recycling

MDPI

Article

A Framework for Public Policy Development in BRICS Countries to Support Circular Economy Development in the WEEE Value Chain

Christian Luiz da Silva * and **Nádia Mara Franz**

Graduation in Technology and Society (PPGTE) and Regional Development (PPGDR), Economics and Management School, Federal University of Technology (UTFPR), Curitiba CEP 80230-901, Paraná, Brazil; nadiamfranz@gmail.com
* Correspondence: christiansilva@utfpr.edu.br

Abstract: Waste Electrical and Electronic Equipment (WEEE) has grown three times faster than the world's population and 13% more than global GDP with increasing urbanization, including in BRICS countries (Brazil, Russia, India, China and South Africa), which were home to around 42% of the world population in 2024. The research question in this study is as follows: how are BRICS countries integrating WEEE actors in moving towards sustainable cities? The integration of actors, based on the principle of sustainable cities, occurs through different forms of interaction: either through the institutional apparatus in which they operate or through the economic, social or environmental issues in which they are involved. The study proposes a framework for public policies of the WEEE value chain under the precepts of sustainable cities in the BRICS countries. The techniques applied were based on bibliographical and documentary research and semi-structured interviews. The Delphi method was applied for the interviews. The framework comprises 39 strategic variables in the urban environmental, economic and social categories. Applying this framework enables the identification of barriers and opportunities in the context of cities in the BRICS countries. Based on the proposed framework, it is possible to evaluate and propose public policies for BRICS countries, reinforcing opportunities and seeking to deal with existing barriers.

Keywords: WEEE; BRICS; public policy; WEEE chain; sustainable cities; circular economy

check for updates

Academic Editor: Michele John

Received: 1 November 2024
Revised: 30 December 2024
Accepted: 2 January 2025
Published: 7 January 2025

Citation: da Silva, C.L.; Franz, N.M. A Framework for Public Policy Development in BRICS Countries to Support Circular Economy Development in the WEEE Value Chain. *Recycling* **2025**, *10*, 7. https://doi.org/10.3390/recycling10010007

1. Introduction

The rapidly increasing world population, urbanization and waste generation constitute challenges for governments to shape and implement public policies that harmonize these variables and promote the sustainable development of their countries in keeping with the UN Agenda 2030 and the principles of the circular economy [1,2]. However, climate change at the global level and the rise in the number of natural disasters mean that it is necessary to seek alternatives for development [3,4].

Within this context, Waste Electrical and Electronic Equipment (WEEE) forms the fastest growing waste stream at present. The amount produced is growing three times faster than the world population and at rates higher than global GDP [5,6].

The WEEE value chain materializes in cities, which are where the economic, social and environmental challenges of today's society are found. Therefore, the concept of sustainable cities is articulated in this context with the territorialization and materialization of public policies intended to minimize the use of resources [7–9].

Sustainable cities are related to the territorial dynamics of public policies linked to urban planning and the multidimensional approach [10]. According to reference [11], cities are hybrid social–economic–natural ecosystems that represent the densest concentrations of people and their activities, leading to a dramatic reduction in urban wetlands and green spaces.

Sustainable development is therefore necessary for urbanization to continue. Thus, the concept of a sustainable city is aligned with the principles of the circular economy, considering that this is a recent attempt to integrate economic activity associated with the environmentally responsible use of resources in a development process, as pointed out by [12].

Despite greater concern over the sustainability of cities, industrialization and urbanization, population and consumption growth have increased levels of waste generation and pollution, causing greater harm to the environment and human health and contributing to the scarcity of resources [9]. Effective urban planning and management practices are needed to address the challenges of expanding urbanization [1].

Given this scenario, countries have established laws and auxiliary standards on waste management in response to local problems but also because they were highlighted in the global scenario, as identified in the early 1990s with the Basel Convention and adherence to the concepts of sustainability, sustainable development and the circular economy, constituting the concept of a sustainable city.

In 2020, it was estimated that 71% of the world's population was covered by some national legislation regarding electronic waste, with China and India accounting for much of this percentage due to their legislation on this waste [13]. In terms of countries, the number grew from 61 countries in 2014 to 78 in 2019. As the report on the global Waste Electrical and Electronic Equipment (WEEE) panorama pointed out, regulatory advances in some regions occur slowly, with weak enforcement and policies, legislation or regulations that do not stimulate the structuring of the waste chain [13].

The reality, however, shows that global WEEE disposal in 2019 was 53.6 Mt, and it is estimated that by 2030 this number will rise to 74 Mt, the highest waste flow in the world. It is estimated that only 17% is currently disposed of properly [13–15].

In this scenario, the BRICS countries, Brazil, Russia, India, China and South Africa, are considered highly relevant in the global context. The aim of the BRICS bloc is to promote measures of economic growth and sustainable socioeconomic development among emerging countries. It plays an important role in the greater involvement of emerging economies in the world economy and in the international geopolitical context. Together, they represent around 41.15% of the world's population and 25.71% of global GDP, but they have high rates of WEEE generation and low percentages of recycling of this waste.

The BRICS countries are a set of countries that are of great importance in terms of territory and population (29.6% and 41.1% of the world, respectively), whose economies showed prospects for continued expansion early this century, emphasizing their geopolitical role. However, these countries have very different economic, social, geographical and natural resource structures. Nevertheless, it is important to study the BRICS because of their importance to and impact on economic growth, their influence on international relations, their consumer markets and their supply of raw materials [16,17].

All of these issues are directly and transversally associated with the electronic waste chain, considering that it is a group of countries with great economic potential, which has seen faster growth than the OECD countries and impacted the international economy. This makes the BRICS a group of countries with great political and military influence, and which can take the lead in initiatives that favor the most vulnerable countries. Moreover, they have a combined population of billions of people, which makes the group a highly important consumer market, and they are important suppliers of raw materials and industrialized products [16,17].

In 2019, for instance, it was estimated that 53.6 million tons of WEEE were generated across the globe, with the BRICS responsible for around 32.03%, of which less than 15% were recycled. Recycled materials can be reintroduced into production chains, reducing pressure on the extraction of natural resources, preserving the environment and human health [13,15–18].

It should be highlighted that this study is limited to the BRICS countries as they were until 2010 (Brazil, Russia, India and China—2006; South Africa—2010). The other countries that joined in 2024 (Saudi Arabia, Egypt, the United Arab Emirates, Ethiopia and Iran) are not included, as they only entered the bloc recently.

Given this context, it is necessary to understand what has been implemented in this diplomatic bloc to manage this waste, in the context of sustainable cities, integrating an economic, social and environmental vision. Therefore, the research question is as follows: how are BRICS countries integrating WEEE actors in moving towards sustainable cities?

The integration of stakeholders, based on the principle of sustainable cities, occurs through various forms of interaction: either through the institutional environment in which they operate or through the economic, social or environmental issues in which they are involved. Public policies must be aligned with this context to promote the development of cities in these different countries. The aim was to propose a framework for public policies of the WEEE value chain under the precepts of sustainable cities in the BRICS countries.

The research methodology follows a qualitative approach of an applied nature, with bibliographic and documentary research techniques and semi-structured interviews, with a multiple case study method. The Delphi method was applied for the interviews, as described in Section 3.

The article is organized into six sections, with this introduction, followed by an establishment of the concept of sustainable cities and the research methodology. The Section 4 presents the results, and the discussions are presented in the fifth section, followed by the conclusions.

2. Sustainability in Waste Electrical and Electronic Equipment (WEEE)

Mendes (p. 1, [19]) noted that the planet's urbanization follows "[. . .] four major global demographic trends: population growth, population aging, migration and urbanization". These variables pressure cities to produce more products and consume natural resources, generating higher levels of all forms of pollution and greenhouse gas emissions [20,21]. With urbanization and the concentration of the population in large urban centers, it is necessary to shape the development of cities in line with the principles of sustainability, with priority for public–private–society partnerships, as local action in city management is fundamental for the sustainability of the planet [15,22,23]. Chang et al. [24] treated a sustainable city as a vision of the future, shared by its citizens, to provide better quality of life in the present, maintaining or expanding possibilities of well-being and prosperity for future generations. Thus, this future vision is a strategy for urban development and planning.

Camagni, Capello and Nijkamp [25] and Cepeliauskaite and Stasiskiene [7] argued that a city is formed by diverse interrelated environments. The sustainable development of an urban environment is a complex process, incorporating several variables and subject to local diversity. Furthermore, sustainable urban environments are analyzed and conceptualized in different fields of research and are thus conceptualized from different viewpoints [26–28].

The Organization for Economic Co-operation and Development (OECD) adopted the premises of the New Urban Agenda (UN—Habitat III) for urban development programs.

In partnership with governments, they seek to set international standards, shaping policies that promote economic growth, social equality and environmental sustainability and prevent international tax evasion [29]. The motto of the World Bank [21] is that sustainable cities are built by “inclusive, resilient and sustainable communities” and follow four premises, in that they are (i) environmentally sustainable in terms of cleanliness and efficiency; (ii) resistant to social, economic and natural shocks; (iii) communities inclusive of all groups of people; and (iv) competitive communities that can remain productive and generate jobs for community members.

This research considers the dimensions of sustainable cities in the OECD approach [29], related to the economic, environmental, social and institutional issue. It is understood that these dimensions are articulated with the perspective of understanding and evaluating public policies for the development of cities. However, the city is sustainable if it is perceived as such by society itself. This necessarily involves the integration of government, market and society [30]. In this respect, companies constitute value chains that interact in urban spaces, influencing public policies [31]. The result is perceived and interacts with society itself, but requires changes and collaboration for integration from the perspective of the dimensions of sustainability in cities [32].

The sustainable development of cities depends first on diagnosing and analyzing trends in regional urbanization, as well as at the national and global level, which are expected to last for the coming years, and public policies that include and meet the demands of urban growth [33,34]. In this respect, having the infrastructure of a smart city is important when it comes to expanding this process [35]. Public policies must provide cities with appropriate infrastructure, allowing everyone access to medical care, education, housing and work [15]. The sustainable development of cities depends first on diagnosing and analyzing trends in regional urbanization, as well as at the national and global level, which are expected to last for the coming years, and public policies that include and meet the demands of urban growth. In this respect, having the infrastructure of a smart city is important when it comes to expanding this process [36]. Public policies must provide cities with appropriate infrastructure, allowing everyone access to medical care, education, housing and work [15]. However, there are tensions between smart city and sustainable city strategies, such as a more neoliberal vision, prioritizing greater access to smart city technology, while not addressing the importance of environmental issues to the city’s dynamics [37]. Therefore, this study reinforces the use of sustainable cities rather than smart and sustainable cities, because it confirms that these tensions are not resolved and create different strategies.

Sustainable cities handle waste management by integrating all dimensions. It is an environmental issue due to the application of the concepts of the circular economy, an economic issue due to income generation and a social issue due to social inclusion [38]. Reverse logistics strategies and competitive advantage involving electronic waste stakeholders interacting within cities through public policies [39]. Public policies can focus on the micro, meso or macro level. The micro level is understood as incentives for changes directly related to the business model and the value chain. Thus, micro public policies are policies for the development of the chain. The meso level is related to regional policies that materialize in territorial dynamics. Meso public policies are public policies related to the territorialization of chain actions in cities. In this case, policies are administered and defined in the context of cities. Macro level policies refer to institutional and regulatory apparatus (governmental and non-governmental actors) and the formal rules of the game (laws and regulations, for example) and informal rules (cultural issues, for example). This macro level also includes international policy on the subject and agreements between countries, as found in the BRICS bloc.

This approach, in keeping with the concept of a sustainable city, is integrated with WEEE management because, in addition to reducing the amount of electronic waste, it reduces the global demand for the exploitation of natural resources [13,38]. WEEE management is associated with the principles of the circular economy, as a sustainable development strategy, although it already had legislation on maximizing natural resources and waste management [39]. Thus, the WEEE problem is particularly concentrated in cities due to the accumulated generation of this type of waste, making it a public problem and creating the need for policies to address it. The institutional issue is related not only to the existence of established rules but how these rules influence the dynamics of the chain and the city.

Economic and social issues are related to WEEE management through micro policies that affect the dynamics of the market. Socioeconomic issues are affected by institutional definitions (rules of the game) and influence the formulation of these rules based on the current condition [40]. On the other hand, the environmental issue is a restriction of natural and important resources in this market that is influenced by its policies (micro policies) that restrict and condition the value chain. At the same time, the importance of this chain influences environmental decisions. The environmental condition impacts institutional issues which, at the same time, are restricted by institutional issues. The institutional issue itself delimits and influences the WEEE chain [41,42].

