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LIXOTEC PROJECT: SOCIAL RESPONSIBILITY IN AN ENVIRONMENTAL MANAGEMENT ACTION

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ABSTRACT

Constant technological innovations bring countless benefits and facilities to the professional and personal environment. On the other hand, the social pressure to have the latest generation of electronics means that consumption habits are constantly renewed, which has an impact on the increased generation of solid waste. This is why, in recent years, electronic waste has become one of the planet's biggest environmental problems. In 2019, 53 million metric tons (Mt) of electronic waste was generated, equivalent to 7.3 kg per capita per year. Of this total, only 17.3% was recycled. With the emergence of sustainability reports and guidelines for reporting the impacts caused, as well as the actions taken to mitigate them, social responsibility has become a strategic governance practice for organizations in terms of the transparency of the actions they take to mitigate the impacts of their operations. In addition, the environmental and social impacts are worrying, since up to a thousand toxic substances and heavy metals can be found in this type of waste, which contaminate the soil, groundwater, air, and cause harm and damage to health. In view of this, the aim of this study is to analyze the contributions of the Environmental Management Action (EMA) of the Lixotec Project in mitigating the impacts caused to the environment and the health of the population of Foz do Iguaçu and the Western Region, through the collection, sorting, and correct disposal of waste. In methodological terms, bibliographical and documentary research was used to support the field of study. In terms of nature, the research is classified as qualitative, in terms of objective, as descriptive, in terms of procedures, as a case study with a holistic approach, and in terms of data collection instruments, participant observation was used. The results show that the Lixotec Project's EMA has been effective in mitigating the environmental and social impacts on the local community. Although approximately 50,000 people have been impacted directly or indirectly, it was found that the amount of waste generated per capita is not proportional to the amount recycled, making it necessary to continue the action until there are changes in consumption habits and in society's socio-environmental education. It is also concluded that the Lixotec Project is an excellent strategic partner for organizations in Foz do Iguaçu and the Western Region of Paraná to jointly develop social responsibility actions through the correct disposal of electronic waste, promoting the circular economy of this waste and, consequently, mitigating social and environmental impacts.

Keywords: Electronic waste; Environmental Management Action (EMA); Lixotec Project; Social responsibility; Environmental and social impacts.

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INTRODUCTION

Constant advances in technology, combined with more affordable prices, have led to changes in consumer buying habits. People are buying more modern electronic equipment. This is generally related to society's call for people to keep themselves updated, driving the purchase of new products (Rocha *et al*., 2010; Lima *et al*., 2015).

Society has come to view the replacement of products as a natural thing, as if they were disposable, once repairs have become financially unviable compared to buying new equipment with more modern configurations and functions, and more affordable prices and payment terms. This triggers an early process of obsolescence and generates a huge amount of solid waste that causes serious environmental impacts (Lima *et al*., 2008; Sakai *et al*., 2009).

The improper disposal of solid waste, in particular waste electrical and electronic equipment (WEEE), popularly known as "e-waste", is a global concern due to its serious environmental and social impacts. It is estimated that more than 50 million tons of electronic waste are generated worldwide every year, which, due to the huge amount of metals and toxic substances, can cause irreversible damage to the environment and human health (Kasper *et al*., 2009; Maciel, 2011; Seo e Firgerman, 2011).

In 2020, the third edition of the Global E-waste Monitor Statistic Partnership (GEMSP) report showed an increase of 9.2 million metric tons (Mt) of e-waste in just 5 years. In 2019, the GEMSP report recorded 53.6 Mt of discarded products with batteries or plugs, such as computers, cell phones and televisions. These products contain toxic substances such as mercury, brominated flame retardants (BFRs) or chlorofluorocarbons (CFCs), among others, which pose serious risks to human health and to the environment when handled or disposed of improperly.

The GEMSP report presents a linear growth forecast, estimating generation of 74.7 Mt by 2030. This forecast is based on the consumption rates of electrical and electronic products, the life cycle, and limited repair options for products (Forti *et al*., 2020).

