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A study of the legislative tools to phase out e-waste in an ever-evolving digital world: environmentally sound initiatives and measures in China, the European Union, Ghana, India, Samoa, Singapore, and South Africa

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A livello globale, governi e parti private come le imprese, le ONG e gli individui lottano per gestire un numero crescente di dispositivi elettronici utilizzati. Ci sono effetti di avvelenamento sulla terra che spesso richiedono molti anni per emergere, ostacolando i diversi tentativi di raggiungere la neutralità nel degrado del suolo. La legislazione e l'applicazione della legge devono concentrarsi sull'eliminazione e la neutralizzazione dei composti pericolosi generati dai rifiuti elettronici, garantendo un adeguato stoccaggio e prevenendone il commercio illecito. Dopo aver esaminato il diritto internazionale pubblico pertinente e le organizzazioni interessate, viene valutato uno scenario mondiale e la tassonomia della pertinente Agenda 2030 delle Nazioni Unite per lo sviluppo sostenibile. Il documento conclude che, sebbene le autorità pubbliche stiano lavorando duramente per ridurre l'inquinamento ambientale causato dai rifiuti elettronici, gli strumenti legislativi e gli approcci esistenti a livello internazionale, regionale e nazionale potrebbero essere attuati in modo più efficace. È necessario intraprendere azioni globali per garantire la protezione dell'ambiente e la sicurezza umana, affrontando nel contempo le ambiguità del diritto nazionale e internazionale.

Globally, governments and private parties such as businesses, NGOs, and individuals struggle to handle a growing number of used electronic devices. There are poisoning effects on land that often take many years to emerge, hindering several attempts to achieve land degradation neutrality. Legislation and legal enforcement must concentrate on eliminating and neutralizing dangerous compounds from e-waste,

ensuring proper storage and preventing illicit trading. After examining relevant public international law and concerned organizations, a worldwide scenario and taxonomy of the relevant UN 2030 Agenda for Sustainable Development are assessed. The paper concludes that although public authorities are working hard to reduce environmental pollution caused by e-waste, existing international, regional, and national legislative tools and approaches could be more effectively implemented. It is necessary to take global actions to ensure environmental protection and human safety while addressing ambiguities in both national and international law.

Summary: 1. Introduction.- 2. E-waste management environmentally sound initiatives and measures adopted in EU, India, Ghana, South Africa, China, Singapore, Samoa. A comparative analysis.- 2. 1. EU.- 2.2. India.- 2.3. Ghana.- 2.4. South Africa.- 2.5. China.- 2.6. Singapore.- 2.7. Samoa.- 3. A comparative analysis: key takeaways.- 4. Final remarks and suggestions.

1. Introduction^[1]

All around the world, national authorities and private stakeholders such as business corporations, NGOs, and individuals struggle to apply a suitable way to manage the increasing volume of used electronic devices.^[2] Through the globalization of trade, the developing countries are substantially following the developed ones' path in consumer electronics and problematically producing e-wastes in an exponential and not sustainable way. Thus considered, it is possible to agree with some scholars' opinion stating that the international community is currently facing a sort of growing *tsunami wave* of used electronics predominantly occurring in most of the developing countries located in several areas of the world, such as Africa, Asia, and the Pacific.^[3] Here, it happens that the poorest people, by putting their own life at risk, try to extract valuable materials so-called Rare Earth Elements (REEs) like copper, silver, even gold, and platinum for selling off in money-spinning and illegal secondhand markets. Therefore, regulations^[4] and legal enforcement worldwide, among other things, must focus on removing and neutralizing toxic substances^[5] (e.g., mercury^[6], lead, and cadmium) from e-wastes ensuring, through new laws, proper management

(especially concerning the circumstances of disposal and transboundary movement^[7]), and striking the illegal trade of this type of wastes. This is vital because, nowadays, the scientific community understands the likely lethal and noxious effects on human health and the surrounding living environment.^[8]