3. Methods

This research is of an applied nature, as it focuses on identifying problems, developing diagnoses and seeking solutions to issues present in the daily lives of various social actors, institutions or organizations.

The research focus is qualitative because it focuses on exploring phenomena in natural environments, where data generate meanings but are not based on statistical analysis [43]. The process is inductive and recurrent and can analyze multiple realities and cover a wider range of research with interpretative richness, leading to depth of meanings [43].

The sample for this research follows the intentionality standards of being selected based on certain characteristics considered relevant by researchers and participants [43]. The purpose of the intentional sample is to conduct a study richer in qualitative content. In this study, the intentional sample consists of the BRICS countries: Brazil, Russia, India, China and South Africa. The research objectives classify the study as combined exploratory–descriptive, as it aims to identify and fully describe a phenomenon [43].

The chosen research method is the case study. From a realistic perspective, this case study (BRICS) is composed of multiple case studies (Brazil, Russia, India, China and South Africa), with each case examined in an individual reality, with cross-analysis at the end and a single set of conclusions. The results of each case may be similar or contrasting but follow the same method replication logic [43].

3.1. Justification of the Case Study

Brazil, Russia, India, China and South Africa make up the BRICS diplomatic group that was formalized in 2009. According to data from the World Bank [44] for the year 2021, the BRICS represented approximately 41.15% of the world's population, 30% of global territory and 25.71% of the world's GDP. Individually, each country in the group makes important contributions to strengthening the BRICS in global governance. Table 1 presents certain socioeconomic data of interest to this study.

Table 1. BRICS data.

	Brazil	Russia	India	China	South Africa
Population, millions (2021)	213.99	146.80	1393.40	1412.36	60.04
Territorial area, mil/km^2	8515.34	17,125.20	3287.25	9600.01	1219.09
Population density, km^2 (2019)	25.3	8.9	459.61	152.7	48.3
GDP, USD billions (2021)	1608.98	1775.79	3173.39	17,734.06	419.94
Per capita GDP, USD (2021)	7518.8	12,172.8	2277.4	12,556.3	6994.2
WEEE generation, kt/year (2019)	2143	1631	3230	10,129	415.5
WEEE generation per capita, kg/year (2019)	10.2	11.3	2.4	7.2	7.1
Recycling of WEEE	<2% (2019)	2.5% (2019)	0.95% (2016)	15% (2019)	10–12% (2019)

Source: [44].

In the electronics market, Brazil is among the largest global producers of EEE, and domestically, the sector represents around 4.1% of the national GDP [45]. However, the country is the fifth largest generator of Waste Electrical and Electronic Equipment (WEEE) in the world, with high per capita WEEE generation (10.2 kg/year in 2019) [13].

Russia has a significant EEE production hub aimed at the domestic market and expansion in the regional market [46]. With the second highest per capita income of the BRICS at USD 12,172.80 (2019), it is the largest generator of WEEE per capita in the group, with 11.3 kg/year per inhabitant in 2019 [46].

India, driven by national strategic policies such as Make in India and Digital India, is rapidly emerging in the global electronics market, accounting for 3.6% of global EEE production in 2019, and has become the world's second largest producer of mobile phones [47].

On the other hand, China stands out in several respects in the global EEE market as one of the world's largest producers of EEE and having the largest domestic consumer market, but it is also the largest generator of WEEE in the world, at around 10,129 kt/year (2019) [13]. China, the United States and India are responsible for around 38% of the global volume of WEEE generation [15]. In 2019, India generated 3230 kt/year of WEEE. In the BRICS, Brazil occupies the third position, generating 2143 kt/year in that year [13], demonstrating the country's potential for material recovery and expansion of secondary resource markets.

South Africa, an emerging economy, has significant reserves of natural resources (gold, copper and iron) that are used in the production of EEE and is attracting foreign investment in the EEE production and WEEE treatment market [42].

This shows the importance of the EEE and WEEE markets to the BRICS countries, whose activities generate income for thousands of people in the formal and informal markets.

3.2. Research Protocol

The techniques applied to the data collection were predominantly based on bibliographical and documentary research and semi-structured interviews [43]. The Delphi method was applied for the interviews (Section 3.3).

For data analysis, which includes the organization and display of data, the strategies established by Yin [48] were adopted. In these, analytical strategies can begin with the observation of patterns, intuitions (insights) and promising concepts related to the specific research goals. The selected theoretical propositions are then used to organize the data analysis, although in this process new patterns may emerge, requiring the treatment of these data from scratch. Simultaneously, the description of each case is developed individually and in line with research priorities, examining rival and/or alternative explanatory frameworks.

Cross-case synthesis is the analytical technique applied to analyze the evidence from multiple case studies in this research, with the cases first being analyzed individually and the findings subsequently totalized, replicating or contrasting the results.

The research protocol presents the activities undertaken with the respective data collection and analysis technique and the resulting product (Table 2).

Table 2. Research protocol.

Activities	Data Collection	Data Analysis	Product
Definition of the relationship between Waste Electrical and Electronic Equipment (WEEE) and sustainable cities	Bibliographic research	Bibliometric study	Section 2
Synthesis and analysis of the legal and institutional compositions of WEEE management in the BRICS countries	Document research	Document and bibliometric analysis; content analysis	Section 4
Synthesis and analysis of the different actors in the processes inherent to WEEE in the BRICS countries (definition of the value chain)	Document research	Document and bibliometric analysis; content analysis	Table 3
Structuring of the important theoretical aspects and positive results in WEEE management in the BRICS countries with the precepts of sustainable cities: barriers and opportunities	Document research	Cross-analysis technique; content analysis	
Assessment of the theoretical propositions applicable to WEEE management policies and actions in BRICS countries in terms of sustainable cities	Delphi method; online semi-structured interviews (35 interviewees, 7 from each country)	Cross-analysis technique; content analysis	Table 3
Definition of a framework applicable for WEEE management policies in the BRICS countries in terms of sustainable cities	Delphi method; online semi-structured interviews (35 interviewees, 7 from each country)	Cross-analysis technique; content analysis	Table 3

Almost 100 documents were analyzed, including official documents from the countries in question and directly related technical and scientific articles, cited with sources in the aforementioned tables. All the documents were classified by the topics under study and two tables were created that guided the presentation of the results and discussions.

This allowed the identification of barriers and opportunities. Together with actions guided by the concept of sustainable cities, the key variables for proposing a framework were defined. These variables were validated using the Delphi method, as highlighted in Section 3.3.

The methodology applied in the semi-structured interview consisted of the three stages proposed by the Delphi method: (i) assemble a panel of experts; (ii) apply the data collection instrument; and (iii) use tools to organize and process data. There now follow more details on the data collection and treatment.

3.3. Delphi Method: Selecting the Group of Specialists and Testing Consistency

To validate and/or incorporate the number of variables in this study, the Delphi method was used, which is based on the principle of collective intelligence. The premises of Linstone and Turoff [49], which included a self-assessment procedure, were considered for the selection of experts. This technique considers the competencies of the participants, allowing them to argue and support their opinions on the topic in question. In this study, experts with diverse technical training who work or have worked in public, private or mixed companies in the Paraná electricity sector, local authorities, councils, associations and/or universities or environmental licensing agencies were considered.

There is no consensus regarding the ideal number of experts in this type of study. In the work of Hasson et al. [50], the authors suggested that the number of experts should vary according to the environment of the problem and the resources available for applying the technique; Landeta [51] suggested 7–30, León and Montero [52] suggested 10–30 and Skulmoski et al. [53] suggested 1–10 expert interviewees should participate.

The interviewees were selected using the snowball technique, in which one interviewee indicates another possible interviewee. After signing the Informed Consent Form, the interviewees were given access to the interview questions. The interviewees' participation in the research followed the precepts of cross-sectional studies, which analyze data in a specific time and scenario. In total, 35 semi-structured online interviews were conducted with technical and scientific experts involved in WEEE management: 7 from each country (Brazil, Russia, India, China and South Africa). There were two interactive rounds with subject matter experts to define the strategic variables. The first round identified relevant topics for the integration of WEEE management in the shift towards sustainable cities. Based on the defined strategic variables, the weight and importance of these variables were considered in the second round, with agreement between experts from different countries.

Regarding the segments in which they operate, 42.85% are linked to government agencies, councils and associations, 28.57% are from the private sector and/or are professionals from recycling companies and 28.57% are from public institutions that focus on compliance with established standards and regulations. It should be noted that some of the interviewees work in academia and in one of the aforementioned groups. Therefore, they were not specifically categorized as belonging to the academic sector. Absolute anonymity of the participants was guaranteed to protect their opinions and judgments.

Statistical methods were used to validate the relevance of the theoretical variables, which all the participants agreed to following the application of the data collection instrument. The variables were judged on a scale of 1 to 10, with 1 meaning that the variable judged individually was unimportant and 10 meaning it was considered extremely important. The results confirmed the relevance of the methodological proposal and the statistically reliable results. To assess the internal consistency of the questionnaire, Cronbach's alpha was calculated. Cronbach's alpha is an indicator of the reliability of a questionnaire that measures the correlation between the respondents' answers. The result was 0.953, which is considered excellent. Kendall's coefficient was also calculated, and the value was 0.248, but it is worth noting that, in a probabilistic evaluation, this value presented in the hypothesis test developed for this statistic a value of $p = 0.000 < 0.01$, indicating strong evidence for rejection of the null hypothesis, which means rejection of the disagreement between the evaluators.

As methodological limitations, it should be noted that the proposed framework has to be evaluated in each city because the weight and importance of each variable change according to the socioeconomic and environmental structure of the cities, as well as the institutional issue that guides public policies. However, the proposed framework defines the key variables for proposing public policies for WEEE management in terms of the concept of a sustainable city. Therefore, it is a model that needs to be adapted to each reality of its application. Another point is that this framework is applied to the BRICS countries that joined before 2024. It is not possible to extrapolate the results to other countries because the framework was defined based on an in-depth study of these countries and the barriers and opportunities relevant to each one.

4. Results

To compare and analyze the functions of the diverse actors in WEEE processes, they are grouped into three segments: (i) macro (ii) meso and (iii) micro, as defined in Section 2.

4.1. Macro Level

Every BRICS national government has WEEE management regulations, monitoring the implementation of their policies, supported by local government awareness campaigns for WEEE disposal, which are in their early stages, with more advances in the metropolises of each country.

A description and analysis of the legal and institutional WEEE frameworks showed that Brazil, China and India have specific WEEE management regulations whereas Russia and South Africa address the issue in broader solid waste management legislation. Brazil introduced legislation in 2020, following a sectoral agreement signed in 2019. Meanwhile, China is moving from specific WEEE management regulations to laws promoting the circular economy that include WEEE, restricting and prohibiting it in parallel with importing this waste.

Moreover, the governments, through their national, state/provincial and municipal spheres, have undertaken policies and actions that support the structuring and sustainable development of the WEEE value chain considering the characteristics of their territoriality [54]. In particular, the Chinese national government has implemented pilot recycling projects in several regions of the country, while the Russian government is enabling the implementation of eco-industrial parks, both projecting greater circularity of materials. Meanwhile, the Indian government seeks to promote the development of technologies for recycling waste alongside training programs and integration of the informal sector, seeking socio-environmental and economic integration from the perspective of a sustainable city [22,24,55]. These three countries apply recycling subsidy rates to EEE production (p. 553 [56]). In China and Russia, the fund is administered by the government, while in India, it is managed by producers/importers, who report to the government, highlighting the economic issue as a transformer for a sustainable city [25–27].

In the government sphere, the BRICS countries appear to share certain functions. At the national government level, there is the responsibility for passing laws and setting regulations and guidelines specifically for the processes and agents involved in WEEE management. These macro public policies define the rules of the game. Furthermore, the government is responsible for monitoring the implementation of national WEEE policies, especially reverse logistics systems, and monitoring and supervising the transport of WEEE in the country and abroad. The national governments of China, India and Russia also play a key role in implementing and transforming production parks. Russia seeks to make eco-industrial parks feasible, while India promotes the development of technologies and China promotes pilot recycling projects.

4.2. Meso Level

At the state/provincial level, all BRICS countries have regional solid waste management plans specifically for WEEE generation and management, except Brazil, which delegates the formatting and implementation of WEEE management plans to the market. At the local level, governments take other actions to manage WEEE and raise society's awareness of its proper disposal. In Brazil, urban public cleaning managers can work in WEEE reverse logistics networks provided they are qualified. Municipal governments in Russia are responsible for maintaining WEEE storage facilities. In India and South Africa, municipal administrations separate WEEE from solid waste, channel it appropriately and support municipal recycling activities, from the perspective of optimizing the resources consumed [28].