Therefore, organizations need to turn their operations towards social responsibility strategies that consider environmental management as a decisive factor that can no longer be neglected. Environmental management is directly related to social responsibility, even if these concepts are approached separately, they are inseparable, since it is impossible to deal with environmental issues without addressing social ones.

Organizations must look at the impacts that their operations can have on local communities and must be responsible for establishing strategies and actions to mitigate them (Barbieri, 2007).

Within this context, it is of the utmost importance to plan environmental management actions (EMA) that can integrate the organization, society and the environment in interventions associated with solving common environmental problems.

In the particular case of electronic waste, this is a problem whose responsibility for mitigating impacts involves companies, the government, society in general, educational institutions, suppliers, and, in short, everyone involved in the complete cycle of this equipment (Silva, 2010).

Consequently, this research aims to answer the following question: how does the environmental management action (EMA) of the Lixotec Project contribute to mitigating the impacts caused to the environment and health by collecting, sorting, and disposing of electronic waste?

Therefore, the main objective of the study is to analyze the contributions of the environmental management action (EMA) of the Lixotec Project in mitigating the impacts caused to the environment and the health of the population of Foz do Iguaçu and the Western Region through the collection, sorting, and correct disposal of waste.

To achieve the general objective, the following specific objectives were set: i) to understand the growth in the generation of electronic waste; ii) to understand the environmental and social impacts of e-waste; iii) to identify ways of disposing of electronic waste correctly; iv) to evaluate the effectiveness of the actions promoted by the Lixotec Project.

The generation of electronic waste

The generation of solid waste has been a worldwide concern, becoming one of the biggest challenges to be faced by society, organizations, and public entities due to its impacts, whether socio-economic or environmental (Selpis *et al*., 2012; Ushizima *et al*., 2014).

Due to technological advances, thousands of products have appeared to make modern life easier. However, their life cycle is decreasing, and when they are not discarded because they are technologically obsolete, they are discarded because it is not economically viable to repair them compared to buying a new model.

S&G Journal
Volume 18, Number 3, 2023, pp. XXX-XXX
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As a result, the amount of waste electrical and electronic equipment is increasing (Sakai *et al*., 2009; Natume e Sant'anna, 2011; Sant'anna *et al*., 2013). Electronic waste, also known as e-waste, is any technological product that has reached the end of its useful life, either due to functionality or obsolescence.

This category of waste includes computers, computer equipment, cell phones, televisions, household appliances in general, light bulbs, batteries, power tools, and any other type of product with plugs that carry an electric current. (Kasper *et al*., 2009; Natume e Sant'anna, 2011; Almeida *et al*., 2015).

This electronic waste is legally divided into four categories: i) white line - which includes large household appliances such as washing machines, freezers, and refrigerators ; ii) blue line - small household appliances such as an iron, blender, sandwich maker ; iii) brown line - audio and video equipment such as televisions, DVDs, cameras ; iv) green line - computer and telecommunication equipment, including cell phones, laptops, computers, printers, among others (El Faro *et al*., 2012; Lima *et al*., 2015).

Among the fastest growing categories of solid waste is electronic waste, both in developed and underdeveloped countries. Statistics show that electronic waste accounts for 5% of all waste generated worldwide, corresponding to an average of 50 million metric tons produced per year. Despite this, only 11% of this amount is destined for appropriate recycling processes (Andrade *et al*., 2010; El Faro *et al*., 2012; Lima *et al*., 2015).

In 2014, the global e-waste monitor, developed through the joint efforts of the International Telecommunication Union (ITU), the Sustainable Cycles Programme (SCYCLE), co-organized by the United Nations University (UNU) and the United Nations Institute for Training and Research (UNITAR), and the International Solid Waste Association (ISWA), began monitoring data on the number of kilograms (kg) per capita and million metric tons (Mt) per year of e-waste produced on the planet. Based on the linear growth observed in the first six years, the monitor projected in 2020 a forecast of the linear growth of waste until the year 2030.