Given the magnitude of this environmental-related issue, it must be stressed that several repercussions that challenge the well-being of the areas mentioned above of the world deserve to be analyzed here in this paper. First and foremost, there are substantial legal implications. The European Union (EU) and African and Asia Pacific countries equipped themselves with laws aiming to protect human security and minimize the impact on the ecosystem. Unfortunately, although these domestic laws found their legal roots or sources within international and regional conventions (e.g., Basel and Waigani Conventions^[9]), at the domestic level, these laws frequently do not refer to e-waste as such. Nonetheless, these refer to the broader term waste creating legal uncertainty in some instances.^[10] To overcome this complex situation, one ought to note that, nowadays, there is a higher level of awareness at the community level so that even the private stakeholders can determine at least the so-called “voluntary” legal standards, which are less reliable. Notably, interfacing law and science is a must to fully understand the *life cycle* (the end of its useful life) of more sophisticated electronics such as semiconductors, batteries, microchips, photovoltaics, and nanotechnologies. In particular, these electronics sometimes can be safely recovered in their most valuable components or just repaired, starting a new life cycle. National laws are set to establish facilities to carry out these kinds of specialized technical operations.^[11] In the Asian countries and particularly in the Pacific Small Islands Developing States (SIDS), these operations are complicated to execute because of the lack of financial resources and land scarcity that characterized their territory. This is an obstacle to the establishment of well-designed facilities. So, the majority of the e-waste is dumped into landfills, increasing the level of soil contamination affecting the quality of life in the Pacific.^[12]

Secondly, there are also legal implications attached to the economic sphere.^[13] In Africa and Pacific SIDS, collection and transport of these e-wastes request people holding technical expertise in creating a new circular economy^[14] with high safety standards that laws must establish for granting an adequate financial coverage of

all activities. This is an economic barrier that is difficult to pull down. So, for example, one ought to note that the *extended producer or user pays principle* could be part of the solution for funding the disposal of electronic devices.^[15]

Thirdly and finally, there are repercussions linked to social, health, and environmental spheres at the global level. In particular, Eastern European, African, and several Asian countries as well as SIDS are receiving a large amount of e-wastes from European and North American countries faster than they can try to reuse them safely. This is due to cheap labor and lax safety standards in developing countries' waste management. A result is an increasing number of poisoned lands worldwide, producing a massive reduction in land values and productivity. This poisoning effect on land often takes many years to manifest, hindering all the attempts to achieve land degradation neutrality.^[16]

Within this perspective, this paper fills the critical gap by examining the necessity of adequate e-waste management almost on a global scale. E-waste management is one of today's most pressing environmental issues closely related to the achievement of Sustainable Development Goals (SDGs), such as the following ones: (i) SDG 3 on good health and well-being; (ii) SDG 8 on decent work, and economic growth; (iii) SDG 6 on clean water and sanitation; (iv) and also SDG indicator 12.4.2 on hazardous waste; and (v) SDG 14 on life below water. Here are the essential questions: To contrast environmental pollution due to the large number of e-wastes, are the available legal instruments and strategic approaches enough? Or do we still need proactive steps forward to take all necessary, adequate, and effective measures to ensure environmental protection and human safety, clarifying certain ambiguities simultaneously? Would it be essential to allocate more economic resources? In providing the answers to these questions, the authors use a textual analysis methodology mixed with a descriptive one that implies the analysis of the e-waste management measures and environmentally sound initiatives. Notably, a contextual and comparative method is adopted, with a study regarding authoritative interdisciplinary literature elaborated by the doctrine, various United Nations documents, and the laws or policies in the EU, Ghana, South Africa, India, China, Singapore, and Samoa. The analyzed countries not only belong to different planetary geographical areas but also these are the ones which produced laws to protect human security in relation to the issue under discussion. As a final note to this introduction, it is essential to

highlight that the e-waste issue has been one of the mainstream sources of pollution globally since the so-called “Great Acceleration.”^[17] It demands extensive cooperation among states and increasingly significant public-private partnerships in selected segments. Involving the private sector is a must to effectively comply with the laws and legal requirements and improve the security and quality of the living environment in large parts of the world. Thus considered, states and other stakeholders who refrain from actively engaging in the debates and then claim that the legal drafts are not sufficiently clear or acceptable bear some of the burdens. However, the responsibility also lies with lawyers, policymakers, and their advisers, who have so far failed to take the technically feasible provisions necessary to broaden the base of support that would make it possible for new measures to be adopted and implemented in the foreseeable future.

