

In China, within a broader purview, there are quite a few general laws on environment that are pertinent to the management of E-waste, for instance, the General Environmental Law, the Solid Waste Pollution Control Law and the Clean Production Promotion Law (Yu, Williams et al. 2010). The "Circular on Strengthening Environmental Management of Waste Electrical and Electronic Equipment" was the first regulation in the country towards governing the E-waste which, in the year 2003, was approved by the State Environmental Protection Administration (SEPA) (known today as the Ministry of Environmental Protection (MEP)) (Yang 2008). The primary focuses of

this regulation include: 1) Reporting on the generation, transport and deposal of E-waste by the creators of the waste to the environmental protection departments; 2) There was a ban on outdated generation and disposal procedures of E-waste; and 3) Obtaining permissions from the environmental protection departments by any organization or individual that was engaged in collection, storage and disposal activities of E-waste (Yang 2008). Further, the SEPA had drafted the technical policy for the prevention of pollution from waste electrical and electronic products which was subsequently accepted in 2004 at a meeting of the experts (Hicks, Dietmar et al. 2005). This technical policy was aimed at reducing the overall quantity of E-waste, increasing not only the reutilisation rate but also the standard of E-waste recycling, and reducing the damaging impacts of E-waste on the environment. Thus, concepts such as green product design/labels found a place in the technical policy along with greater emphasis on proper collection/storage/recycling/disposal; devising national standards and policies and research-development activities on technology etc. (Hicks, Dietmar et al. 2005).

It has been observed that the directives of the European Union (EU) has profound influence on the regulatory measures in China towards addressing the E-waste concerns of the country. The “Regulations on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products” was enacted by the State Council which was rooted in the principle of Extended Producers’ Responsibility (EPR) (Wang, Gu et al. 2017). The “Administrative Measures on the Collection and Use of WEEE Treatment Fund” was ratified in 2012 by the Ministry of Finance (Tong and Yan 2013). As argued by Zhao and Yang (2018:2), “the fund adopts the principle of EPR to regulate the WEEE flow direction actively. It requires the producers and importers to fulfil their financial responsibility for the collecting and recycling of WEEE in the form of paying subsidies”. With an aim at reducing the quantity of E-waste and launching contemporary recycling systems in licensed enterprises, the “Regulation on Management of Waste Electrical and Electronic Equipments Recycling and Disposal” is the Chinese counterpart of the European Union’s Waste Electrical and Electronic Equipment (WEEE) Directive (Zhou and Xu 2012; Salhofer, Steuer et al. 2016) and was effective from 1st January 2011. It is popularly viewed as the China’s WEEE directive (Lu, Yang et al. 2018). Wei and Liu (2012) argue that there are apparent ambiguities in this regulation, especially in terms of the electronic equipments coming under the purview of this directive which needs due attention. Nevertheless, it has been proven

successful in many contexts. For instance, once changes are enacted as per the WEEE Regulation of the country, there are 109 authorized E-waste recycling enterprises towards processing about 79 million E-waste units weighing an approximately 1.7 million tons as of 2017 (Chen, Ogunseitan et al. 2018).

Likewise, the “Ordinance on Management of Prevention and Control of Pollution from Electronic Information Products (EIPs)” corresponds to the Restriction of Hazardous Substances (RoHS) Directive of the EU with the goal for eco-design in terms of restrictions on the usage of six perilous chemical substances, lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr6+), polybrominated biphenyls (PBBs) (Yu, Williams et al. 2010). The motivation of both Europe and China towards ensuring responsible E-waste management is visible in the promotion of circular economy. Such as, an official text entitled “Several Opinions of Promoting the Development of Circular Economy in China” was issued by the State Council of China in 2005 with emphasis on the state’s responsibility towards developing a circular economy (Babbitt, Gaustad et al. 2018). Afterward, the Circular Economy Promotion Law of People’s Republic of China was put into force in 2009 (Babbitt, Gaustad et al. 2018). In the year 2008, the “Administrative Measures on Pollution Prevention of WEEE” was formulated in the country with a goal to avert any pollution instigated by the dismantling, recycling, and discarding of E-waste and subsequently, a licence scheme for E-waste recycling companies was introduced by the Chinese government (Wong 2018).