In this context of sustainable cities, integrative policies to stimulate circular economy practices in municipal spheres with WEEE constitute an opportunity. Although WEEE is a global challenge, it can be transformed into strategic waste for sustainable management if properly managed, treated and discarded [55].

It is clear, therefore, that governments act beyond the institution of standards and laws regarding WEEE management, undertaking and coordinating the development of technologies, infrastructure and human capital that enable the circularity of materials, reducing amounts of WEEE and providing opportunities to generate sustainable income for thousands of workers [10,11].

However, the circularity of WEEE materials is complex, either due to the substances in this waste or the practices historically constructed by societies. Thus, the precepts of sustainable cities are not observed as they do not consider the complete cycle of the chain and prioritize circular economy strategies [57–60]. The result still focuses on the production and import of WEEE, but without a flow that can be enhanced in cities [8,11,12].

In BRICS countries, EEE producers, importers, distributors and traders are responsible for implementing WEEE reverse logistics networks and channeling them to licensed means of treating and recycling the materials. Conversely, EEE consumers are prioritized with some variations among the BRICS depending on the amounts of WEEE discarded. Brazil and China consider consumers in general. Russia classifies EEE consumers into household and business, India and South Africa into consumers and large-scale EEE consumers.

Every BRICS country has laws on specific or detailed WEEE management within broader waste management legislation. These regulations are fundamental for guiding the actors involved, establishing their responsibilities and the country's aims in the sector.

In Brazil, it is estimated that there are around 800 thousand recyclable collectors [61], 272 organizations and 46 collector cooperatives involved in WEEE recycling activities [62]. In Russia, studies have mapped 80 formal WEEE recyclers [63,64]. However, the government intends to implement 70 industrial parks with 216 waste treatment, recycling and neutralization facilities by 2030 [64–66]. In India, in 2021, the Central Pollution Control Board announced that 407 WEEE collection and recycling organizations operate in the country [67], generating more than 450 thousand direct jobs and 180 thousand indirect jobs [68]. In China, data from 2015 indicated the activity of 109 formal WEEE recyclers [69]. In 2021, official data identified 90,000 formal waste recycling establishments and an estimated 300,000 unregistered establishments [70], generating income for around 18 million people [70]. South Africa has 25 medium-sized and small recyclers and seven large WEEE recyclers, which, respectively, employ around 5–25 and 100 workers in each plant [71–73]. Furthermore, it is estimated that there are over 600 collection and repurchase points in the country [74] and around 90 thousand recyclable collectors work informally in the country [75–78].

At the state government level, the aim is to implement regional solid waste management plans. Russia, India, China and South Africa strive for highly integrated regional WEEE generation and management plans linked to national WEEE management policies.

Finally, municipal governments raise awareness in society regarding the proper disposal of recyclable waste. However, different strategies are used to this end from one country to another within the scope of meso public policies (at the city and regional level). In Brazil, municipal governments are responsible for urban public cleaning and solid waste management and can operate in WEEE reverse logistics networks providing they are qualified. In Russia, municipal governments are responsible for maintaining WEEE storage sites in accordance with the regional waste management plan. In India, they even separate WEEE from solid urban waste and channel it to authorized collection centers, dismantlers and recyclers. In China, they have municipal waste management plans to implement national/regional WEEE generation and management plans and are involved in supervising and formalizing WEEE market activities. Finally, in South Africa and India, WEEE is separated from municipal solid waste and channeled to collection centers, dismantlers and authorized recyclers, with support for recycling at the municipal level.

Therefore, it should be noted that public policies at the meso level establish differentiated functions and responsibilities for municipal governments and their actions in managing the chain, integrating municipal public policies (meso) with policies to stimulate the WEEE chain (micro), based on national policy.

4.3. Micro Level

In relation to the market (micro level), actors implement individual or collective WEEE reverse logistics systems and channel WEEE for licensed and environmentally appropriate recycling methods. Russia, China and South Africa have specific rates that directly influence the market. Distributors and retailers participate in the reverse logistics network in all BRICS countries. Recycling companies collect, dismantle, separate and recycle WEEE. The other actors are collective WEEE managers, reconditioners and repairers, intermediaries, informal waste pickers, cooperatives and collectors' associations [74–78].

All EEE consumers are responsible for the proper disposal of WEEE in accordance with the legislation of the BRICS countries, although it appears that the practice remains under construction and depends on the level of awareness and habits of society [35,36]. Chinese and Indian consumers perceive WEEE as a source of financial resources and prefer to sell used EEE and WEEE through intermediary traders and reconditioners, whose formal and informal market has expanded over the years. In South Africa, the market for selling used EEE and WEEE is developing, given the combination of low incomes and donations of used EEE from other countries. In Brazil, this market is also forming, but to a lesser extent. In Russia, no emphasis was identified on the used and reconditioned EEE and WEEE market.

WEEE in the BRICS is collected by producers/importers individually or collectively and by recyclers, but also by other agents typical of each country. In Brazil, India, China and South Africa, the work of recyclable collectors is relevant, and in Brazil, cooperatives and collector associations organize, train, recognize and scale up the work of these collectors. In India and South Africa, cooperatives and associations operate at recyclable collection centers, performing the same functions as in Brazil. In these countries, national and international NGOs help train these workers. WEEE is sorted, dismantled and separated by small, medium-sized and large recyclers in all BRICS countries and also by reconditioners in China, India, South Africa and, to a lesser extent, Brazil. In India and South Africa, WEEE dismantlers are involved in this process.

The development of WEEE recycling research and technology, and the training of those involved and raising awareness of adequate disposal are issues addressed by learning and research institutions in BRICS countries, aided by national and international NGOs. In China and Russia, government organizations share these functions. Moreover, the BRICS' official and open media help to inform and raise awareness in society regarding the proper disposal of WEEE. In Brazil, India and China, the media's approach to sustainable consumption is also observed. However, environmental education in all BRICS countries is the responsibility of the national, state and municipal governments.

The WEEE markets in the BRICS countries are still forming and developing and rely on state action to a greater or lesser extent depending on the administrative and political characteristics of each country. The governments and government agencies in China and

Russia appear to undertake more in the field of developing technologies and implementing recycling and eco-industrial parks to enable the circularity of WEEE. On the other hand, the governments of India, Brazil and South Africa recognize informal workers and the pressing need for training and integration of the informal sector, given the precarious working conditions and potential harm to the environment and human health. It is worth noting that the Indian market is significant in the global production of electronics and seeks to develop recycling technologies, albeit adapted to their local realities [79].

With the exception of Russia, the recyclable and WEEE value chain processes involve formal and informal activities, recognized in Brazilian, Indian and South African legislation, while China is committed to monitoring and formalizing these activities. In Russia, although the World Bank [80] references informal activities in Russia, no studies were identified that report them in WEEE management activities [75,78].

Therefore, the WEEE markets of the BRICS countries have common points, but they also have their own characteristics built by society over time, which need to be observed, as noted by Sachs [22].

The regular WEEE value chain processes of disposal, collection, sorting, dismantling, separation, treatment, recycling and final disposal of WEEE are found in all BRICS countries, but the composition of actors in each process reveals the unique features of each country, whose practices can serve as a basis for other countries with similar features. Likewise, the BRICS metropolises have common points but highlight the specific characteristics of their territory that shape the actions and implementation of national and regional waste management policies [40,47,74].

Based on this description regarding the definition of each country's value chain and the role the different actors play in defining and implementing public policy, interviews were conducted with experts, as described in Section 3. The aim of these semi-structured interviews was to identify the barriers and opportunities for WEEE management from the perspective of the concept of sustainable cities, and to define the strategic variables for the public policy framework applied to the reality of these countries.

4.4. Result of the Interviews

The specialists are technical and scientific experts who have conducted important research and been involved in important activities in their respective countries. However, they have research links or have been involved in professional activities with BRICS countries. Thus, each one's analysis was related to the situation of their own country but have also observed a comparative analysis with other countries. The specialists from Brazil attributed the most important aspects for developing new circular business models and environmental education (average 9.71). Interviewee 1, for example, highlighted the importance of environmental education as a transversal strategy and with a national policy in force. However, there is still a need to put its precepts into practice. According to interviewee 3, this would favor the implementation of new circular businesses. Interviewee 5 was the only one to give a score of 8 for environmental education, despite considering it fundamental, but he regarded it as more utopian than realistic. The new circular business models are seen as fundamental by all the interviewees from Brazil.

Entrepreneurship is not the main strategy for establishing new circular business models. In fact, it was the lowest-rated economic strategic variable in Brazil, Russia and China. Interviewee 9 from Russia, for example, as well as interviewee 1 from Brazil and interviewee 25 from China, attributed a low value to it because they considered that more actions coordinated by public policies and with public resources from the state are needed rather than depending on entrepreneurship to be validated as a strategy.

In Brazil and China, inclusion and social progress are seen as strategic variables in the economic dimension, as highlighted by interviewees 6 and 7 from Brazil and interviewee 28 from China (average score 9.5). In the other countries, it was considered a relevant but less representative variable.

The social dimension was considered as being of little importance by most of the interviewees, showing how this issue is regarded more as a consequence than as a cause of a sustainability model for cities. Synergy was the strategic variable considered the most important between the parties involved, especially in Brazil, as exemplified by interviewee 4, because it is necessary for the articulation of the value chain. According to this participant, there is a strong relationship between the formal and informal markets, as highlighted by Da Silva, Weins and Potinkara [16], and therefore, this synergy is dependent on the effectiveness of public policies. This also appears in the institutional dimension as articulation between the parties involved. It was one of the most relevant strategic variables. Interviewee 27, from China, emphasized that the coordinated actions of the different actors, especially governments at their different levels, are fundamental to making public policy more than a mere intention.

In this regard, intraregional cooperation and partnerships and policy management in metropolitan areas are other relevant strategic variables in the institutional dimension. Interviewee 9, from Russia, stressed the need not only for companies to be held accountable for waste, but also the state. For this reason, he highlighted the need for partnerships and policy management in metropolitan areas. Interviewee 13, from Russia, reinforced this aspect and justified the importance of specific legislation so that the rules of the game are well defined for all stakeholders and at all levels. This point was considered of great importance by interviewees from other countries. Interviewees 29 and 34 from South Africa, for example, reported that specific legislation is a seminal issue for initiating any change in business models, not only as a restrictive factor but also as a stimulus. In India, interviewees 17 and 20 also considered it a starting point for any business transformation and, therefore, essential for a new sustainability model.

Interviewees 8, from Russia, and 18, from India, emphasized that, theoretically, a new business model that is more in keeping with sustainable development is known and possible. However, as stressed by interviewee 6, from Brazil, this refers to a change in concept for all agents: companies, society and government, requiring incentives to shape these new policies. Interviewee 23 pointed out, as emphasized in other studies referenced in this work, that China has examples of policies at the micro level and even aligned with a national policy. However, the effectiveness of these policies depends on the articulation between the agents, as highlighted by the interviewees.

The stimulus for technological and strategic business change tends to stem from environmental restrictions and public enforcement. In Brazil, according to the interviewees, this enforcement should be more effective, but this institutional weakness is also found elsewhere, as reported by interviewees from the countries in question. Other issues, such as sustainable consumption, depend on a new business model, which emerges as the strategic variable for this conversion of the system into a more sustainable process. According to some of the interviewees, such as interviewee 21 from India, or 33 from South Africa, this will only occur when this business model is more economically viable than the current linear model.

Nevertheless, interviewees 7, from Brazil, 15, from India, and 23, from China, believe that the change will take place following a top-down action and through enforcement that will make circular models more feasible. Otherwise, the continual growth and poor disposal of electronic waste will become more widespread, especially in countries with high consumption of this type of equipment. The framework for public policies is defined below, based on the document research and interviews that were conducted.

4.5. Framework for Public Policies of the WEEE Value Chain in the BRICS Countries

The interviews and documental analysis showed that some basic barriers remain in the government environment, such as the absence of specific national legislation, difficulties in implementation and the lack of coordination by the state to implement producer responsibility systems. Given these barriers, there is an opportunity for greater government involvement in the coordination and synergy between the parties, which essentially involves variables related to legislation.