2. E-waste management environmentally sound initiatives and measures adopted in EU, India, Ghana, South Africa, China, Singapore, Samoa. A comparative analysis.

2. 1. EU

The quantity of WEEE, or largely e-waste, created each year in the EU rises alarmingly. Currently, it is one of the waste streams growing at the fastest rate. EU regulations on WEEE are intended to contribute to environmentally friendly manufacturing and use. They address environmental challenges that have arisen due to the increasing number of discarded gadgets in the EU. For instance, the 1999 Landfill Directive^[18] attempts to limit landfill dependency. It aims to restrict landfills’ environmental and health implications while ensuring a uniform minimum standard throughout the EU.^[19] Determining where, how, and how long to operate a landfill is mandated under the Landfill Directive, which sets objectives for reducing biodegradable municipal waste in landfills.^[20]

In 2002, the European Union passed the Restricting Use of Hazardous Substances in Electrical and Electronic Equipment (RoHS 1) Directive^[21], which prohibits certain hazardous substances in electrical and electronic equipment. Under the Directive, six hazardous compounds are prohibited from being used in

the manufacturing of different kinds of electrical and electronic equipment. Subsequently, in 2003, the EU's Waste Electrical and Electronic Equipment Directive (WEEE Directive) governs the disposal of waste electrical and electronic equipment.^[22] This Directive calls for the establishment of collection services through which customers may return their e-waste without incurring any fees. These programs are designed to increase the recycling of e-waste and the reuse of electrical and electronic equipment. In 2006, the European Parliament and the Council adopted Regulation (EC) No. 1013/2006 on waste transportation.^[23] The regulation focuses on encouraging safe waste shipments within the European Union and between the EU and non-EU nations and on establishing mechanisms for enforcing waste transport regulations. According to the European Commission's Circular Economy Action Plan^[24], additional measures have been implemented to ensure that the waste shipment regulation is implemented and illegal shipments resulting in the leakage of raw materials are effectively addressed. The law has recently been updated to reflect these additional measures. The EU's Waste Electrical and Electronic Equipment Recast Directive (WEEE - 2012/19/EU)^[25] governs waste electrical and electronic equipment recycling. The Recast Directive improves on the current WEEE Directive by establishing high recycling collection objectives in line with international standards. It seems that the WEEE Directive is to prevent the creation of WEEE. This allows the efficient use of resources and the recovery of valuable materials through re-use and recycling. This is accomplished by the distinct collection and correct treatment of WEEE, which is mandated by the Directive establishing collection and recovery goals for WEEE and targets for their recovery and recycling. This Directive, among other things, (i) assists European nations in more effectively combating illicit waste exports by making it more difficult for exporters to conceal unlawful shipments of WEEE in their cargoes (ii) decreases the administrative burden by advocating for the harmonization of national WEEE reports. The so far passed EU law for e-waste management has been established in every member state of the EU and other European nations such as the United Kingdom (UK), Switzerland, and Norway in line with their environmental agenda. After *Brexit*, the United Kingdom would most likely retain this law or reformulate it to reflect a new environmental plan.^[26]

2.2. India

In India, the amount of e-waste that each electronic item makes is likely to grow in the future because people are becoming more dependent on computers and other electronic household items due to technological advancement.^[27] Since the vast majority of e-waste is destined for the unorganized or informal sector, where profit is the primary driving factor, enhanced management and improved working conditions, directed by strict regulations, are unavoidably required for e-waste recycling to be successful. The problem of electrical and electronic equipment disposal, import, and recycling has emerged as an essential topic of discussion and debate among government organizations, environmentalist organizations, and private producers of computers and consumer electronic devices in recent years.^[28] In its Report on the Functioning of the Central Pollution Control Board (CPCB), the Department-related Parliamentary Standing Committee on Science & Technology, Environment & Forests has concluded that e-waste will become a significant problem in the future as a result of modern lifestyles, an increase in people's living standards, and an increase in economic growth.^[29] The Committee has recommended that the CPCB take a more proactive role in addressing the threat, adding that it should conduct research to make future estimates and design measures to combat the problem. In light of the significant strides that the nation has achieved in the information technology sector and electronic industry, it has become necessary to address the issue of e-waste importation and its proper processing and disposal. Between 1986 and 2008, the rules were focused on: (i) Preventing, controlling, and abating environmental contamination as the primary goals of this program; (ii) Containing export and import of EEE compounds that have the potential to deplete the ozone layer; (iii) Prohibiting the importation of hazardous waste for the disposal or dumping of e-waste. Companies or people that receive, process, transport, or store hazardous waste are required to get approval from the appropriate State Pollution Control Board (SPCB) in compliance with the significant conventions of public international law signed and ratified by India. Until 2010, there are no special environmental laws governing the management and disposal of e-waste in India. Electronic waste and its treatment were not explicitly mentioned as dangerous in any existing environmental regulations. In