There are also policy initiatives in China for tackling the import of E-waste from other countries. The government of China signed the “Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal” which came into force in 1992 and recently, in 2018, the government implemented rules towards banning the import of waste (Wong 2018). Further, there are regulations such as the Prohibited Goods Catalogue for Processing and Trade (2004) and Notification on Importation of the Seventh Category Waste (MEP, 2000) to address the restriction and ban on the trade of E-waste in the country (Li, Tian et al. 2006). Overall, China has put considerable efforts through formulating and implementing regulations to deal with the increasing generation of E-waste in the country. Significant research and development activities are being carried out in the country on this novel category of waste which, in turn, aid in locating policy solutions.

3.2. Brazil

The country of Brazil is the sixth largest economy in the world and fifth largest country based on its geographical area (Jabbour, Jabbour et al. 2014). Among its counterparts in the emerging world, the country is one of the largest generators of E-waste with approximately 1.4 million tonnes of E-waste produced in the year 2014 alone (Ghisolfi, Diniz Chaves et al. 2017). Standing second only to the USA, it is the second largest producer in the Americas with 1.5 million tonnes of E-waste produced in the year 2016 (Baldé, Forti et al. 2017). Unfortunately, this astounding volume of E-waste is yet to be adequately addressed in the country. The system of managing or controlling E-waste is characterized either by the mixing of E-waste with regular municipal solid waste which is finally directed to the open dumping sites/landfills or by the involvement of a prominent informal recycling sector (Abbondanza and Souza 2019). In the year 2010, Brazil approved its first national law in the form of Política Nacional de Resíduos Sólidos (PNRS) or National Policy on Solid Waste to deal with waste management after 20 years of judicial debates (Oliveira, Bernardes et al. 2012). Accordingly, the discarding of post-consumer waste is controlled by the PNRS which was established by Law No. 12305 on the 23rd December 2010 (Azevedo, da Silva Araújo et al. 2017). Through this Brazilian policy, solid waste is regulated in the country at a federal level since 2010 and it highlights the idea of reutilization, reduction and reuse of waste (Dias, Machado et al. 2018). This particular regulation came into existence once various municipalities and states in the country started to develop policies towards regulating the handling of some specific categories of waste (Oliveira, Bernardes et al. 2012). Under this policy, the 26 Brazilian states and the federal district have the freedom to produce their own range of laws, which consequences in a diverse set of rules for individual states (Dias, Machado et al. 2018).

Under the collective accountability of the governments, companies and consumers, this National Policy on Solid Waste (2010) administers the execution of reverse logistics systems (de Souza, Clímaco et al. 2016). Accordingly, it is rooted on the principles of collective product responsibility, product lifecycle in conjunction with the reverse logistics for numerous sectors, including waste electrical and electronic equipments (Araújo, Magrini et al. 2012). The primary purpose of the reverse logistics is to provide permanence or continuance to the lifecycle of a substance. For instance, under the system of reverse logistics, as argued by Dias, Machado et al. (2018), companies that produce goods are accountable for locating alternatives towards the end of

their functional lives, government is in authority for collecting and regulating the material and the users are liable for disposal of their waste appropriately. Among the changes executed by this policy comprise: 1) the ban on the import of hazardous waste that could possibly be harmful to the human health and environment, 2) the economic incentives to the local councils from the federal aimed at devising waste management strategies, 3) the closure of the so-called “dumps” which were typically used by the local population to discard their waste (Dias, Machado et al. 2018). The Brazilian policy for solid waste has been considered as a regulatory milestone in the country owing to the fact that the policy integrates waste pickers as a part of the shared responsibility process meant for the lifecycle of products and makes it mandatory to implement the reverse logistics systems (Ghisolfi, Diniz Chaves et al. 2017). Nevertheless, it is argued that despite the national policy and other regulations associated to the environment in Brazil, over 3300 counties still discard their waste in uncontrolled sites in the country (Dias, Machado et al. 2018). Accordingly, in an emerging economy like Brazil, it is essential to identify the forces that inspire the individuals to adopt effectively a responsible method of waste disposal in order to address the record surges in the E-waste generation and escalating pressures of it over the society and the environment at large (Echegaray and Hansstein 2017).