It can be seen in the government segment that the laws enacted on WEEE management are complex in encompassing and relating to other regulations, as well as stumbling over the limitations of government structures in coordinating the parties involved in the implementation and control of WEEE pre-processing and recycling systems. All the BRICS countries have legislation on WEEE management and have adopted producer or shared responsibility systems. However, there has been a decline in the BRICS countries with regard to other global agents, such as the UN, or concerning international cooperation, as is the case with the European Union. International policy on the subject is very incipient, especially in the BRICS bloc, and its integration with other economic blocs needs to evolve to ensure minimum and necessary rules to deal with an increasing flow of international waste.

Brazil, China and India have specific regulations for the management of this waste. However, while countries without specific legislation indicate a lack of clarity regarding responsibilities, countries with specific laws have shown institutional weaknesses in the enforcement of the law, demonstrating a gap between the laws in place and their actual implementation and compliance with the standards. This is evident in China and Russia, which are advancing in eco-industrial park projects and have imposed fees on producers/importers for the WEEE recycling subsidy fund. However, they face difficulties in managing and balancing their accounts.

Limitations in the enforcement of the law can clearly be seen within the government itself, but also in the market and in society in general. The lack of coordination and synergy between agents widens the gap between regulations and reality in practice, as well as in the development of the market for secondary resources related to WEEE. The insufficiency and divergence of national data on the generation and recycling of WEEE make decision making difficult and compromise the formatting of more assertive and enforceable public policies.

The development of the WEEE recycling market, in turn, is hindered by a lack of national infrastructure for the collection and sorting of this waste, resulting in low material flows, in addition to the high costs of implementing and maintaining WEEE recycling systems and little integration between the informal and formal sectors. The former exists amid precarious and unsafe working conditions and few subsidies for its formalization and training. Moreover, recyclers are concentrated in certain regions of the country, making the transportation of WEEE more expensive, affecting the entire recycling chain.

However, in all case studies of the BRICS countries, society's lack of awareness of the issue of WEEE management is clear. It is understood that the lack of guidance and awareness of society (residents and organizations) regarding sustainable environmental and social awareness influences the behavior of the parties involved throughout the WEEE value chain, compromising the success of public policies' implementation of other practices.

The interviewees claimed that legislative reform should be the result of a broad dialog between the parties involved in the government, market and society and be associated with the development strategy of the industrial sector and management of urban solid waste. Since industries and households are the major sources of WEEE, it is necessary to increase awareness-raising actions among these agents, drawing attention to the need for the segregated and safe disposal of this waste. This would ensure a greater flow of materials to recycling companies to enable their financial balance, given the high cost of implementing and maintaining WEEE recycling companies. In addition, the interviewees specifically recommended reviewing the charge of environmental taxes and other measures that lead EEE producers and distributors to implement extended producer responsibility systems (Table 3).

Furthermore, although national legislation provides for the application of the best available technologies in WEEE management, the development of more advanced technologies for recycling and more accurate data measurement of WEEE is recommended, supporting more assertive decision making. In addition, it is essential to recognize the concepts and principles of the circular economy in regulations on the management of waste and WEEE, since the aforementioned recommendations are directed at post-consumption in disposal and recycling activities, requiring the incorporation of eco-design, waste prevention and reduction projects, developing the secondary resources market and integrating existing small and medium-sized companies in the sector.

The strategic variables related to government are more specifically related to legislation, not only to its improvement in terms of effective implementation. The market and society dimensions were considered the most important by the interviewees. It is clear from the strategic variables that the importance of strengthening the value chain and structuring it is evident. Some aspects are fundamental to transforming business and the way that the value chain materializes in cities, such as eco-design, shared producer–consumer responsibility, development of recycling technologies and circular business models and production systems. To this end, the major public–private partnership is strengthened, reinforcing the articulating role of the state, but with concern over strengthening the articulation and promotion of the intermediate stages of recycling. In this respect, variables such as urban mining, public–private partnerships, opportunities for individual and collective income generation and reverse logistics stand out, along with synergy between the parties involved, cooperation and intraregional partnerships and organizations that manage producer responsibility.

The proposal to strengthen inclusive producer responsibility systems involves policies more closely related to the training of organizations, qualifying and strengthening the markets. Ongoing training involves the promotion of entrepreneurship and incentives for formalization, which is a complex issue for the BRICS countries.

In the social dimension, there is greater interaction with urban planning and the leading role of metropolises is strengthened. WEEE management occurs in cities, and the integrated vision with the role of the state is fundamental for the development of policies, considering the features of each city. Infrastructure, from the perspective of smart cities, was considered important for the organization of the chain.

Table 2 summarizes the results with the framework for proposing public policies based on the dimensions of sustainable cities: environmental, economic, social and institutional.

Table 3. Framework for public policies of the WEEE value chain under the precepts of sustainable cities in the BRICS countries.

INSTITUCIONAL	ENVIRONMENTAL	ECONOMIC
Intra-regional cooperation and partnerships	Environmental education	Circular business models
Extended procuder responsability	Raising society's awareness of adequate disposal	Markets that enable the circulation of materials
Articulation of the parties involved	Management of environmental risks and risks to human health	Economic feasibility
Specific nacional legislation on WEEE	Reducing the generation of waste and pollution	Social inclusion and progress
Role of metropolises in WEEE management	Sustainable consumption	Nacional policies adapted to regional capacities
Adaptation of global ideals in local policies	Urban planning	Individual and collective income generation opportunities
Regional and local legislation on WEEE	Reverse logistics	Development of recycling technologies
Public-private partnerships	Circular production systems	Entrepreneurship
Public subsidies and incentives for recycling	Ecodesign	
National recycling subsidy fund	Urban mining	
Training for public and private organizations		
Laws and international agreements		
Shared producer-consumer responsability		
Producer responsability management organizations		
Application of sustainable city concepts		
Application of smart city IT solutions		

SOCIAL
Synergy between the parties involved
Recognition and integration of informal work
Public incentives for formalization
Public-private qualification of the informal sector
Cooperatives and associations of wastepickers

Note:

First priority level
Second pirity level

Source: Based on [13,16,17,62–65,67–69,71–75,78–144] and Delphi method application.

In the environmental impacts category, the management of environmental and human health risks stands out as a method to help with the reduction in waste generation and pollution. Next, society orientation, in which environmental education and awareness of society regarding proper disposal, in parallel with the preservation of finite resources with sustainable consumption were highlighted. On a second scale level, the themes of reverse logistics, circular production systems, eco-design, urban mining and urban planning.

In their comments on this dimension, the experts who were interviewed emphasized the value of environmental issues as a basis for the other sustainability dimensions, since the environment shapes economic, social and institutional relations, supplying and/or limiting these activities. In addition, they stressed the establishment of policies and actions for environmental education and raising awareness in society regarding the direct positive results of sustainable WEEE management. They also emphasized that planned obsolescence of EEE increases the disposal of WEEE and that it is necessary to make sustainable consumption and circular production systems economically feasible.

In the economic dimension, the aspects related to the category of business models linked to WEEE reduction and management had the highest scores, with a median of 9.0 for circular business models, markets that enable the circulation of secondary materials and economic feasibility. Likewise, inclusion and social progress linked to the category of income generation were considered very important. Furthermore, it was considered necessary to advance the development of technologies for recycling. Additionally, national policies must be adapted to regional capacities and opportunities for individual and collective income generation, as well as entrepreneurship.

Studies conducted and validated by experts show that it is necessary to develop the secondary resources market by investing in recycling technologies and circular and economically feasible business models. Consequently, individual and collective income is generated, providing opportunities for inclusion and social progress.

However, the establishment of related public policies guides and clarifies the responsibilities of the agents involved. According to comments from the experts interviewed on this dimension, producers/distributors and the state should bear the most responsibility for managing WEEE. Nevertheless, it falls to the state to promote the development of technologies and the national recycling industry in public–private partnerships, promoting the transition from a linear to a circular economy.

In the social dimension, the category of actors involved stands out for the synergy between the parties involved. The other topics, such as recognition and integration of informal work, public incentives for formalization, public–private qualification of the informal sector and cooperatives and associations of collectors, are related to the actors involved, but also to the informal sector.

It can be inferred that the synergy between the parties involved in government, market and society is vital to the effective management of WEEE in the implementation of inclusive producer responsibility systems that provide opportunities for the integration and qualification of informal workers. It is worth noting that in the case study of Russia, no research was found, nor did experts point out the existence of informal workers in activities inherent to the management of WEEE in the country.

On the other hand, in Brazil, there are successful cases of formalization, qualification and integration of collectors and cooperatives/associations in WEEE management, such as the metropolis of São Paulo, while in South Africa, the experts reported, and the related case study detected, obstacles to establishing and maintaining associations/cooperatives of collectors/recyclers in that country. In this dimension, the experts highlighted in their final comments that circular economy business models provide opportunities for generating income, qualification and social inclusion, resulting from awareness, coordination and synergy between the parties involved.

Regarding the institutional dimension presented on the following page, relevant aspects to the management of WEEE were identified with emphasis on the role of the state in coordinating the parties involved and in implementing national legislation on WEEE management.

The subject of specific national WEEE legislation, included in the legal and institutional compositions category, had the highest median for this dimension and for all the sustainability dimensions, with 10.0. Next, the issue of coordination between the parties involved was considered more important, and cooperation and intraregional partnerships, extended producer responsibility and the leading role of metropolises in WEEE management were considered very important.

The aspects related to the training of public and private organizations and international laws and agreements, the adaptation of global ideals to local policies, regional and local legislation on WEEE, public–private partnerships, subsidies and public incentives for recycling, national recycling subsidy funds, shared producer–consumer responsibility, producer responsibility management organizations, application of sustainable city concepts and application of IT solutions in smart cities, which were considered in the second level, had a median of 8.0.

In this dimension, in keeping with the research that was conducted, it is clearly important to establish specific national regulations for WEEE management, clarifying responsibilities and coordinating government spheres with the parties involved in implementing producer responsibility systems, with cities, especially metropolises, playing a greater role. In this respect, it is necessary to train public and private managers and technicians on the topic of WEEE management and to establish intraregional public–private partnerships and cooperation based on the sustainable development of cities. Moreover, the use of IT solutions means more accurate and faster data for WEEE management, both for decision makers and end users. On the other hand, policies and the creation of national funds to subsidize the recycling chain have shown deficiencies in their application. In the BRICS countries, China has a growing deficit in the fund, access to subsidies is too complex in Russia and India has difficulties in charging recycling fees from producers to create the national fund, indicating the need to improve the implementation and management of these funds.

The experts emphasized that most countries have laws and regulations for WEEE management but lack actions to implement national legislation and guidelines. In this respect, a calendar of discussion forums can create environments that favor the commitment of agents and the structuring of measures for the implementation of regulations.

In the final comments regarding the semi-structured online interview, the experts emphasized that enacting laws on WEEE management is important, but the coordination and synergy between the parties involved in the enforcement of these laws is fundamental to transform solutions for society and the economy. In particular, it is necessary to establish gradual recycling targets for the sector and stimulate the development of research and technologies that detail the various aspects for the development of the WEEE market.

5. Discussion and Implications

Some barriers identified in field research through interviews indicate problems common to the five countries, such as inadequate disposal of WEEE; lack of awareness in society regarding the proper disposal of WEEE; lack of synergy and articulation between the parties involved; insufficient volumes of WEEE flow to recyclers; institutional apparatus (relevance of the actions of government actors and the rules of the game) weaknesses in the management of WEEE; government and market not prioritizing actions to reduce and reuse waste; and insufficient and divergent data on WEEE generation and management. These issues are fundamental because they make the planning, management and coordination of the WEEE chain difficult.

Among these aspects, issues involving the region, such as inadequate disposal, greater awareness in society and institutional issues, have more adherence to public policies applied to cities and that affect economic, environmental, social and institutional issues. Thus, the concept of a sustainable city means the best use of resources, as well as social participation [7,25,26], and policies related to urban planning in a multidimensional approach [10,11]. These are themes that must be developed in all BRICS countries as a guide for other public policies.

Lack of national infrastructure for implementing recycling networks is an issue related to the economic dimension and requires a public policy in cities, as it was identified as a barrier in all the BRICS countries except China. China has addressed this issue with policies integrated with the circular economy at the micro, meso and macro level. The concentration of recycling centers in certain metropolises is a problem in Brazil, India and South Africa [145]. Although it is an economic problem, it requires an industrial policy articulated with public policy in cities.

Different social issues are present in each country, such as the lack of subsidies for waste picker cooperatives in Brazil, the organization of the chain in Russian cities, the inadequate working conditions in the informal market in India, the informal market in China and the failure rates of cooperatives in South Africa. All of these barriers must be considered in cities to develop economic and social inclusion strategies often articulated with industrial policy. These are, in part, different problems, but with a common origin: the need for greater organization and volume of the chain based on the stimulation of a circular economy process in cities [2,26,28].