2011, the E-waste (Management and Handling) Rules were introduced by the government on the factual grounds that the public interest needed to enable the recovery and reuse of helpful material from e-waste, thereby reducing the amount of hazardous waste destined for disposal and ensuring the environmentally sound management of all types of waste electrical and electronic equipment. It regulates the management of e-waste at every stage of the EEE life cycle, from the point of manufacture to recycling.^[30] The legislation establishes collection centers for e-waste created from 'end of life' items. In 2016, e-waste management rules introduced and implemented the notion of Extended Producer Responsibility (EPR), ensuring that such e-waste is channeled to a registered refurbisher, dismantler, or recycler after being collected.^[31] EPR refers to the responsibility for management of the disposal of products by producers once those products are designated as no longer useful by consumers. All in all, e-waste management in India requires ecologically friendly technologies with a high yearly recycling capacity.^[32]

2.3. Ghana

Most African nations are economically underdeveloped, and almost all of the EEE is imported from rich countries in America, Europe, and Asia. As a result, a significant volume of e-waste from various regions of the globe is illegally sent to numerous African nations, where it is recycled using simple, informal techniques owing to the lack of regulations governing e-waste recycling.^[33] However, in recent years, most African nations have expressed worry about the dangers of crude e-waste processing due to a lack of regulatory oversight. They have recognized the need for laws and more rigid rules to restrict the unlawful, informal handling of e-waste. They are now working on drafting legislation and regulations to address this issue. So far, Ghana is among the few nations (Kenya, Madagascar, Nigeria, and South Africa), which have enacted legislation governing e-waste disposal. These restrictions include a prohibition on the import of e-waste from foreign nations, as well as the EPR. In reality, EPR has been minimal rather than transformative, and efforts have been underfunded.^[34] Many groups are likewise collaborating with local governments to reduce the amount of e-waste generated. Poor e-waste rules and worker safety precautions in

Accra, Ghana, encourage exploitation and pose health dangers to individuals working and living near e-waste processing operations. In 2016, the Ghanaian government approved the Hazardous and Electronic Waste Control and Management Act (Act 917)^[35] which governs the management of hazardous and electronic waste.^[36] This regulatory framework necessitates the registration of manufacturers and private importers with Ghana's Environmental Protection Agency (EPA) and the payment of an Advance Eco Levy for electronic items brought into the country. The money collected is utilized to assist in the implementation, monitoring, and enforcement of the legislative framework and to support the formalization of informal players in the system. Previous initiatives in this area have mainly concentrated on the site of Agbogbloshie^[37] in the Ghanaian capital of Accra, which has attracted widespread public attention as the world's supposedly most prominent dumping place for electrical and electronic garbage.^[38] The lack of physical infrastructure and advanced technology across the e-waste sector in Ghana has proven destructive to human and physical environments.^[39] Due to the high danger of injury and pollution involved with handling electronic garbage, Agbogbloshie does not employ sustainable technology to collect, deconstruct, and sell it.^[40] The Ghanaian system is meant to be governed by international law (particularly the Basel and Bamako Conventions), yet non-compliance is the norm. The Ghanaian government has done nothing in particular to regulate this informal commerce in e-waste. Although actions must be taken in other regions to have a more significant impact on a broader scale, the national regulatory framework necessitates the creation of favorable conditions for informal workers to be integrated into the formal e-waste value chain without jeopardizing their livelihoods.^[41]