3.3.Russia

The Russian Federation generated 1392 kt of E-waste in the year 2016 with a per capita generation rate of 9.7 kg/inhabitant/year (Baldé, Forti et al. 2017). The federal law “on waste of production and consumption” (Federal law #49-FZ) sets the general principles on waste management in the country (Ghosh, Debnath et al. 2016). Russia does not have a specific legislation on E-waste management and thus, regulatory and judicial support, supervision and accounting of waste from home appliances and other electronics is being carried out according to the general law on waste management (Ghosh, Debnath et al. 2016). Consequently, in executing waste and environmental management regulations, the EU precedes Russia significantly, although recently the country has introduced an EPR that forced E-waste management obligations on both producers and importers of EEEs³. On a positive development, the Technical Regulation on

³ See: <http://www.pravsky.com/russia-weee-management-legal-framework>

Restriction on the use of Certain Hazardous Substances in Electrical and Electronic Equipment (TR EAEU 037/2016), commonly known as the “Russian RoHS” came into force as of 1st March, 2018⁴. Unlike its counterpart in the EU, here in this regulation, exemptions are provided to the prohibitions in the usage of certain hazardous substances. For instance, the use of mercury is allowed in certain kinds of lamps, so is the use of lead in electronic ray tubes etc⁵.

3.4.South Korea

Along with the EU and Japan, South Korea has an advanced regulation on E-waste management with executed controls (Zeng, Yang et al. 2017). The “Act on the Promotion of Conservation and Recycling of Resources” (commonly known as the Waste Recycling Act) of 1992 was the first law in the country to regulate its E-waste (Jang 2010). The Act was aimed at effectual collection and recycling of waste as a part of which the country introduced an EPR regulation for electronic devices and packaging materials in the later years (Kim, Jang et al. 2013). Televisions and washing machines were the first two home appliances controlled by the Waste Recycling Act which was followed by the inclusion of air conditioners and refrigerators in the year 1993 and 1997 respectively (Jang 2010). The country is regarded as one of the pioneers in the world in having a legal framework inspiring the manufacturers to take back and recycle their E-waste (Manomaivibool and Hong 2014). In general, the producers bore the cost of collection and recycling and consumers are liable to pay a cost of collection only when the local authority collect the E-wastes (Lee and Na 2010). The Korea Ministry of Environment (Korea MOE) played a major role in ensuring such a practice. As a component of the Waste Recycling Act, the Waste Deposit Refund System was introduced by the Korea MOE for certain groups of packaging materials, home appliances, and other items (Jang 2010). Within this Deposit Refund System, a deposit is levied on recyclable products and packages at a constant rate which is reimbursed once the recycling is ensured (Lee, Song et al. 2007).

The existing Waste Recycling Act was modified in the year 2003 by the MOE towards promoting the EPR regulation for the objects within the Deposit Refund System (Jang 2010). Thus, in the turn of the century, the EPR policy introduced by the MOE started imposing to producers

⁴ See: <http://www.pravsky.com/eaue-restriction-hazardous-substances-electronic-equipment-rohs>

⁵ *ibid*

recycling obligations (Park and Lah 2015). Electronic products such as mobile phones, audio equipment, printers, copying machines and facsimiles were included in the EPR regulation during 2005 and 2006 along with batteries, tires, packaging materials, fluorescent light bulbs, lubricants (Park and Lah 2015; Jang 2010). Finally, the “Act on the Resource Recycling of Waste Electrical Electronic Equipment (WEEE) and End-of-life Vehicles” was introduced as a new legislation in 2007 with an aim to cut down the quantity of E-waste directed to the incinerators/landfills, to approve the EPR regulation towards realizing a high rate of recycling for the stipulated products, and enhancing the general environmental performance of the electronic equipments within their lifecycle (Jang 2010). Over the last twenty years, the scope of the regulation has been increased manifold. For instance, the types of EEEs coming under the purview of the regulation have been increased from four to ten and producer responsibilities towards recycling compulsion have been modified from voluntary to mandatory with obligatory targets and performance penalties (Manomaivibool and Hong 2014).

The Act focusses primarily on large home appliances and restricted IT products in the form of ten specific electronic and electrical devices – refrigerators, washing machines, televisions, air conditioners, computers, printers, facsimiles, audio equipment, copy machines, and mobile phones (Kim, Jang et al. 2013). The Korea WEEE Act is a counterpart of the EU’s WEEE Directive and RoHS Directive which takes many clues and inspirations from these EU laws. For instance, the Korean WEEE Act too regulates six toxic substances in electronics in the line of the EU’s RoHS Directive (Kim, Jang et al. 2013). The EPR system in Korea is considered as a success (Park and Lah 2015). The MOE extended the scope of the policy to add further a number of diverse electrical and electronic equipments in 2014 (Park and Lah 2015). A major accomplishment of the EPR system could be counted from the fact that the obligation rate has been continuously increased for the products that come under the purview of EPR (Rhee 2016). Overall, although Japan is considered as a country with best-functioning E-waste management system in terms of both scope and compliance level, the South Korea too is equipped with a well-advanced system to address the E-waste produced in the country (Sthiannopkao and Wong 2013). The country could be an example of how a precise and systematic approach helps in successful formulation and implementation of policies addressing a new yet toxic category of waste.