It appears that the barriers to WEEE management in Brazil are not concentrated in its legislation but rather in its implementation. The difficulties raised are related to the implementation phases and the actors involved. The lack of articulation and synergy between government, market and society, in addition to the limited national physical and institutional infrastructure, make it difficult to implement shared responsibility and effective WEEE reverse logistics systems. Society does not have sufficient guidelines for the proper disposal of WEEE. The complexity and dangerous nature of WEEE makes recycling this waste more difficult. Waste picker cooperatives, which are recognized in legislation, remain without legal, financial and operational subsidies to structure themselves and be competitive in the WEEE recyclables market. Furthermore, Brazil's continental dimensions make the logistics of this waste to recycling centers, concentrated in the southeast and south of the country, more expensive [111,112].

The barriers encountered in the management of WEEE in China largely focus on the historical relationships and behaviors between the parties involved in the processes inherent to WEEE. The informal sector was created over decades and dominates the majority of the WEEE recycling market, which maintains an interdependent relationship with the formal sector. However, informal activities are associated with inadequate and unsafe working conditions, which result in damage to human health and the environment. The central and local governments strive to formalize the recycling market. However, the policies and actions are more prohibitive than integrative regarding the informal market. Furthermore, the recycling subsidy fund, intended to enable a return on investment for formal recyclers faces the challenge of balancing the accounts between the amount collected and allocated, in addition to the financial balance of the recyclers themselves. It is also worth noting that both policies and the market are focused on the recycling process of medium-sized and large WEEE, while millions of small EEE units are not being recycled and little is said about their eco-design.

The increase in consumption of new and used EEE, combined with Indian society's preference for selling used equipment and its waste, encourages the informal WEEE market. Furthermore, the lack of guidance and public awareness of the dangers involved in WEEE management has led to inadequate disposal of this waste. On the other hand, the precarious facilities and working conditions regarding activities inherent to the informal processing of WEEE make around two-thirds of the workers involved sick, including children. The activity also pollutes the environment [79,84,106,118].

It appears that although South Africa has legislation that addresses various aspects of WEEE, the lack of specific regulations for this waste is seen as a barrier to effective WEEE management, as the various responsibilities have not been made clear to the parties involved. This results in institutional weaknesses in the structuring, monitoring and inspection of related policies.

The WEEE recycling market is in its early stages and faces implementation challenges due to the lack of accurate data, national infrastructure and public and private investments in the sector. Furthermore, the inadequate disposal of WEEE resulting from a lack of guidelines and awareness in society means that insufficient volumes of WEEE are channeled to enable returns on investments in recyclers and advanced technologies capable of recycling more complex waste [16,17,70,71,74,83,98,108].

It is clear that the low awareness of the population and organizations regarding the proper disposal of waste makes reducing the channeling of recyclable materials to landfills one of the country's major challenges. The legislation on WEEE management is included in a complex legal framework with gaps in assigning responsibilities. In addition, the absence and divergence of data on WEEE contribute to the lack of structures necessary for the collection, sorting, storage and recycling of waste, as projects are undertaken with inconsistent data.

The government and the market prioritize recycling policies and actions and adequate disposal of recyclables, but do not complement them to the same extent with policies and actions to reduce and reuse waste. In the market, the production sector does not adhere to EPR systems and eco-design projects with the necessary intensity. A considerable number of producers and importers choose to pay environmental fees to the government for non-compliance with the EPR legislation targets, as they are lower than investments in their own or associated recycling projects.

Thus, the lack of synergy between stakeholders favors market distortions such as competition between recyclers and regional operators for urban solid waste, uneven flows of recyclable volumes between waste processors and a poorly developed market for secondary resources [61–63,103,112,139].

One of the main propositions is greater awareness in society regarding the proper disposal of WEEE and a more engaging dialog on WEEE between government, market and society. This is fundamental for greater coordination between different agents and to shape public policies for effective implementation in cities.

The propositions are interconnected and depend on greater synergy and articulation between actors who promote research on alternative recycling technologies. Efforts and resources are needed to raise society's awareness, also achieved through environmental education in schools and the training of the parties involved, especially waste pickers and their associations. For these actors, subsidies are required for them to participate in the WEEE recycling market [137].

It can also be seen that the propositions are related to the main parties involved in the processes inherent to WEEE, that is, society, producers, recyclers and government.

Research has shown that despite advances in the population's environmental education, more policies and actions are necessary to raise awareness regarding the reuse and proper disposal of WEEE for every social class and region of the country. On the other hand, greater participation of EEE producers in the recycling market is proposed in partnerships with recyclers, reverse logistics processes, green technological innovations and eco-design projects that enable the reuse and recycling of materials. To this end, legislation can regulate the duties of producers and recyclers regarding the collection of WEEE, expanding collection channels and increasing the volume collected, as well as green innovations. As for the informal market, measures to integrate informal activities into the formal recycling market are recommended. IT solutions, in turn, can enable the implementation of such practices and accelerate the processes of commercialization, collection and recycling of WEEE, increasing the volumes treated and thus contributing to the profitability of recycling companies [146].

Proposals for improving WEEE management in India are primarily aimed at implementing the country's regulations, including raising awareness among stakeholders and society in general. Research has focused on greater involvement and synergy of the interested parties in building infrastructure, including production systems and the design of ecological and sustainable products and safe and adequate facilities and working conditions, as well as recognizing the work of informal collectors. More actions are required that encourage collective forms of work for informal collectors and dismantlers and integrate the informal sector into the formal WEEE management market. The use of digital technologies can provide more reliable and faster data, helping the parties involved in decision making. Arya and Kumar [40] highlighted the importance of mapping and analyzing scenarios of the formal and informal WEEE market in India to provide public policy makers and decision makers with more consistent data. Sharma, Joshi and Govindan [147] concluded that the success of EPR systems and public–private partnerships depends on the awareness of the parties involved, qualified labor and local and regional infrastructure [105,117].

Proposals for WEEE management in South Africa include actions related to the government, market and society. Corporate and domestic consumers need to be guided and made aware of the proper channeling of WEEE, but the network of disposal and repurchase points needs to be expanded so that it is easier and more attractive to dispose of this waste. Furthermore, it is essential to invest in the research and development of technologies tailored to local and national realities, as well as training the parties involved. At this juncture, recognition of the work of informal operators and their integration into the WEEE recycling market requires more inclusive regulations and programs, in collective efforts on the part of the government and market. Thus, it is hoped that the livelihoods of informal collectors and dismantlers will be guaranteed, and their working conditions will ensure more safety and dignity. The cited authors emphasized that the implementation of these and other proposals necessary to advance the WEEE recycling market in circular systems in the country requires greater synergy, cooperation and partnerships between the parties involved [72].

Proposals for the management of WEEE and other waste in Russia involve all the parties in the value chain, namely the government, market and society. Actions appear to be necessary to raise public awareness regarding proper disposal, but segregated collection points must be expanded as close as possible to the origin of the waste. On the other hand, there is a perceived need to update and integrate current regulations, clarifying responsibilities and goals based on reliable data systems. The vision of the market demonstrates that greater commitment is needed from producers/importers in the implementation and improvement of EPR systems, with the adoption of more ecological production systems and products, reducing waste [89]. In this way, the whole value chain can show improvements, and more analytical research and technological solutions should be encouraged, as well as more dialog and synergy between the stakeholders.

Currently, the government's main objective is to divert waste from landfills, increasing recycling (utilization) and introducing extended producer responsibility (EPR) systems. Although these policies constitute the initial stages of transition from linear production systems to the circular economy model, they contribute little to the prevention and reduction in per capita waste generation. These authors claim that policies and investments focused on waste recycling have the full support of Russian government spheres, but reuse and waste reduction projects are not viewed as so important, leading the market and society to concentrate only on the post-consumer phase.

Finally, the lack of specific legislation on WEEE management, as in Russia and South Africa, was found to make it difficult to prioritize this waste and clarify responsibilities among the parties involved. On the other hand, the lack of government coordination, as in Brazil and India, in actions to enforce laws creates gaps when it comes to compliance with WEEE management regulations.

It was found that secondary resource markets are in the early stages of development in the BRICS countries. In the specific case of WEEE derivatives, the countries lack national and regional infrastructure that covers most of the population and territories for collecting and processing this waste. It was shown that the high costs of transporting and recycling WEEE, due largely to the extensive territorial areas and complexity of this waste, hinders the implementation and maintenance of reverse logistics networks, recycling and the recovery of materials from production chains.

In this scenario, only limited actions have been taken to integrate the informal sector into the formal WEEE market, even though it is present on a large scale in most BRICS countries. It was noted that this greatly slows down the waste flows required by recyclers to achieve and maintain their economic feasibility. Moreover, the integration of the informal market into the formal market aids the traceability of WEEE flows and amounts, generating more accurate data for decision making in the WEEE value chain. Furthermore, it was observed that the WEEE value chains in the BRICS countries are directed towards post-consumption of EEE, with little regard to eco-design projects and cleaner production, which are essential for the circularity of materials. Thus, the drive to raise the awareness of the population and organizations focuses more on the proper disposal of WEEE and little on sustainable consumption.

In particular, the analyses revealed latent problems in each country that should be addressed. There are gaps in Brazil and India between what is established by law and how it is enforced. China, Russia and India have flaws in the management of recycling subsidy funds that lead to difficulties in membership, access and deficit. Meanwhile, South Africa has experienced a significant percentage of failures in the formation and maintenance of associations/cooperatives of waste pickers/recyclers.

6. Conclusions

BRICS national governments initially passed legislation on solid waste management, prioritizing the most dangerous waste categories, including certain WEEE. With increasing EEE consumption and its growing generation, largely driven by the import of WEEE and international donations of used EEE, the governments began to legislate more vigorously and specifically on WEEE management.

The research question was as follows: how are BRICS countries integrating WEEE actors in moving towards sustainable cities? The proposed framework identified a set of 39 strategic variables from the perspective of institutional, environmental, economic and social dimensions. At the first level, there are the most important strategic variables for the development of integration in each BRICS country and among countries in order to advance in this value chain regarding sustainable cities. The institutional dimension shows that intraregional cooperation, extended producer responsibility, articulation of the parties involved, specific national WEEE legislation and the role of cities in WEEE management should be prioritized. It is worth noting that this refers not only to having legal instruments but also to having a public policy that integrates and creates responsibility among agents.

The environmental dimension of the framework involves fundamental issues such as environmental education, raising society's awareness of adequate disposal and the need to reduce the generation of waste and pollution. This theme is directly related to the strategic variable of sustainable consumption. Moreover, it involves the responsibility of stakeholders in the management of environmental risks and risks to human health.

The economic dimension involves circular business models, markets that enable the circulation of materials and economic feasibility. In association with the social dimension, social inclusion and progress were considered. Finally, in the social dimension, synergy between the parties involved was considered a priority. Other strategic variables were identified at the second level that interact with these priority strategic variables, identifying how to plan progress towards the integration of WEEE actors based on the precepts of sustainable cities.

It falls to EEE producers and importers to implement WEEE logistics networks in accordance with the producer accountability systems established by law, which demonstrates the need for greater integration of the international policy of these countries and other economic blocs. In these systems, waste must be collected and sent to licensed WEEE pre-processing and recycling channels. However, these systems are in the structuring phases in all BRICS countries to a lesser or greater degree, as several variables and agents influence the advancement of these processes.

It falls to the state, with greater involvement of the cities, to enact WEEE management legislation. This legislation should clarify responsibilities and coordinate the parties involved in cooperation and intraregional partnerships for the effective implementation of guidelines and regulations, such as responsibility systems for the producer. However, the environmental issue in cities involves the management of environmental and human health risks. Actions are also required to provide society with environmental education and raise awareness concerning the reduction and adequate disposal of WEEE combined with sustainable consumption. From an economic perspective, circular business models could be used to form a secondary resources market, which is economically viable and provides opportunities for inclusion and social progress. Finally, in the social dimension, the pressing need for synergy between the parties involved for the effective management of WEEE has been highlighted.