Figure 1 shows the amount in kg of electronic waste generated per person each year. It can be seen that in 2019 each person generated 7.3 kg/year and that by 2030 it could reach 9.0 kg/year. **Figure 2** shows the amount generated in millions of metric tons per year. In 2019, 53.6 Mt/year was generated, and it is estimated that by 2030 it could rise to 74.7 Mt/year. Therefore, the global volume of e-waste is increasing at a rate of approximately 2 Mt per year.

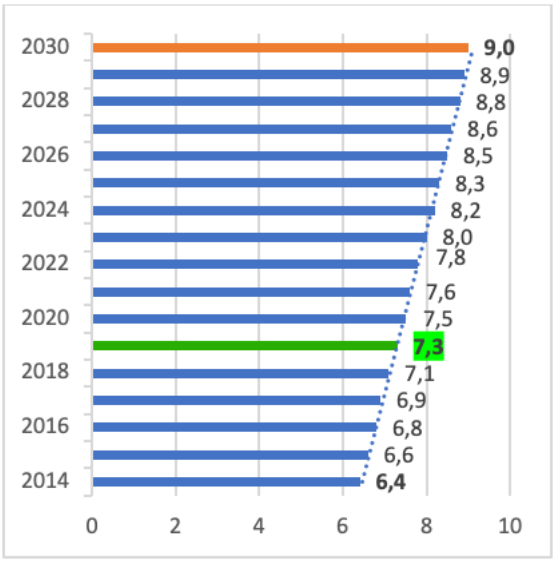

Figure 1. Kg per capita/year
Source: Adapted from Forti *et al*., (2020)

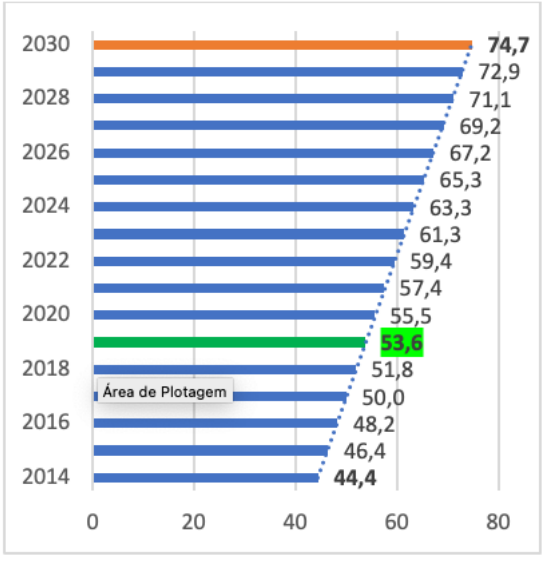

Figure 2. Mt/year
Source: Adapted from Forti *et al*., (2020).

Also based on the report, data on e-waste recycling in 2019 shows that only 17.4% was recycled, which is equivalent to 9.3 Mt of e-waste generated, while the vast majority (82.6%) was neither formally collected nor managed in an environmentally correct manner, given that when this type of waste is properly disposed of, it follows flows that are documented in a consistent or systematic manner, ensuring recycling or de-characterization (Forti *et al*., 2020).

It was also revealed that Asia was the continent that generated the most e-waste in the world, totaling 24.9 Mt. However, Europe was the continent that generated

the most waste per person, with 16.2 Kg, and has the highest documented rate of e-waste collection and recycling through official channels - 42.5%. **Figure 3** shows the amount in Mt of electronic waste generated per continent, the amount in Kg per capita and the percentage recycled.

Continent	Mt	Kg per capita	% Recycled
Asia	24.9	5.6	11.7%
America	13.1	13.3	9.4%
Europe	12	16.2	42.5%
Africa	2.9	2.5	0.9%9
Oceania	0.7	16.1	8.8%

Figure 3. Electronic waste generated worldwide
Source: Adapted from Forti *et al*. (2020).

According to the information showed in **Figure 3**, Asia is the largest generator of electronic waste due to the development of technology and production, however, it has the lowest consumption behavior in relation to the amount generated, with 5.6 kg/year discarded per person. Oceania, the smallest generator, has the highest consumption behavior in relation to the proportion of e-waste generated, discarding 16.1 kg per person per year. The Americas are in second place in terms of e-waste generation, with 13.1 Mt/year, generating 13.3 kg/year per capita and recycling only 9.4% of e-waste.