3.5.Indonesia

In the recent past, the considerable growth in the economy coupled with rapid technological developments resulted in an increasing generation of E-waste in Indonesia (Andarani and Goto 2014). Indonesia generated 1274 kt of E-waste in the year 2016 with per capita generation of 4.9 kg (Baldé, Forti et al. 2017). The informal recycling sector has a prominent presence in the country's waste management sector. In the country, municipal agencies are the major actors in the formal sector while the informal sector essentially comprises of unregulated and unregistered small businesses, groups, or individuals (Sembiring and Nitivattananon 2010). With no presence of a specific regulation to manage its E-waste, the Republic of Indonesia Act No. 32/2009 (concerning Environmental Protection and Management) and government regulation No. 18/1999 (concerning solid waste management) regulate the E-waste produced in the country as a major component of toxic and hazardous waste (Yoshida, Terazono et al. 2016). Thus, E-waste is categorized as general hazardous waste by the government of the country rendering its handling neither centralized via the formal recycling amenities nor particularly differentiated (Rochman, Ashton et al. 2017). Ratifying the Basel Convention and through the Decision of the Ministry of Trade No. 229 of 1997, government of Indonesia prohibits commerce from importing E-waste, used electronic products, and toxic and hazardous materials (Maheswari, Yudoko et al. 2019). Till the year 2016, the process of devising an E-waste regulation for the country is still undertaken by the Indonesian government and consequently a constructive system which could be applicable to all the 37 Indonesian provinces is yet to be realized (Rochman, Ashton et al. 2017).

Today, the absence of required number of licensed recycling companies in the countries prompt improper disposal of majority of the residues and scraps from businesses and industries including E-waste (Yoshida, Terazono et al. 2016). The authors Maheswari, Yudoko et al. (2019) argue that complementing the situation is many developing countries, scheming a sound regulation to manage the E-waste in Indonesia is a massive task primarily due to three factors: 1) the government is yet to comprehend the interest of the stakeholders; 2) the current government machinery makes regulations gainful only solely to a few parties and 3) there exists substantial friction among the government agencies. Nevertheless, considering the fact that the country still relies very much on the informal actors towards household collection and sorting of E-waste and their significant role in the current waste management system, they should certainly be integrated

into any new management and regulatory initiatives, as is presently being devised by the Indonesian government (Rochman, Ashton et al. 2017). Further, through the national standard of Indonesia (SNI) which is responsible for enforcing electronic products in the regulation of the Ministry of Industry No. 36 of 2017, the Indonesian government evaluates and controls the product quality with an aim to reduce the E-waste generated in the country (Maheswari, Yudoko et al. 2019). Overall, it is essential to take into consideration the prevailing conditions of obsolete EEES and associated environmental impacts together with the legal aspects in order to ensure a sustainable system for E-waste management in Indonesia (Andarani and Goto 2014).

3.6.Taiwan

Taiwan has emerged as a major global centre for electronic products manufacturing in the recent years. Among its Asian compatriots, the country is considered both as a key exporter of electronic equipments and generator of E-waste. In Taiwan, a prominent environmental leader in the Asia Pacific region, E-waste management and recycling has been acknowledged as a major focus area during the last 15 years (Fan, Fan et al. 2018). The Waste Recycling Fund (WRF), as a resource-recycling programme controlled by the central government and supervised by the TEPA, was established in 1998 with an aim to integrate the private recycling programmes (Lin, Wen et al. 2010). Consequently, a national EPR system was launched after incorporating eight private recycling organizations in the same year (Wen, Lin et al. 2009). The Act was concerned about the procurement of the resources considered valuable in selected appliances that are supposed to be recycled (Lee and Na 2010). The Recycling Fund Management Board (RFMB) of the Taiwan Environmental Protection Administration (TEPA), authorized by the Waste disposal Act, was introduced in the country in 1998 (Shih 2017). The aim of the RFMB was to handle the fees associated with the collection, disposal and treatment of the compulsorily controlled materials from the accountable producers or parties (Lin, Wen et al. 2010).