The development of WEEE management from the perspective of sustainability applied to the BRICS countries allowed us to understand similarities in barriers and proposals and define a line of action. At the macro level, it is necessary to achieve a better specific legislation and coordinate it with regional and local legislation. In addition, it needs to focus on the economic strengthening of the chain, with national subsidy funds, and propose policies that encourage the formalization, qualification and integration of informal work. At the micro level, new technologies, with themes such as eco-design, new circular business models and reverse logistics, are decisive for strengthening the WEEE value chain and require strong integration and stimulation of public policies to regularize the market and expand waste flows. At the meso level, the leading role of metropolises in WEEE management aligned with urban planning and IT applications in smart and sustainable cities are priorities for expanding the organization of the value chain from the separation process to final disposal.

Each BRICS country and metropolis has its own features and characteristics, and the weight of each variable is relative to this context. However, the research demonstrated that these are the main points. Thus, it is possible to prioritize actions so that the management of WEEE in these countries can be an opportunity for the development of cities in terms of sustainability. Thus, this article advances in the definition of a framework that can be applied to understand the WEEE value chain and shape public policies that allow the strategic conversion to a circular economy model. This model is aligned with the precepts of sustainable cities and the strategic variables formulate important and high-priority issues for all BRICS countries.

A suggestion for future research is to conduct case studies considering the framework applied to the reality of each BRICS city, which will provide a set of analyses capable of identifying the different applications and results. The research shows that even when analyzing countries with distinct cultural characteristics, institutional structures can standardize policies and actions required for WEEE management based on the principles of the circular economy. This, in turn, can act as a driver to promote sustainable development in territories, balancing economic growth, social progress and a healthy environment.

Author Contributions: Conceptualization, C.L.d.S.; methodology, C.L.d.S. and N.M.F.; formal analysis, C.L.d.S. and N.M.F.; investigation, C.L.d.S. and N.M.F.; resources, C.L.d.S.; data curation, N.M.F.; writing—original draft preparation, C.L.d.S. and N.M.F.; writing—review and editing, C.L.d.S. and N.M.F.; visualization, N.M.F.; supervision, C.L.d.S.; project administration, C.L.d.S.; funding acquisition, C.L.d.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Council for Scientific and Technological Development (CNPq), grant numbers 304937/2022-3 and 407021/2023-0.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Acknowledgments: We are very grateful to the referees for the careful reading of the paper and for their comments and detailed suggestions which helped us to considerably improve the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Bartniczak, B.; Raszkowski, A. Implementation of the Sustainable Cities and Communities Sustainable Development Goal (SDG) in the European Union. *Sustainability* **2022**, *14*, 16808. [CrossRef]
2. Dincă, G.; Milan, A.-A.; Andronic, M.L.; Pasztori, A.-M.; Dincă, D. Does Circular Economy Contribute to Smart Cities' Sustainable Development? *Int. J. Environ. Res. Public Health* **2022**, *19*, 7627. [CrossRef] [PubMed]
3. Shang, W.-L.; Lv, Z. Low carbon technology for carbon neutrality in sustainable cities: A survey. *Sustain. Cities Soc.* **2023**, *92*, 104489. [CrossRef]
4. Kamińska, J.A.; Sciavicco, G.; Kazak, J.K. Sustainable Cities and Regions—Statistical Approaches. *Sustainability* **2023**, *15*, 7607. [CrossRef]
5. Dias, P.R.; Cenci, M.P.; Bernardes, A.M.; Huda, N. What drives WEEE recycling? A comparative study concerning legislation, collection and recycling. *Waste Manag. Res.* **2022**, *40*, 1527–1538. [CrossRef]
6. Huovila, A.; Bosch, P.; Airaksinen, M. Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when? *Cities* **2019**, *89*, 141–153. [CrossRef]
7. Cepeliauskaite, G.; Stasiskiene, Z. The Framework of the Principles of Sustainable Urban Ecosystems Development and Functioning. *Sustainability* **2020**, *12*, 720. [CrossRef]
8. Simon, E.B. A foundational framework for smart sustainable city development: Theoretical, disciplinary, and discursive dimensions and their synergies. *Sustain. Cities Soc.* **2018**, *38*, 758–794. [CrossRef]

9. Rodríguez-Bello, L.A.; Estupiñán-Escalante, E. The impact of waste of electrical and electronic equipment public police in Latin America: Analysis of the physical, economical, and information flow. In *Handbook of Electronic Waste Management*; Elsevier: Amsterdam, The Netherlands, 2020; pp. 397–419. [CrossRef]
10. Petit-Boix, A.; Llorach-Massana, P.; Sanjuan-Delmás, D.; Sierra-Pérez, J.; Vinyes, E.; Gabarrell, X.; Sanyé-Mengual, E. Application of life cycle thinking towards sustainable cities: A review. *J. Clean. Prod.* **2017**, *166*, 939–951. [CrossRef]
11. Sun, X.; Liu, X.; Li, F.; Tao, Y.; Song, Y. Comprehensive evaluation of different scale cities' sustainable development for economy, society, and ecological infrastructure in China. *J. Clean. Prod.* **2017**, *163*, S329–S337. [CrossRef]
12. Murray, A.; Skene, K.; Haynes, K. The circular economy: An interdisciplinary exploration of the concept and application in a global context. *J. Bus. Ethics* **2017**, *140*, 369–380. [CrossRef]
13. Forti, V.; Baldé, C.P.; Kuehr, R.; Bel, G. The Global E-waste Monitor 2020. United Nations University (UNU), International Telecommunication Union (ITU) & Inter-national Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. 2020. Available online: https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf (accessed on 20 September 2023).
14. Gollakota, A.R.K.; Gautam, S.; Shu, C. Inconsistencies of e-waste management in developing nations–Facts and plausible solutions. *J. Environ. Manag.* **2020**, *261*, 110234. [CrossRef] [PubMed]
15. United Nations—UNDATA. Available online: https://data.un.org/ (accessed on 30 October 2020).
16. Da Silva, C.L.; Weins, N.; Potinkara, M. Formalizing the informal? A perspective on informal waste management in the BRICS through the lens of institutional economics. *Waste Manag.* **2019**, *99*, 79–89. [CrossRef]
17. Ghosh, S.K.; Debnath, B.; Baidya, R.; De, D.; Li, J.; Ghosh, S.K.; Zheng, L.; Awasthi, A.K.; Liubarskaia, M.A.; Ogola, J.S.; et al. Waste electrical and electronic equipment management and Basel Convention compliance in Brazil, Russia, India, China and South Africa (BRICS) nations. *Waste Manag. Res.* **2016**, *34*, 693–707. [CrossRef]
18. Baldé, C.P.; Forti, V.; Gray, V.; Kuehr, R.; Stegmann, P. The Global e-Waste Monitor 2017: Quantities, Flows and Resources. United Nations University, International Telecommunica-tion Union, and International Solid Waste Association. Bonn/Geneva/Vienna. 2017. Available online: https://collections.unu.edu/view/UNU:6341 (accessed on 15 August 2023).
19. Mendes, T.C.M. *Smart Cities: Solução Para as Cidades ou Aprofundamento das Desigualdades Sociais?* Observatório das Metrópoles, Instituto Nacional de Ciência e Tecnologia: Rio de Janeiro, Brazil, 2020.
20. Handayanto, R.T.; Tripathi, N.K.; Kim, S.M.; Guha, S. Achieving a sustainable urban form through land use optimisation: Insights from Bekasi City's land-use plan (2010–2030). *Sustainability* **2017**, *9*, 221. [CrossRef]
21. World Bank. World Inclusive Cities Approach Paper. 2015. Available online: http://documents.worldbank.org/curated/pt/402451468169453117/World-Inclusive-cities-approach-paper (accessed on 21 April 2020).
22. Sachs, I. *Caminhos para o Desenvolvimento Sustentável*; Garamond: Rio de Janeiro, Brazil, 2009.
23. Leite, C.; Awad, J.D.C.M. *Cidades Sustentáveis, Cidades Inteligentes: Desenvolvimento Sustentável Num Planeta Urbano*; Bookman: Porto Alegre, Brazil, 2012.
24. Chang, T.; Deale, D.; Gupta, R.; Hefer, R.; Inglesi-Lotz, R.; Simo-Kengne, B. The causal relationship between coal consumption and economic growth in the BRICS countries: Evidence from panel-Granger causality tests. *Energy Sources Part B Econ. Plan. Policy* **2017**, *12*, 138–146. [CrossRef]
25. Camagni, R.; Capello, R.; Nijkamp, P. Towards sustainable city policy: An economy-environment technology nexus. *Ecol. Econ.* **1998**, *24*, 103–118. [CrossRef]
26. Kenworthy, J.R. The eco-city: Ten key transport and planning dimensions for sustainable city development. *Environ. Urban.* **2006**, *18*, 67–85. [CrossRef]
27. Bibri, S.E.; Krogstie, J. Generating a vision for smart sustainable cities of the future: A scholarly backcasting approach. *Eur. J. For. Res.* **2019**, *7*, 5. [CrossRef]
28. Wong, K.W.; Khor, K.S.; Homer, S.T. Perception of smart sustainable cities: A conceptual framework development using group concept mapping method. *Asia-Pac. J. Reg. Sci.* **2023**, *7*, 959–985. [CrossRef]
29. Organization for Economic Co-Operation and Development—OCDE. National Urban Policies and Habitat III. Available online: https://www.oecd.org/regional/regional-policy/habitat-iii.htm (accessed on 15 September 2020).
30. Tedong, P.A.; Zyed, Z.A. Searching for sustainable cities: Residents' perceptions on the implementation of sustainable cities in Malaysia. *Community Dev. J.* **2022**, *57*, 112–131. [CrossRef]
31. De Falco, S.; Corbino, A. Sustainable Cities: Some Reflections on Companies' Settlements. *Sustainability* **2021**, *13*, 12622. [CrossRef]
32. van de Meene, S.; Bettini, Y.; Head, B.W. Transitioning toward Sustainable Cities—Challenges of Collaboration and Integration. *Sustainability* **2020**, *12*, 4509. [CrossRef]
33. Cai, M.; Kassens-Noor, E.; Zao, Z.; Colbry, D. Are smart cities more sustainable? An exploratory study of 103 U.S. cities. *J. Clean. Prod.* **2023**, *416*, 137986. [CrossRef]
34. Yigitcanlar, T.; Kamruzzaman, M.; Foth, M.; Sabatini-Marques, J.; da Costa, E.; Ioppolo, G. Can cities become smart without being sustainable? A systematic review of the literature. *Sustain. Cities Soc.* **2019**, *45*, 348–365. [CrossRef]