In this scenario, the importance of correctly disposing of electronic waste is highlighted, since it is a type of waste composed of more than a thousand different substances, including lead, mercury, cadmium, arsenic, and various other toxic components which, when disposed of improperly, can cause serious damage to both human health and the environment, polluting the air, soil, and water (El Faro *et al*., 2012; Moi *et al*., 2012).

Environmental and social impacts of e-waste

The impacts range from the manufacturing process of electronic products, where natural resources such as water, energy, minerals and various chemical substances are consumed, to the end of the useful life cycle.

The recycling process mitigates the impact on the use of natural resources, since precious metals such as gold, silver, platinum, thallium, zinc, and beryllium are found in many electrical and electronic components, reducing the extraction of these resources from nature.

When waste is disposed of in landfills or dumps, in contact with rainwater and corrosion it generates leachate (a polluting liquid, dark in color and with a strong odor, originated from the biological, chemical and physical processes of waste decomposition) which, when it seeps into the ground, contaminates surface water, soil and groundwater (Maciel, 2011).

Although the soil has a great natural capacity to retain heavy metals, when this capacity is exceeded, the metals are leached out, compromising the quality of surface water and groundwater, causing impacts on the biotic health of ecosystems and living beings due to the bioaccumulation of these metals.

As a result, in some countries in Asia, Africa and South America, the high level of pollution caused by this waste is causing concern among environmental agencies (Almeida *et al*., 2015; Lima *et al*., 2015; Martins *et al*., 2013).

The impacts caused by e-waste can put existing fauna and flora in the environment and the community at risk, which is why it is considered one of the biggest environmental problems in the world. According to Ferreira and Ferreira (2008), when they are dumped in landfills they can cause serious damage to health, both by contaminating the groundwater and by combustion, which pollutes the air.

Several products present in this type of waste can compromise health, since persistent organic pollutants and heavy metals can easily accumulate in the body through inhalation of contaminated air, ingestion and through the skin. **Figure 4** shows some examples of harmful substances, their harm and damage, and what kind of products they are found in.

Suitable alternatives for disposing of electronic waste

According to Tanaue *et al*. (2015), many people do not know that a large part of electronic waste can be recycled and, for this reason, dispose of it improperly. There are companies and cooperatives that sort, separate the components and use the products in a usable condition. There are also recycling companies that recycle materials that have not been used in the previous ways, so that this waste can be returned as raw material to industries.

According to Celinski *et al*. (2011), there are three ways to properly dispose of electronic waste:

> [...] "The first action is related to equipment that still has some life left in it, which could be used

S&G Journal
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Substance	Harm and Damage	Location
Mercury	Brain and liver damage	Computers, monitors and plasma TVs
Cadmium	Poisoning, bone, kidney and lung problems	Computers, tube monitors and laptop batteries
Arsenic	Lung cancer, skin diseases and damage to the nervous system	Cell phones
Beryllium	Lung cancer	Computers and cell phones
Flame Retardants	Hormonal disorders, problems in the nervous and reproductive systems	Used to prevent fires in various electronics
Lead	Nervous and blood systems	Computers, cell phones and TV
Barium	Cerebral edema, muscle weakness, damage to the heart, liver and spleen	Fluorescent lamps and tubes

Figure 4. Some harmful substances found in electronic waste
Source: Ferreira e Ferreira (2008, p. 165)

> by the community in digital inclusion projects. The second is to dispose of obsolete parts, which could be reused and recycled. The third would be to raise awareness among the population through lectures and the creation of collection points, with a view to the importance of recycling electronic waste for the sustainability of its consumption cycle" (Celinski *et al*., 2011, p. 3).

Reverse logistics is also an alternative practiced by product manufacturers, but this obligation depends on the regulation and application of laws in each country. In Brazil, reverse logistics is regulated in art. 33 of the National Solid Waste Policy (NSWP), which provides for the mandatory return to manufacturers, importers, distributors and traders of pesticides, their waste and packaging, batteries, tires, lubricating oil packaging, sodium vapor, mercury and mixed light fluorescent lamps, electrical and electronic products and their components. (Brazil, 2010; Assunção, 2019).