2.4. South Africa

Suppose one compares South Africa to other regions of the continent. In that case, it is a developed nation with various regulations for environmental protection, consumer protection, labor safety, and waste management, all of which govern certain aspects of e-waste management.^[42] In fact, legislation has been enacted particularly to address the issue of e-waste management. Several

groups, including the South African Waste Electrical and Electronic Enterprise Development Association, worked together to draft laws for handling e-waste. This area has seen a significant amount of study and planning. There is legislation in place that includes standards for e-waste disposal and processing and the concept of environmental protection through recycling.^[43] Developed under Section 18 (1) of the National Environmental Waste Management Act (NEWMA)^[44], the EPR regulations impact on the electronics industries which include battery importers or makers, direct distributors, paper and packaging manufacturers, and the single-use product sector.^[45]

Section 18 states that the plastics industry, or EPRs, will be able to “determine, raise, manage, and pay fees themselves and not work through somebody else”; this allows for implementing the industry-managed model. The EPR system will help improve South Africa’s circular economy prospects. Still, the emphasis should stay on the value of the product, or the trash, at the end of the day and on ensuring that this value is not lost in the process of recycling. The collection, reuse, and recycling of the plastic items involved will provide an integrated approach across the value chain, presenting a potential for developing new end markets and technologies. The rules were issued in November 2020, and revisions were made on May 5, 2021, to mirror the most recent changes.^[46] They went into effect in their entirety six months later, on November 5, 2021. All in all, the main goal of the legislation is to guarantee that manufacturers assume full responsibility for the lifetime of their goods, even after they have passed the point at which a customer must dispose of them appropriately.^[47] Optimistically, electronic devices, many of which are potentially detrimental to the environment, are expected to be diverted away from landfills due to the new laws. The new regulation is intended to make sure materials are recovered and recycled to the greatest extent reusable, rather than contributing to the rising issue of e-waste.^[48]

2.5. China

China is one of the world’s most prominent manufacturers of electronic products. And yet, in the counterfeit electronic trade, China is a significant source country for counterfeit products.^[49] The Chinese government has taken several domestic measures to manage e-waste properly. While economic

development enormously increased during the last two decades, the consumption of electronics rapidly produced a significant amount of “dead” electronic devices. Domestic migrants were assigned to the more dangerous and physically demanding professions, including dismantling and sorting electronic waste. At the national level, the legislation is framed and issued by the Ministry of Environmental Protection (now is *Ministry of Ecology and Environment*). In particular, in 1989, as a reflection of the polluter pays principle, the Ministry established general laws on the Environmental Protection System stipulating compensation for environmental pollution losses. In 2000, the Central Government chose to ban the import of several categories of waste. In 2003, the public institutions encouraged the producers to promote actions for cleaner production and eco-design. Subsequently, in 2006, it was established that the guiding principles of the 3Rs (*Reduce, Reuse, Recycle*)^[50] combined with the polluters pays principle, led to general provisions on eco-design, the information disclosure of products, and requirements for the environmentally sound collection, reuse, recycling, and disposal of e-waste. Following this, the state issued “Regulation on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products”^[51] and two specific policies under the Circular Economy Promotion Law (2018 Amendment)^[52], namely: (i) Administrative Rules on Prevention of Pollution by WEEE to reduce pollution caused by e-waste recycling and disposal; and (ii) Collection and Treatment Decree on Waste Electrical and Electronic Equipment which foresaw that e-waste must be collected through several channels and recycled by licensed recycling companies.

Under a prevention and control regulation against pollution scheme, the Ministry established restrictions on the use of hazardous substances in line with the provisions of the Basel Convention. The meaningful normative progress happened in 2012, among other things, with the implementation of the extended producer responsibility^[53] – basically to improve efficiency in utilization of resources – and the establishment of a special fund^[54] to assist e-waste recycling; a proper certification is also requested secondhand appliances and recycling enterprises.^[55] Notably, provincial programs correspondingly set waste collection systems and storage.