Presently, nominated by the RFMB, there exists 33 mandatory regulated products within 14 categories for recycling, which are referred to as “Due Recycled Waste” (Wen, Lin et al. 2009). This includes electrical appliances (TV sets, Refrigerators, Washing machines, Air conditioners, Electrical fans), Computers and IT accessories (Main boards, Cases, Hard disk drives, Power

supplies, Monitors, Printers, Laptop computers, Keyboards), and Fluorescent tubes and light bulbs. The largest contribution of the RFMB is the fact that since 2001, it enforced the society to recycle its electronic products and also takes up operations annually through the joint participation of industry representatives, the Fee Rate Inspection Committee (FRIC) etc. (Shih 2017). Both the importers and the manufacturers of the designated items are obliged to pay recycling fees as per the rates derived by the FRIC of RFMB (Shih 2017). The Zero Waste policy was introduced in Taiwan by the TEPA in the year 2003. One of the approaches to accomplish the Zero Waste policy comprises of increasing the compulsorily controlled materials by intensifying the scope of the Due Recycled Wastes (Lin, Wen et al. 2010).

3.7.Turkey

The intensity of the problem of E-waste in Turkey could be predicted by the penetration rate of mobile phones in the country. A Turkish national telecommunications regulatory authority called Information and Communication Technologies Authority (ICTA) estimated that between 2007 and 2012, mobile phone penetration rate in Istanbul ranges from 118% to 122% whereas was only about 0.9% in the year 1994 (Çetinsaya Özkır, Efendigil et al. 2015). The amount of E-waste produced in Turkey is expected to rise to 894k tonnes in 2020 with 4.87 kg per capita generation (Kilic, Cebeci et al. 2015). As argued by Öztürk (2015), the RoHS Directive (2002/95/EC) by the EU has been a motivation for Turkey to have a similar E-waste regulation in the country which came into effect on 01.06.2008 (published in the Official Journal No. 26891 on 30.05.2008). Similarly, in the line with the EU's WEEE Directive (2002/96/EC), a new regulation draft was formulated after two years which came into effect on 22.05.2012 (published in the Official Journal No 28300). The regulation is known as the "Regulation on the Control of Waste Electrical and Electronic Equipments. Subsequently, the RoHS version was removed, the scope of the Turkish WEEE Directive was broadened and finally, the two regulations were unified under same general principles, purpose, foundation and extent (Öztürk 2015).

3.8.Mexico

Mexico is the third largest producer of E-waste in the Americas after the USA and Brazil with an annual generation of 998 kt and per capita generation of 8.2 kg/inhabitant/year (Baldé, Forti et

al. 2017). Mexico is one of the seven countries in the Latin America to enforce a national E-waste legislation. A precise regulatory framework for solid waste, titled the “General Law for Waste Prevention and Integrated Management” (Spanish LGPGIR) was enacted in 2003 under which three categories of waste are defined: 1) hazardous waste, 2) special handling waste, and 3) urban solid waste (Cruz-Sotelo, Ojeda-Benítez et al. 2017). Within the framework of LGPGIR, E-waste is included under the category of special handling waste. In the country, it has been observed that the E-waste legislation is the central factor towards responsible disposal of E-waste particularly at the meso-level (which characterizes the flow of information amongst organizations) since it outlines the E-waste management responsibilities (Estrada-Ayub and Kahhat 2014).

4. E-waste Governance in India and South Africa

India and South Africa are two major emerging economies in the world today. As members of the BRICS group, in the upcoming years, the significance of these two countries in the globe is expected to rise primarily from economic perspective (Shen, Shuai et al. 2017). While climbing the ladder of economic growth and development, these countries are subjected to enormous environmental challenges. For instance, both these countries today face a significant E-waste problem in terms of the massive generation and inadequate management mechanisms. While India generated 1975 kt of E-waste in the year 2016, South Africa produced 321 kt in the same year (Baldé, Forti et al. 2017). The per capita generation of E-waste was 1.5 kg/inhabitant and 5.7 kg/inhabitant for India and South Africa respectively (Baldé, Forti et al. 2017). One major characteristic of the E-waste generation in India has been that, although the per capita generation in the country is less, the total volume produced is considerably higher due to its massive population of the country. It is interesting to note that, although the per capita generation is higher in South Africa than India, the overall volume of E-waste produced is much lesser. This could be attributed to this large difference in the population size in both the countries. Nevertheless, considering the growth potential of both these countries in the coming years, both the per capita and absolute volume of E-waste generated will remain a prime factor in determining effective and local-specific policy solutions for both the countries.