35. Bouzguendaa, I.; Alalouch, C.; Fava, N. Towards smart sustainable cities: A review of the role digital citizen participation could play in advancing social sustainability. *Sustain. Cities Soc.* **2019**, *50*, 101627. [CrossRef]
36. Basiri, M.; Azim, A.Z.; Farrokhi, M. Smart city solution for sustainable urban development. *Eur. J. Sustain. Dev.* **2017**, *6*, 71. [CrossRef]
37. Martina, C.J.; Evans, J.; Karvonenc, A. Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technol. Forecast. Soc. Chang.* **2018**, *133*, 269–278. [CrossRef]
38. Kumar, A.; Holuszko, M.; Espinosa, D.C.R. E-waste: An overview on generation, collection, legislation and recycling practices. *Resour. Conserv. Recycl.* **2017**, *122*, 32–42. [CrossRef]
39. Zhou, W.; Zheng, Y.; Huang, W. Competitive advantage of qualified WEEE recyclers through EPR legislation. *Eur. J. Oper. Res.* **2017**, *257*, 641–655. [CrossRef]
40. Arya, S.; Kumar, S. E-waste in India at a glance: Current trends, regulations, challenges and management strategies. *J. Clean. Prod.* **2020**, *271*, 122707. [CrossRef]
41. Lopes dos Santos, K. Resíduos de equipamentos eletroeletrônicos na macrometrópole paulista: Normas e técnicas à serviço da logística reversa. *Ambiente Soc.* **2020**, *23*, e01211. [CrossRef]
42. Bimir, M.N. Revisiting e-waste management practices in selected African countries. *J. Air Waste Manag. Assoc.* **2020**, *70*, 659–669. [CrossRef] [PubMed]
43. Creswell, J. *Research Design: Qualitative, Quantitative and Mixed Methods Aprroaches*, 3rd ed.; SAGE: Washington, DC, USA, 2009.
44. World Bank Data. Available online: https://data.worldbank.org/ (accessed on 21 November 2022).
45. Valente, D.B.; Guabiroba, R.C.d.S.; Conejero, M.A.; da Silva, M.A.V.; César, A.d.S. Economic analysis of waste electrical and electronic equipment management: A study involving recycling cooperatives in Brazil. *Environ. Dev. Sustain.* **2021**, *23*, 17628–17649. [CrossRef]
46. Baldé, C.P.; Iattoni, G.; Luda, V.; Nnorom, I.C.; Pecheniuk, O.; Kuehr, R. Regional e-Waste Monitor for the CIS + Georgia—2021. United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR)—Co-Hosting the SCYCLE Programme, Bonn, Germany. 2021. Available online: http://collections.unu.edu/eserv/UNU:8703/REM_2021_CISGEORGIA_English.pdf (accessed on 15 October 2022).
47. Invest India. 2021. Available online: https://www.investindia.gov.in/pt-br/sector/electronic-systems (accessed on 8 November 2021).
48. Yin, R.K. *Estudo de Caso: Planejamento e Métodos*, 5th ed.; Bookman: Porto Alegre, Brazil, 2015.
49. Linstone, H.A.; Turoff, M. *The Delphi Method: Techniques and Applications*; Addison-Wesley Publishing Company Inc.: Boston, MA, USA, 2002.
50. Hasson, F.; Keeney, S.; Mckenna, H. Research guidelines for the Delphi survey technique. *J. Adv. Nurs.* **2000**, *32*, 1008–1015. [CrossRef]
51. Landeta, R.J. *El Método Delphi: Una Técnica de Previsión para la Incertidumbre*; Ariel: Barcelona, Spain, 2002.
52. León, O.G.; Montero, I. *Métodos de Investigación en Psicología y Educación*; McGraw-Hill: Madrid, Spain, 2004.
53. Skulmoski, G.J.; Hartman, F.T.; Krahn, J. The Delphi method for graduate research. *J. Inf. Technol. Educ.* **2007**, *6*, 1–21. Available online: http://jite.org/documents/Vol6/JITEv6p001-021Skulmoski212.pdf (accessed on 22 July 2022). [CrossRef]
54. Vieira, B.d.O.; Guarnieri, P.; Camara e Silva, L.; Alfinito, S. Prioritizing Barriers to Be Solved to the Implementation of Reverse Logistics of E-Waste in Brazil under a Multicriteria Decision Aid Approach. *Sustainability* **2020**, *12*, 4337. [CrossRef]
55. Pan, X.; Wong, C.W.Y.; Li, C. Circular economy practices in the waste electrical and electronic equipment (WEEE) industry: A systematic review and future research agendas. *J. Clean. Prod.* **2022**, *365*, 132671. [CrossRef]
56. Liu, H.; Wu, X.; Dou, D.; Tang, X.; Leong, G.K. Determining Recycling Fees and Subsidies in China's WEEE Disposal Fund with Formal and Informal Sectors. *Sustainability* **2018**, *10*, 2979. [CrossRef]
57. Ghisellini, P.; Quinto, I.; Passaro, R.; Ulgiati, S. Circular Economy Management of Waste Electrical and Electronic Equipment (WEEE) in Italian Urban Systems: Comparison and Perspectives. *Sustainability* **2023**, *15*, 9054. [CrossRef]
58. De Waal, I.M. The Legal Transition towards a More Circular Electrical and Electronic Equipment Chain—A Case Study of The Netherlands. *Sustainability* **2023**, *15*, 935. [CrossRef]
59. Azizi, D.D.S.; Hanafiah, M.M.; Woon, K.S. Material Flow Analysis in WEEE Management for Circular Economy: A Content Review on Applications, Limitations, and Future Outlook. *Sustainability* **2023**, *15*, 3505. [CrossRef]
60. Wang, Q.; Wang, X. An Expert Decision-Making System for Identifying Development Barriers in Chinese Waste Electrical and Electronic Equipment (WEEE) Recycling Industry. *Sustainability* **2022**, *14*, 16721. [CrossRef]
61. Movimento Nacional dos Catadores de Materiais Recicláveis (MNCR). Available online: http://www.mncr.org.br/ (accessed on 23 July 2021).
62. Giese, E.C.; Araujo, R.A.; Ottoni, M.; Santos, J.; Contador, L.; Rebello, R.Z.; Sierpe, R.S.; Silva, M.L.M.; Xavier, L.H. *Cooperativas e a Gestão de Resíduos Eletroeletrônicos*, 1st ed.; CETEM/MCTI: Rio de Janeiro, Brazil, 2021.

63. Liubarskaia, M.A.; Piliavsky, V.P.; Putinceva, N.A. Circular Economy in the Russian Federation: Problems and Potential for the Development. In *Circular Economy: Recent Trends in Global Perspective*; Springer: Singapore, 2021; pp. 281–307.
64. Albrecht, M.; Yarovoy, G.; Karginova-Gubinova, V. Russia's waste policy and rural waste management in the Karelian Republic: Building up a ruin to come? *Fennia* **2020**, *198*, 135–150. [CrossRef]
65. RÚSSIA. Decree of the Government of the Russian Federation Nº 84. On Approval of the Strategy for the Development of the Industry for the Processing, Recycling and Neutralization of Production and Consumption Waste. Russian Federation. 2018. Available online: http://static.government.ru/media/files/y8PMkQGZLfbY7jhn6QMruaKoferAowzJ.pdf (accessed on 18 May 2022).
66. Dutta, D.; Goel, S. Understanding the gap between formal and informal e-waste recycling facilities in India. *Waste Manag.* **2021**, *125*, 163–171. [CrossRef]
67. Abalansa, S.; El Mahrad, B.; Icely, J.; Newton, A. Electronic Waste, an Environmental Problem Exported to Developing Countries: The GOOD, the BAD and the UGLY. *Sustainability* **2021**, *13*, 5302. [CrossRef]
68. Guo, B.; Geng, Y.; Sterr, T.; Zhu, Q.; Liu, Y. Investigating public awareness on circular economy in western China: A case of Urumqi Midong. *J. Clean. Prod.* **2017**, *142*, 2177–2186. [CrossRef]
69. Li, H.; Lu, Y. A Bilevel Programming Location Approach to Regional Waste Electric and Electronic Equipment Collection Centers: A Study in China. *Math. Probl. Eng.* **2021**, *2021*, 1–10. [CrossRef]
70. Steuer, B.; Ramusch, R.; Salhofer, S. Is there a future for the informal recycling sector in urban China? *Detritus* **2018**, *4*, 189–200. [CrossRef]
71. Era E-Waste INDWMP (in Short). E-Waste Recycling Authority E-Waste Industry Waste Management Plan. South African E-Waste Industry Waste Management Plan (V.1) 2019–2024. Intellectual Property of ERA NPC Under CIPC Registration No. 2018/248881/08. 2018. Available online: http://eranpc.co.za/wp-content/uploads/2018/09/Industry-Waste-Management-PlanFINAL-v.3.pdf (accessed on 30 January 2022).
72. Lydall, M.; Nyanjowa, W.; James, Y. *Mapping South Africa's Waste Electrical and Electronic Equipment (WEEE) Dismantling, Pre-Processing and Processing Technology Landscape*; Department of Science and Technology and the Council for Scientific and Industrial Research: Pretoria, South Africa, 2017. Available online: https://www.itu.int/en/ITU-D/Environment/Documents/Events/2021/Fostering-E-waste-Management-across-Africa/weee_technology_landscape_assessment_report.pdf?csf=1&e=dWYDtB (accessed on 15 December 2022).
73. Council for Scientific and Industrial Research (CSIR). Integrating Informal Waste Pickers into the Economy. Publication Date: 31 March 2016. Available online: https://www.csir.co.za/integrating-informal-waste-pickers-economy (accessed on 9 February 2022).
74. Godfrey, L.; Strydom, W.; Phukubye, R. *Integrating the Informal Sector into the South African Waste and Recycling Economy in the Context of Extended Producer Responsibility*; CSIR Briefing Note: Pretoria, South Africa, 2016. Available online: https://www.csir.co.za/sites/default/files/Documents/Policy%20Brief_Informal%20Sector_CSIR%20final.pdf (accessed on 12 May 2022).
75. Pienaar, C.; Basson, L.; Williams, Q. *Waste: Market Intelligence Report 2020*; Green Cape: Cape Town, South Africa, 2020. Available online: www.greencape.co.za (accessed on 14 February 2022).
76. South African Waste Pickers Association (SAWPA). Available online: https://wastepickers.org.za/ (accessed on 9 February 2022).
77. Agência Brasileira De Desenvolvimento Industrial (ABDI). Logística Reversa de Equipamentos Eletroeletrônicos: Análise de Viabilidade Técnica e Econômica. 2012. Available online: https://sinir.gov.br/images/sinir/LOGISTICA_REVERSA/EVTE_ELETROELETRONICO (accessed on 19 July 2021).
78. Andeobu, L.; Wibowo, S.; Grandhi, S. A Systematic Review of E-Waste Generation and Environmental Management of Asia Pacific Countries. *Int. J. Environ. Res. Public Health* **2021**, *18*, 9051. [CrossRef]
79. Associação Brasileira de Normas Técnicas (ABNT). Available online: https://www.abntcatalogo.com.br/ (accessed on 6 July 2021).
80. World Bank. Modest Growth; Focus on Informality. Russia Economic Report 41. The World Bank. 2019. Available online: https://openknowledge.worldbank.org/bitstream/handle/10986/31933/Russia-Economic-Report-Modest-Growth-Focus-on-Informality.pdf?sequence=1&isAllowed=y (accessed on 3 June 2022).
81. Awasthi, A.K.; Li, J. Management of electrical and electronic waste: A comparative evaluation of China and India. *Renew. Sustain. Energy Rev.* **2017**, *76*, 434–447. [CrossRef]
82. Bai, H.; Wang, J.; Zeng, A.Z. Exploring Chinese consumers' attitude and behavior toward smartphone recycling. *J. Clean. Prod.* **2018**, *188*, 227–236. [CrossRef]
83. Balkevicius, A.; Sanctuary, M.; Zvirblyte, S. Fending off waste from the west: The impact of China's Operation Green Fence on the international waste trade. *World Econ.* **2020**, *43*, 2742–2761. [CrossRef]
84. Bob, U.; Padayachee, A.; Gordon, M.; Moutlana, I. Enhancing innovation and technological capabilities in the management of E-waste: Case study of South African government sector. *Sci. Technol. Soc.* **2017**, *22*, 332–349. [CrossRef]