In 2012, the Chinese government implemented an EPR for e-waste, including

general regulations, tax administration, subsidy use, monitoring, legal responsibility, and additional rules. It applies to domestic EEE producers who are subject to taxation by the State Administration of Taxation of China and EEE imports subject to tax by the Chinese Customs Administration. These levies are primarily utilized as subsidies for e-waste recycling and as fees for installing management information systems. The incentives also encourage legal recycling firms to acquire e-waste from private merchants, which is beneficial since the vast majority of e-waste is purchased and disposed of by informal enterprises in the first place.^[56]

Since 2009, China has successfully launched the *Home Appliances Old for New Rebate Program* with positive results. Unfortunately, China is still one of the most frequent destinations for e-waste produced abroad. As pointed out by some NGOs such as Greenpeace and Basel Action Network, the disposal cost in some countries such as the European Union, the United States of America, Korea, and Japan is higher than the exportation fee to China.^[57] This former aspect does not have to be underestimated because it discourages the new circular economy while encouraging the creation of illegal landfills.^[58] On this particular point, it is possible to interface law and science because, as we know, “toxins in electronic equipment leak into the soil and water from landfills and into the air through the burning of waste.”^[59]

By the way, now, regulations are framed by Central and Local Governments setting proper stringent safety standards in connection with the creation of the *Chinese Ecological Civilization* initiative.^[60] Since its inception, this initiative, also promoting the circular economy, has stimulated the construction of extensive state-supported central disassembling facilities.^[61] Attempts by the authorities to impose a more civilized vision of modern and planned recycling as part of a circular economy, in line with the central rhetoric of ecological civilization, could be seen in the current construction site for e-waste recycling.^[62] As a result, to promote environmental civilization practices, it is essential to garner the support of people, governments, educational institutions, and social groups working together. The government, every social organization, and every household and institution should work together to establish the enabling circumstances that would allow each individual to acquire conscious habits of ecological civilization.

2.6. Singapore

Singapore is a small country that makes efforts to set up and enforce political solutions in the environmental protection field. Throughout its young history, Singapore has enacted several regulations to control and mitigate the impacts of e-waste within its boundaries, not only since the country ratified 1996 the Basel Convention 1989. Based on a specific policy entitled “National Voluntary Partnership for E-Waste Recycling”, Toshiba, HP, StarHub, Panasonic, and other industry partners will continue to play a prominent role in driving recycling initiatives, with further assistance and recognition from the National Environmental Agency.^[63] Anyway, in our present context, it is essential to highlight the Resource Sustainability Act (RSA) 2019 that disciplines the treatment and liabilities for e-waste and food waste, obligating the producers to join a licensing scheme.

Thus, the RSA makes the manufacturer’s registration of regulated items a legal requirement.^[64] The objective of this Act is primarily to establish a framework in which those who profit from the supply of products bear the costs of collecting and treating those products when they become waste. To encourage producers to reduce, reuse, or recycle packaging, production and retail businesses are responsible for collecting and disposing of unwanted regulated non-consumer products without charging any fees to consumers.^[65] Of note, according to the law, large retailers must offer an in-store collection of certain e-waste.^[66] A person, other than an individual operating with a license, must not provide a receptacle in a public place to collect any regulated product for disposal. This regulation also includes the implementation of the producer responsibility scheme. License conditions may consist of the fees payable by members of the producer responsibility scheme and the waste collection operations of the licensee. The requirements of a license can be modified at any time by section 30(3) of the Public Health (Waste Management) Act 2003. The Singaporean law is identifiable as producer and retailer-centered legislation following the Swedish legal model (where a large part of electronics can have a second life – the 3Rs). The legal novelty is that the subjects above have liability connected to the packaging, collection, and disposal.^[67] This legislation, as part of the doctrine, marks the beginning of proper e-waste management.^[68] Since recycling is

becoming more popular nationwide and many private businesses are voluntarily implementing recycling programs to help the environment, Singapore could potentially lead the ASEAN countries in establishing a newer subregional legal framework and support other countries by providing adequate know-how for efficient e-waste management.^[69]