Over the last decade, India has devised and implemented policies to specifically deal with the E-waste produced in the country. In the year 2008, Ministry of Environment and Forest (MoEF)

in India introduced a guideline for environmentally responsible E-waste management in the country. Titled as the “Guidelines for Environmentally Sound Management of E-Waste”, it was approved by the MoEF through letter No. 23-23/2007-HSMD dated March 12, 2008. This guideline was the result of the consultation of the Task Force constituted by the MoEF on E-waste management with its members. The members of the task force include senior representatives from the Central Pollution Control Board (CPCB), Ministry of Information Technology, Ministry of Health, Ministry of Industrial Policy and Promotion, Indian Toxicological Research Institute, Confederation of Indian Industries, National Metallurgical Laboratory and Manufacturer Association of Information Technology (CPCB, 2008). The first legislation on E-waste came into existence in the country in the form of “E-waste (Management and Handling Rules), 2011”. Although the problem of E-waste started surfacing in the country a few years after the economy opened up in the early 1990s, it took considerable amount of time to formulate and implement a law to exclusively deal with the apprehension (Borthakur 2016). In the lines of the EU’s WEEE Directive, at the core of this legislation was the principle of EPR. Two categories of EEEs was included within the purview of these rules: 1) Information Technology and Telecommunication Equipment, 2) Consumer electrical and electronics. The EEEs came under the first category are: Centralized data processing, Mainframes, Minicomputers, Personal computing, Personal computers, Laptop computers, Notebook computers, Notepad computers, Printers including cartridges, Copying equipment, Electrical and electronic typewriters, User terminals and systems, Facsimile, Telex, Telephones, Pay telephones, Cordless telephones, Cellular telephones, Answering systems. Whereas, under the category of “Consumer electrical and electronics”, Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology), Refrigerator, Washing Machine, Air Conditioners excluding centralized air conditioning plants were included⁶.

In the year 2016, the Government of India introduced the “E-waste (Management) Rules, 2016 with an aim to ensure effective enactment of EPR by the producers and to enhance their role in the effective E-Waste management of the country. One significant step towards this was to set target based collection approach. Accordingly, based on either number or weight, the collection targets

⁶ See: <http://www.indiaenvironmentportal.org.in/files/e-waste%20management%20and%20handling%20rules%202011.pdf>

are set for the producers. The phase-wise targets are: “(1) 30% (either by number or by weight) of the quantity of waste generation during the first two years of implementation of rules, (2) 40% during third and fourth years, (3) 50% during fifth and sixth years and (4) 70% during seventh year onwards” (MoEF 2016: 22). Further Fluorescent and other Mercury containing lamps are included in the purview of the new rules. Thus, the rules of 2016 do provide several rigorous and insightful perspectives as compared to the previous rules of 2011 (Borthakur and Govind 2017). Nevertheless, this legislation of 2016 had to be amended in the year 2018 and the collection targets had to be revised. In the E- Waste (Management) Amendment Rules, 2018, the collection targets (based on the weight) are set as: 1) 10% of the quantity of waste generation in 2017-2018; 2) 20% of the quantity of waste generation in 2018-2019; 3) 30% of the quantity of waste generation in 2019-2020; 4) 40% of the quantity of waste generation in 2020-2021; 5) 50% of the quantity of waste generation in 2021-2022; 6) 60% of the quantity of waste generation in 2022-2023; 7) 70% of the quantity of waste generation after 2023 onwards. Accordingly, the targets for the initial years after the implementation of the rules are redefined, although the final target, after the year 2023, has been kept the same.

Unlike India, South Africa is yet to have a legislation exclusively to address the problem of E-waste although the country is considered amongst the guiltiest of causing E-waste pollution in the African continent⁷. Although all the countries in Africa ratified the Basel Convention, majority of them including South Africa are yet to formally pass an E-waste law (Baldé, Forti et al. 2017). The country has a set of laws such as the ‘2008 National Environmental Management: Waste Act’, ‘The National Environmental Management Waste Amendment Act, 26 of 2014’ and ‘the National Environmental Management Act of 1998’ to cover hazardous substances, waste and their management and disposal. These Acts provide guidelines to manage the E-waste produced in South Africa. However, as argued by Keith Anderson, the chairman of the e-Waste Association of South Africa (eWasa), these legislations have gaps and their implementations are not monitored. Thus, these kinds of factors need to be addressed adequately for sustainable E-waste management in the country. Further, there are host of other legal frameworks having elements associated directly and indirectly with E-waste such as: The National Waste Management Strategy, Hazardous Substances Act, Environmental Conservation Act, National Water Act, Atmospheric