Regarding action to change production and consumption patterns, Assunção (2019) also introduces the concept of the circular economy, as it is a restorative and regenerative economy, which aims to maintain products, components and materials at the highest level of usefulness and value throughout their lifetime, distinguishing between thermal and biological cycles. In this vision, design becomes "cradle to cradle", with the potential to expand rather than reduce material choices. The circular economy is based on.

Production in the linear model uses natural resources without considering their limitations. In this model, after use, products are discarded without going through the transformation process to reuse the raw material, leading to an increase in waste and environmental and social impacts. In the circular model, there is a cyclical process in which waste is transformed and reinserted into the production process or used as a source of energy and by-products, which consequently preserves more natural resources and mitigates impacts. (Assunção, 2019).

MATERIAL AND METHOD

This study was conducted using bibliographical research, and the aim of which was to provide a basis for the field of study. The bibliographic survey was performed using Google Scholar, with the following descriptors: "electronic waste" and "environmental management actions". Articles were then selected that were related to the proposed topic and, in order to understand the current situation of e-waste, the period selected was the last 15 years. Documentary research was also used to analyze the Global E-waste Monitor Statistic Partnership report, which presented data on the monitoring of electronic waste on the planet, and documents and information obtained from the Lixotec Project website, at the following address: https://www.projetolixotec.com.br/.

In terms of the nature of the research, it is a qualitative study. In terms of objective, it is a descriptive study and in terms of procedure, it is classified as a case study. According to Martins (2008), the main characteristic of a case study is the analysis of a current phenomenon in its real context, covering all the variables that can influence it, as well as offering descriptions, interpretations and explanations that are particular and even unprecedented.

The focus of this case study will be holistic, when the researcher aims to examine only the global nature of a program or an organization. Finally, the data collection technique used in the case study was participant observation, in which the researcher is inserted into the con-

text studied in order to understand the complexity and generate insights for more effective dialogue (Zanelli, 2002).

According to Mattar (2001, p. 23), "participant observation should be informal and directed, focused solely on observing behaviors, facts, objects, and situations of interest to the problem under study". The process flow will therefore be mapped using this technique.

LIXOTEC project characterization

The object of study was the Lixotec Project - the Electronic Waste Collection and Sorting Center - which is part of the OSCIP Biomas do Brasil, the Wild Animal Management and Reintegration and Environmental Conservation Unit (WAMRECU), located in the city of Foz do Iguaçu, in the state of Paraná.

The project was founded in 2011 by three partners who are enthusiastic about preserving the environment, with academic qualifications in computer technology, history and environmental management, and extensive technical knowledge of electronic waste. It is a project with sustainable actions and environmental management that acts independently of private or governmental actions, while at the same time raising awareness in society about the correct disposal of electronic waste. Collections are free of charge, conducted by prior appointment and by optimizing the route by neighbourhood, and are also received directly at the project's address.

The project collects and receives all types of materials classified as electrical and electronic waste, in white, blue, brown and green lines, as well as aluminum (profile, piston, soft, hard, block), tin cans, copper and pure stainless steel (clean and ferrous). **Figure 5** shows the types of electronic waste most collected by the project.

The green line has the greatest diversity of electronic waste. All the waste remains in a covered area and is separated according to the classification of the line and then by type of material, such as cell phones, computers and batteries, to continue with the sorting, de-characterization, proper processing and dispatch to the recycler through partners.

Environmental management actions of the LIXOTEC Project

The project aims to correctly dispose of electronic waste and raise awareness among the community of Foz do Iguaçu and the Western Region of Paraná about the correct disposal of this waste, strictly following the environmental laws in force.

The need for action arose from the rampant increase in the generation of electronic waste in the city and region. Foz do Iguaçu has atypical peculiarities because it is located in a triple border region, because it is a tourist city that receives millions of visitors attracted by the Iguaçu Falls (one of the seven wonders of nature), because it concentrates the greatest diversity of ethnicities in the country, impacting on cultural issues, and because of the ease of access to new technologies from Paraguay, which contributes even more to the generation of waste.