2.7. Samoa

Samoa is a SIDS located in the Pacific area of the world. It has had an approved general legal framework on waste management since 2010, which, for hazardous waste^[70], refers to the Basel Convention 1989. Within this critical legislation, it is possible to highlight environmental and public health standards. Accordingly, it plainly states that the Minister may impose regulatory requirements for waste management techniques and facilities, and the Ministry is responsible for monitoring and enforcing compliance with the standards that have been authorized. The Minister of Health may prescribe public health standards about waste management techniques and facilities, and the Ministry of Health is responsible for the monitoring and enforcement of the measures that have been authorized. Compliance with the standards set under this section may require certified waste management operators and their contractors and any other individuals in the right middle. The failure or refusal to comply with an established standard by someone to whom the measure applies constitutes an offense punishable by a fine of up to 20 penalty units in addition to any other penalties. Failure to observe or comply with an approved standard may also result in (i) the suspension or revocation of any registration or license applied for by the person in violation; (ii) the denial of a subsequent registration or license sought by the person in violation; and (iii) the termination of any contract between a waste management operator and the person in violation. Samoa is making efforts to create environmentally sound storage facilities on its small territory, assuming a holistic approach. In 2020, Samoa will commit itself to improving e-waste management by collaborating with the vital support of the EU PacWastePlus Program for effective e-waste management.^[71] Of particular interest is the public-private partnership stipulated between Samoa and HP to collect office-produced e-waste such as toners and ink cartridges that may negatively affect the

surrounding living environment.^[72] All in all, Samoa is making its maximum efforts but still lacks adequate legislation and financial resources to build specialized infrastructures out of the 4Rs activities.

3. A comparative analysis: key takeaways

At the start of this succinct legal comparative analysis, it is important to note that this paper collects and compares the e-waste laws of different countries in an effort to find the legal doctrine of universal civilization for the betterment of all people.^[73] From a legal standpoint, it must be stressed that the EU has the most comprehensive legislation. Using legal instruments such as the 2012/19/EU directive, the EU disciplines e-waste management regulating the whole collection, recycling, and recovery of resources following significant standards (e.g., EPR). According to the directive, all member states have their own national e-waste management rules. Due to low EEE use, some nations may be exempt from this legislation by 2021.^[74] Differently, in India, the legislation lacks stringent standards for regulating the disposal of e-waste to protect human health and the environment. This aspect makes the country an exploitative environment for e-waste dumping from developed nations. The government should set proper rules to fight informal recycling and illegal imports and allocate the necessary financial resources. One should note that India and China are among the most significant global contributors to e-waste. These two countries should organize more programs and activities to build proper infrastructure for collection and disposal.^[75] Both nations need to balance the tensions of having businesses compete in the marketplace while also having enterprises work together to build industrial ecology processes. This will require the adoption by legislators of a new paradigm for our industrial system — an industrial ecology whose dynamics are similar to those of a natural ecosystem. In this sense, the *Chinese Ecological Civilization* initiative is a sign of progress and a positive shift.^[76]

As a theoretical model and point of discussion, South Africa is a leading country that acts as a strategic link between the African countries. The 2020/2021 legislation follows a simplistic approach to e-waste management but tends to evolve by setting up the EPR system, improving South Africa's prospects in the circular economy. The ideal would be to choose materials and manufacturing

techniques that provide a more circular flow as part of this system. To accomplish this, it may be necessary to form partnerships between the private and public sectors as it occurs in Samoa but also in Singapore overall. As explained, (i) Samoa and HP have agreed to work together to collect office-produced e-waste such as toners and ink cartridges that may harm the surrounding environment. (ii) Toshiba, HP, StarHub, Panasonic, and other industry partners will continue to play a significant role in advancing Singapore's recycling activities, with more aid and recognition from the National Environmental Agency. These types of collaboration are also crucial in the enforcement of sectorial laws. Interestingly, Samoa committed to improving e-waste management by partnering with the EU, which provides critical assistance for the country's efforts to make e-waste management as effective as possible. Similarly, Ghana is seeking the formalization of its e-waste management system with the support of the EU, developing an e-waste collection system, sharing best practices, and involving universities and public authorities.^[77] Nevertheless, more effort is needed to fully execute the legislation's aims and limit the adverse impacts of WEEE on human health and the environment.

Advocacy activities have to be organized in the European, African, and Asian continents to spread environmental awareness about the issue at hand and the importance of circular economy (which is the legal mindset behind most e-waste management laws of the world).