⁷ See: <https://mg.co.za/article/2018-03-16-00-south-africans-are-drowning-in-e-waste>

Pollution Prevention Act and Occupational Health and Safety Act (Ghosh, Debnath et al. 2016). The fact that different governmental departments at different levels are responsible for the implementation of each act result in examining the issue of E-waste from different perspectives (Ghosh, Debnath et al. 2016). In the absence of one particular law to address the concerns associated with E-waste management, the current initiatives look both perplexing and challenging.

5. Discussion

A recent report by McKinsey Global Institute (September 2018) states that emerging economies account for nearly two-thirds of the world's GDP growth and over half of the new consumption during the past 15 years⁸. Accordingly, it is evident that the emerging economies are instrumental in the wellbeing of the global economy and its sustenance. The intense growth of these countries, unfortunately, has severe implications to the local environment or ecosystems and the problem of E-waste is a good example of the same. Today, the emerging economies are fraught with increasing volume of E-waste and serious management challenges. Although the per capita generation of E-waste in these countries are still much lower than many developed countries, the absolute volume generated is considerably higher owing to the fact that most of the emerging countries are characterized by a higher population size and larger markets as compared to their compatriots in the developed world. Emerging countries such as India and China often rank among the top five generators of E-waste in the world. Intensifying the problem further, many of these countries are not only burdened with domestically generated E-waste, but also are major destinations for exported E-waste from the developed countries. Emerging Asian countries such as India, China, Taiwan and Indonesia are subjected to the toxic trade of E-waste. These countries are often characterized by the presence of a dominant informal waste recycling sector which poses its own management and policy challenges. Recognizing the growing concerns associated with E-waste, the emerging economies have come up with their own policies and strategies to address this ever-increasing stream of toxic waste, although most of their E-waste policy initiatives are influenced by the EU's WEEE and RoHS Directive. Consequently, the principles of EPR has

⁸ See:
<https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Innovation/Outperformers%20High%20growth%20emerging%20economies%20and%20the%20companies%20that%20propel%20them/MGI-Outperformers-Full-report-Sep-2018.ashx>

found a prominent place in the legislative approaches of the majority of the emerging economies that we studied as a part of this review.

Among the emerging countries, China has been able to devise a series of appropriate regulations to address the country's E-waste. The country has undertaken stepwise policy approaches where a number of laws has been ratified and implemented to address the concerns associated with E-waste both directly and indirectly. For instance, it is one of the first countries in Asia to focus on circular economy through legislative approach. Moreover, although still at an early stage, China has been able to make considerable progresses in the formal E-waste recycling sector (both in terms of quality and treatment capacity) through pilot projects and legislative approaches (Peng, Tu et al. 2018). The experiences of the developed countries on responsible E-waste management are studied adequately by the Chinese government which resulted in the Chinese counterpart of the European Union's WEEE Directive (in the form of "Regulation on Management of Waste Electrical and Electronic Equipments Recycling and Disposal") and RoHS Directive (the "Ordinance on Management of Prevention and Control of Pollution from Electronic Information Products (EIPs)") (Salhofer, Steuer et al. 2016; Yu, Williams et al. 2010). The trade of E-waste has also been addressed through legislative measures in the country. In 2018, the government implemented rules towards banning the import of waste (Wong 2018)

The current policy successes in a few representatives from the emerging economies refers to the fact that the evolution of policy processes should be systematic, organized and stepwise. It is evident from the review that the countries that took such a systematic approach are today at a better position to deal with their E-waste complexities. Apart from China, South Korea is an excellent example in this context. The South Korean WEEE law initially included only a handful of EEEs within its purview. However, subsequently with time, the country took the effort to include more and more EEEs towards having a comprehensive E-waste management plan. Today, South Korea is considered as a successful case of E-waste management in the world. Further, the country is regarded as one of the pioneers in the world in having a legal framework inspiring the manufacturers to take back and recycle their E-waste (Manomaivibool and Hong 2014). The inclusion of more EEEs over time after the inception of a legislation is something India has failed to do yet. Although the initial plan of the Indian government was to include gradually increasing types of EEEs under the purview of the E-waste Rules of the country, it has hardly happened in

698 reality. As a result, only a handful variety of EEEs are included under the current rules and thus,
699 the scope of the rules is too narrow to comprehensively address this crisis of E-waste in the country
700 (Borthakur, 2017). Further, the average lifespan of the EEEs estimated in the E-waste
701 (Management) Rules, 2016 in India has the potential to be deceptive and thus, should ideally be
702 reconsidered after appropriate research evaluation. For instance, as in the Rules, smartphones are
703 considered to have an average lifespan of 5 years and feature phones, 7 years. However, in reality,
704 these lifespans could be much shorter.