85. Borthakur, A. Policy approaches on E-waste in the emerging economies: A review of the existing governance with special reference to India and South Africa. *J. Clean. Prod.* **2020**, *252*, 119885. [CrossRef]
86. Borthakur, A.; Singh, P. The journey from products to waste: A pilot study on perception and discarding of electronic waste in contemporary urban India. *Environ. Sci. Pollut. Res.* **2021**, *28*, 24511–24520. [CrossRef]
87. Brasil. Lei Nº 6.938, de 31 de Agosto de 1981. Estabelece a Política Nacional do Meio Ambiente, Seus Fins e Mecanismos de Formulação e Aplicação. Available online: http://www.planalto.gov.br/ccivil_03/leis/l6938.htm (accessed on 6 July 2021).
88. Brasil. Lei Nº 12.305, de 2 de Agosto de 2010 (a). Institui a Política Nacional de Resíduos Sólidos. Presidência da República. 2010. Available online: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm (accessed on 22 June 2021).
89. Chung, S.; Zhang, C. An evaluation of legislative measures on electrical and electronic waste in the People's Republic of China. *Waste Manag.* **2011**, *31*, 2638–2646. [CrossRef]
90. Brook, J. Russia 2021: The Current Status of EPR Regulations. LORAX EPI. 2021. Available online: https://www.enviro-pac.com (accessed on 17 May 2022).
91. Coelho, S.T.; Diaz-Chavez, R.; Cortez, C.L.; Perecin, D.; Possetti, G.R.C.; Rietow, J.C. Circular Economy in Brazil. In *Circular Economy: Recent Trends in Global Perspective*; Ghosh, S.K., Ghosh, S.K., Eds.; Springer: Singapore, 2021; pp. 459–496. [CrossRef]
92. Department of Forestry, Fisheries and the Environment. Annual Performance Plan 2021/22. Pretoria. South Africa. 2020. Available online: https://www.dffe.gov.za/sites/default/files/reports/2021.2022annualperformanceplan.pdf (accessed on 5 March 2022).
93. Department of Science and Innovation—DSI. Republic of South Africa. A Waste Research, Development and Innovation Roadmap for South Africa (2015–2025). Available online: https://wasteroadmap.co.za/ (accessed on 2 February 2022).
94. Department of Trade Industry and Competition—DTIC. Available online: http://www.thedtic.gov.za/ (accessed on 2 February 2022).
95. E-Waste Association of South Africa—EWASA. Available online: https://www.ewasa.org/ (accessed on 14 February 2022).
96. Fan, Y.; Fang, C. Circular economy development in China-current situation, evaluation and policy implications. *Environ. Impact Assess. Rev.* **2020**, *84*, 106441. [CrossRef]
97. Fedotkina, O.; Gorbashko, E.; Vatolkina, N. Circular economy in Russia: Drivers and barriers for waste management development. *Sustainability* **2019**, *11*, 5837. [CrossRef]
98. Finlay, A.; Liechti, D. E-Waste Association of South Africa (eWASA). eWASA/Empa. 2008. Available online: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.476.1116&rep=rep1&type=pdf (accessed on 12 February 2022).
99. GM&C. Available online: https://www.gmclog.com.br/site/ (accessed on 8 July 2021).
100. Green Eletron. Available online: https://greeneletron.org.br/ (accessed on 28 September 2022).
101. Ground Work. Available online: https://www.groundwork.org.za/index.php (accessed on 14 February 2022).
102. Gutman, S.; Teslya, A. Potential for transition to circular economy in regions of the Russian Arctic. In *IOP Conference Series: Earth and Environmental Science*; IOP Publishing: Bristol, UK, 2020; p. 012064. [CrossRef]
103. Heidemann, T.; Bogdanov, D. Waste Reform in Russia: Administrative Powers at Federal, Regional and Local Levels; CMS Law-Now: Russia. Available online: https://www.lexology.com/library/detail.aspx?g=c0f5d11d-c753-46f2-8180-7defb15069fe (accessed on 27 December 2020).
104. Índia, S.O. 1035 (E). E-Waste (Management & Handling) Rules, 2011. Ministry of Environment & Forests, Government of India. Gazette of India. 2011. Available online: https://www.meity.gov.in/writereaddata/files/1035e_eng.pdf (accessed on 25 October 2022).
105. Instituto De Pesquisa Econômica Aplicada (IPEA). Situação Social das Catadoras e dos Catadores de Material Reciclável e Reutilizável—Brasil. Brasília. 2013. Available online: https://www.ipea.gov.br/portal/images/stories/PDFs/situacao_social/131219_relatorio_situacaosocial_mat_reciclavel_brasil.pdf (accessed on 26 July 2021).
106. Joon, V.; Shahrawat, R.; Kapahi, M. The emerging environmental and public health problem of electronic waste in India. *J. Health Pollut.* **2017**, *7*, 1–7. [CrossRef]
107. Kumar, A.; Dixit, G. Evaluating critical barriers to implementation of WEEE management using DEMATEL approach. *Resour. Conserv. Recycl.* **2018**, *131*, 101–121. [CrossRef]
108. Ledwaba, P.; Sosibo, N. Cathode ray tube recycling in South Africa. *Recycling* **2017**, *2*, 4. [CrossRef]
109. Wang, R.; Deng, Y.; Li, S.; Yu, K.; Liu, Y.; Shang, M.; Wang, J.; Shu, J.; Sun, Z.; Chen, M.; et al. Waste Electrical and Electronic Equipment Reutilization in China. *Sustainability* **2021**, *13*, 11433. [CrossRef]
110. Liu, Y.; Li, H.; An, H.; Guan, J.; Shi, J.; Han, X. Are the environmental impacts, resource flows and economic benefits proportional? Analysis of key global trade routes based on the steel life cycle. *Ecol. Indic.* **2021**, *122*, 107306. [CrossRef]
111. Lopes Dos Santos, K. The recycling of e-waste in the industrialized Global South: The case of Sao Paulo Macrometropolis. *Int. J. Urban Sustain. Dev.* **2020**, *13*, 56–69. [CrossRef]

112. Lopes dos Santos, K.; Jacobi, P.R. O acordo setorial para gestão de resíduos eletroeletrônicos: Desafios e possibilidades. In *10 anos da Política de Resíduos Sólidos: Caminhos e Agendas para um Futuro Sustentável*; Besen, G.R., Jacobi, P.R., Silva, C.L., Eds.; IEE-USP/OPNRS: São Paulo, Brazil, 2021; pp. 42–53. Available online: https://www.opnrs.org.br/images/10_anos_da_Politica_de_Residuos_Solidos_caminhos_e_agendas_para_um_futuro_sustentavel_-_DOI_10116069786588109076_1pdf-_VF_compressed.pdf (accessed on 21 March 2022).
113. Maryev, V.A.; Smirnova, T.S. Perspective of CE in Russia: From Theory to Practice. In *Circular Economy: Recent Trends in Global Perspective*; Springer: Singapore, 2021; pp. 259–279. [CrossRef]
114. Ministério do Meio Ambiente. Acordo Setorial para a Implantação do Sistema de Logística Reversa de Produtos Eletroeletrônicos de Uso Doméstico e seus Componentes, de 31 de outubro de 2019. Available online: https://www.gov.br/mma/pt-br/centrais-de-conteudo/acordo-20setorial-20-20eletroeletrnicos-pdf (accessed on 24 June 2021).
115. Omelchenko, E.; Serebrennikova, A.; Gumenyuk, D.; Chivragova, M.; Anichkin, A.; Mikhaleva, A.; Chance, C. *Environmental Law and Practice in the Russian Federation: Overview*; Thomson Reuters: London, UK, 2021. Available online: https://uk.practicallaw.thomsonreuters.com/w-013-5609?transitionType=Default&contextData=(sc.Default)&firstPage=true (accessed on 13 June 2022).
116. Ogunmakinde, O.E. A review of circular economy development models in China, Germany and Japan. *Recycling* **2019**, *4*, 27. [CrossRef]
117. Organization for Economic Co-Operation and Development—OECD. Environmental Policy and Regulation in RUSSIA. The Implementation Challenge. Organization for Economic Co-Operation and Development. OECD. 2006. Available online: https://www.oecd.org/env/outreach/38118149.pdf (accessed on 17 May 2022).
118. Pathak, P.; Srivastava, R.R.; Ojasvi. Assessment of legislation and practices for the sustainable management of waste electrical and electronic equipment in India. *Renew. Sustain. Energy Rev.* **2017**, *78*, 220–232. [CrossRef]
119. RECLAM. Reclamation Group (Pty) Ltd. Available online: https://www.reclam.co.za/ (accessed on 9 February 2022).
120. Republic of South Africa. National Environmental Management Act, Nº 107—1998. Government Gazette. Available online: https://www.gov.za/sites/default/files/gcis_document/201409/a107-98.pdf (accessed on 27 January 2022).
121. Rússia. Decree of the Government of the Russian Federation Nº 1657. About Requirements for Processing, Recycling, Treatment and Disposal of Solid Municipal Waste. Russian Federation. 2020. Available online: http://extwprlegs1.fao.org/docs/pdf/rus198360.pdf (accessed on 17 May 2022).
122. Rússia. Decree of the Government of the Russian Federation Nº 284. On the Establishment of Environmental Duty Rates for Each Group of Goods to be Disposed of After They Have Lost Their Consumer Properties, Paid by Manufacturers, Importers of Goods That do not Provide Independent Disposal of Waste from the Use of Goods. Russian Federation. 2016. Available online: https://rg.ru/2016/04/18/ecosbor-dok.html (accessed on 11 May 2022).
123. Rússia. Federal Law Nº 219-FZ. On Amendments to the Federal Law "On Environmental Protection" and Certain Legislative Acts of the Russian Federation. Russian Federation. 2014. Available online: http://extwprlegs1.fao.org/docs/pdf/rus140704.pdf (accessed on 12 May 2022).
124. Rússia. Federal Law Nº 503-FZ. On Amendments to the Federal Law "On Production and Consumption Waste". Russian Federation. 2017. Available online: http://www.kremlin.ru/acts/bank/42728 (accessed on 19 May 2022).
125. Rússia. Federal Law of The Russian Federation Nº 89. About Production Wastes and Consumption, of June 10, 1998. Russian Federation. 1998. Available online: http://extwprlegs1.fao.org/docs/pdf/rus22617.pdf (accessed on 12 May 2022).
126. Rússia. Federal Law of The Russian Federation Nº 89. About Production Wastes and Consumption, of June 10, 1998, as Amended on 2 July 2021. Russian Federation. 2021. Available online: https://cis-legislation.com/document.fwx?rgn=1630 (accessed on 10 May 2022).
127. Rússia. Fundamentals of State Policy in the Field of Environmental Development of Russia for the Period up to 2030. Russian Federation. 2012. Available online: http://kremlin.ru/events/president/news/15177 (accessed on 11 May 2022).
128. Rússia. The Russian Government. Ministry of Natural Resources and Environment of the Russian Federation (Minprirody). Available online: http://government.ru/rugovclassifier/516/events/ (accessed on 13 May 2022).
129. Russian Environmental Operator—REO. Available online: https://reo.ru (accessed on 10 June 2022).
130. SA Metal. Available online: https://www.sametal.co.za/ (accessed on 9 February 2022).
131. Shittu, O.S.; Williams, I.D.; Shaw, P.J. Global E-waste management: Can WEEE make a difference? A review of e-waste trends, legislation, contemporary issues and future challenges. *Waste Manag.* **2020**, *120*, 549–563. [CrossRef]
132. Sinctronics. Available online: https://sinctronics.com.br/ (accessed on 8 July 2021).
133. Sko Electronics—Recycling. Available online: https://e-epr.ru (accessed on 30 May 2022).
134. The State Council of the People's Republic of China. Available online: https://en.ndrc.gov.cn/ (accessed on 16 September 2021).
135. Tong, X.; Tao, D.; Lifset, R. Varieties of business models for post-consumer recycling in China. *J. Clean. Prod.* **2018**, *170*, 665–673. [CrossRef]
136. Tran, T.; Goto, H.; Matsuda, T. The impact of China's tightening environmental regulations on international waste trade and logistics. *Sustainability* **2021**, *13*, 987. [CrossRef]

137. Universal Recycling Company. Available online: https://www.urc.co.za/ (accessed on 18 February 2022).
138. Wiego's Organization & Representation Programme—ORP. Available online: https://www.wiego.org/ (accessed on 14 February 2022).
139. Wiesmeth, H.; Starodubets, N.V. The management of municipal solid waste in compliance with circular economy criteria: The case of Russia. *Экономика Региона [Econ. Reg.]* **2020**, *16*, 725–738. [CrossRef]
140. Yan, M.; Wibowo, H.; Liu, Q.; Cai, Y.; Rahim, D.A.; Hu, Y. Municipal solid waste management and treatment in China. In *Sustainable Waste Management Challenges in Developing Countries*; Pariatamby, A., Hamid, F.S., Bhatti, M.S., Eds.; IGI Global: Hershey, PA, USA, 2020; pp. 86–114. [CrossRef]
141. Zeng, X.; Duan, H.; Wang, F.; Li, J. Examining environmental management of e-waste: China's experience and lessons. *Renew. Sustain. Energy Rev.* **2017**, *72*, 1076–1082. [CrossRef]
142. Zhang, L.; Qu, J.; Sheng, H.; Yang, J.; Wu, H.; Yuan, Z. Urban mining potentials of university: In-use and hibernating stocks of personal electronics and students' disposal behaviors. *Resour. Conserv. Recycl.* **2019**, *143*, 210–217. [CrossRef]
143. Zhou, L.; Xu, Z. Response to waste electrical and electronic equipments in China: Legislation, recycling system, and advanced integrated process. *Environ. Sci. Technol.* **2012**, *46*, 4713–4724. [CrossRef] [PubMed]
144. Zhu, J.; Fan, C.; Shi, H.; Shi, L. Efforts for a circular economy in China: A comprehensive review of policies. *J. Ind. Ecol.* **2019**, *23*, 110–118. [CrossRef]
145. Monteiro, M.D.S. Panorama da logística reversa de resíduos de equipamentos eletroeletrônicos no Brasil. In Proceedings of the 10º Forum Internacional de Resíduos Sólidos, João Pessoa, Brazil, 12–14 June 2019. Available online: http://www.institutoventuri.org.br/ojs/index.php/firs/issue/view/Anais-FIRS-2019 (accessed on 29 June 2021).
146. Steuer, B. What Institutional Dynamics Guide Waste Electrical and Electronic Equipment Refurbishment and Reuse in Urban China? *Recycling* **2016**, *1*, 286–310. [CrossRef]
147. Sharma, M.; Joshi, S.; Govindan, K. Issues and solutions of electronic waste urban mining for circular economy transition: An Indian context. *J. Environ. Manag.* **2021**, *290*, 112373. [CrossRef]