Here, writing a good progress note, it is essential to highlight the way forward related to the circular economy provided by the World Economic Forum in January 2023 as follows:

«We are seeing industries and policymakers turn towards resource circularity to help secure, transform and diversify the supply of industry-critical materials while reducing the need for extraction and associated emissions. Industry coalitions have worked with future-focused governments to establish the incentives, policy frameworks, standards, operating models, certifications and circularity-focused capabilities that are necessary to scale. In some markets, business models have been transformed to decrease demand and increase both the recovery potential and actual recovery of these resources, partially mitigating the demand-supply gap going forward»^[78]

From a broad comparative legal perspective, one ought to note that EPR is a

global rule and a primary component of several e-waste management legislations worldwide with varying degrees of implementation from one nation to another. EPR stimulates the advancement of the circular economy and SDG achievement at the global level.^[79] Hence, cleaner production is the critical instrument for laws, which entails researching the interactions and linkages between industrial and ecological systems.

4. Final remarks and suggestions

The discussion in the above paragraphs shows that EEE waste is a broad category of products that have reached the end of their useful lives, including computers, refrigerators, and mobile phones. As already explained, this form of garbage comprises a complicated variety of components, some of which are potentially harmful and toxic. If the abandoned gadgets are not correctly handled, they might result in serious environmental and health consequences for humans. Thus, this is a severe environmental issue threatening human security. Furthermore, contemporary electronics include REEs or other valuable materials, which may be recycled and re-used if the trash is handled correctly. It is a personal belief of the author that the lockdowns during the current pandemic (in some areas of the globe) in 2022 may lead to a rise in the usage of electrical and technological devices and an increase in their disposal. Growth in video game consoles, smartphones, laptop computers, and microwaves was attributed to COVID-19. To prove that this is the current dynamic between Global North and Global South, high-income nations are the only ones responsible for the rise in demand.^[80] Although, to contrast environmental pollution due to the large number of e-wastes, many efforts are being made by the public authorities worldwide, the available international, regional, and domestic legal instruments and strategic approaches are not yet enough.

We still need proactive steps forward to take all necessary, adequate, and applicable measures to concurrently guarantee environmental protection and human safety, clarifying certain ambiguities that sometimes we may encounter in the legislation (e.g., the problematic definition of e-waste). In several countries, like those analyzed above, it would be essential to allocate more economic resources to build infrastructure for recycling the e-waste and train more people

to gather the necessary know-how. Automating e-waste recycling, increasing throughput, and lowering energy usage will be critical in the future, and governments should finance and promote such advances. For countries to take global leadership in advancing the circular economy, they have a tremendous opportunity to do so. E-waste is a global environmental problem that asks for urgent global responses. From a legal perspective to some extent, it is plausible, *de jure condito*, to draw the conclusion that it is crucial to interpret the current international environmental law in an evolutive way (e.g., Basel and Waigani conventions). This would allow to build up an international platform for states and non-state actors for information sharing, transboundary monitoring, capacity building, etc. Based on best practices and state consent, it is advisable, *de jure condendo*, that a specific international environmental treaty would provide a more coordinated approach to cleaning up and neutralizing e-waste imposing specific obligations on private operators such as big companies. The potential treaty should be based on principles of international environmental law, such as “prevention”, “polluter pays” and “common but differentiated responsibilities” and on the emerging principles of non-regression, *in dubio pro natura*, and possibly land degradation neutrality.

Cleaning up e-waste is not only the state’s obligations but also individuals are equally responsible. Consequently, the laws have to be updated following the technological evolution of the products; these laws must be regarded as a trustworthy societal tool in order to produce an effective and considerable positive behavioral change. We may avoid purchasing superfluous electronics or discard them. We need to avoid information asymmetries and a lack of information. We may also disseminate e-waste literacy in nearby communities to maximize involvement. In the end, harmony with nature requires maintaining and sustaining ecosystems, landscapes, cultures, and traditions.

1. This paper is the result of a common intellectual reflection of the two authors, with particular reference to the comparative analysis and final remarks as well as the suggestions. Except for the paragraph on China, that was co-developed with the second author (Ji Hua), the first author (Giuseppe Poderati) fully elaborated the legal analysis of the surveyed countries, though.
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