705 One of the noteworthy attributes of the Brazilian E-waste policy for solid waste has been that
706 the policy integrates waste pickers as a part of the shared responsibility process meant for the
707 lifecycle of products and makes it mandatory to implement the reverse logistics systems (Ghisolfi,
708 Diniz Chaves et al. 2017). The country has been able to devise its E-waste policy instruments
709 considering the local circumstances, although many researchers argue that it has still a long way
710 before it could be considered as a success story for responsible E-waste management. Like
711 majority of its counterparts in the emerging economies, Taiwan relies on the principles of the EPR
712 to address its E-waste. However, Shih (2017) argues that as compared to the EPR systems, for
713 instance of South Korea, the Taiwanese system has observed to been subjected to two weaknesses:
714 1) high monitoring costs; and 2) adverse competition between recyclers inside and outside. Among
715 the emerging economies, some countries are visibly absent in E-waste research. Within the
716 countries we considered for this review, the research interest on E-waste is substantially lower in
717 South Africa and Russia – two countries in the prominent BRICS group. There is a dearth of
718 research carried out in these two countries which makes their policy approaches and assessment
719 difficult to review. As argued by Jabbour, Jabbour et al. (2014), it is evident that the most
720 vulnerable ecosystems in the world are situated in the emerging economies and developing
721 countries. Accordingly, it is essential to formulate internal regulatory policies having teeth and
722 judiciously assess the emergent regulatory policies and their enforcement.

724 6. Conclusions

725 The significance of emerging economies in the present-day world is indisputable, both from
726 the market and environmental perspectives. These are mostly the countries with enormous

financial potentials on one hand and rich natural resources (including biodiversity) on the other. These are also the countries with a major share in the size of the population, land area and GDP and call for responsible environmental management efforts. Accordingly, it is essential to deal with the increasing volume of E-waste produced in these countries, effectively and passably. The emerging economies have ratified and implemented legislative measures to deal with their concerns associated with E-waste. Today, most of these countries have rules and regulations, in some form of the other, to deal with their solid waste including E-waste. The EU's landmark WEEE Directive and RoHS Directive are observed to have considerable influence on the policies of most of the emerging economies considered for our study purpose such as China, India, Taiwan, Turkey etc. We argue that the policy approach of a particular country towards addressing a complex category of waste stream such as E-waste necessitates a local-specific approach where all the inherent socio-cultural, economic, political and environmental considerations of that country is taken into consideration while devising the policy.

Further, it is imperative to have a systematic, organize and stepwise approach towards formulating and implementing the E-waste policies. Such approaches have proven to attain significant success in countries such as South Korea and China. Given the complex socio-economic structures of the emerging economies, it is essential to review and re-review the policy efforts constantly at regular intervals to locate possible gaps in implementation. India, for instance, had revised its yearly collection targets set in the 2016's E-waste Rules in the year 2018 in order to ensure maximum potential success. In the revised rules, the collection targets for the initial years were reduced while keeping the final collection target from the year 2023 onward constant. Also, the research interests on E-waste calls for adequate attention from the scientific community and policymakers. The fact that a few representatives from the well-known emerging economies, such as Russia and South Africa, are underrepresented in the E-waste research needs adequate consideration. Overall, it could be concluded that, barring a handful of representative countries, E-waste governance in the emerging economies are yet to be addressed comprehensively both by themselves and the global North. This necessitates increasing future research attention on E-waste of these countries both from the natural science and social sciences' perspectives. It is also essential to ensure interdisciplinary research approaches on the topic as understanding the roots of the E-waste problem needs a comprehensive effort. The growth trajectory of the emerging economies is

projected to continue in the near future. Thus, it is imperative to address the environmental concerns of these countries (including substantial initiatives towards responsible E-waste management) simultaneously with their economic development.

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