In order to mitigate the environmental problem of e--waste in the city and the region covered by the project, the waste collected and received is sorted to see if it can still be used and repaired. After this stage, a flow of processes begins, redirecting the electronic waste to the appropriate recovery chains.

Based on participant observation and analysis of the information provided by the project, the process of this environmental management action (EMA) was mapped using the flowchart shown in **Figure 6**, divided into sorting into products that can still be used and those that cannot. After collection and/or receipt, the process begins with sorting, in which it is checked whether the product is still in usable condition; if so, it is repaired,

Classification	Types of waste
White Line	Air conditioning, fridge, stove, washing machine, freezer and similar.
Blue Line	Heater, GPS, blender, toaster, coffee maker, hair dryer, screwdriver, electric saw, electric motors and similar.
Brown Line	DVD players, fax machines, stereos, video games, CDs, DVDs and stereos, monitors and LCD/LED TVs, projectors, cameras, telephone exchanges and similar.
Green Line	Cell phones, computers, tablets, printers, X-ray film, chargers, card machines, UPS batteries, notebooks, motorcycles and cars, mice, stabilizers, pen drives, internal computer components and similar.

Figure 5. Types of Electronic Waste collected by the Lixotec Project
Source: Based on the site: https://www.projetolixotec.com.br

S&G Journal
Volume 18, Number 3, 2023, pp. XXX-XXX
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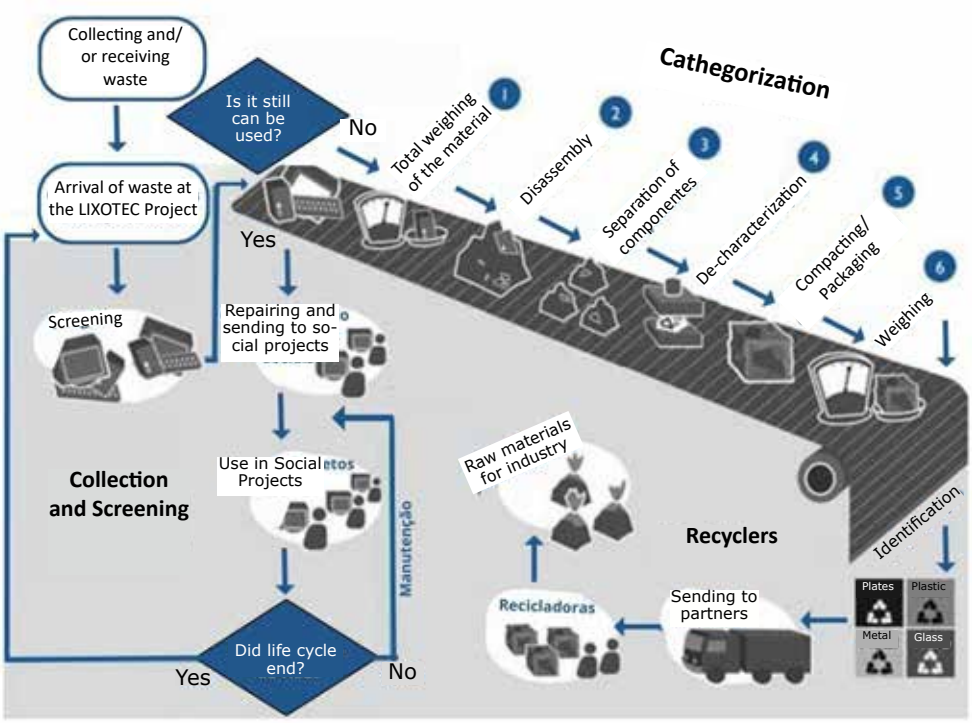

Figure 6. Flowchart of the Lixotec Project's AGM processes
Source: The authors (2023).

sanitized and sent to social projects, thus working on the social aspect of the project.

Figure 6 details the process flowchart: when the products can no longer be used, the categorization stages begin (total weighing, disassembly, separation, de-characterization, compacting, packaging, final weighing, identification) and finally the recycling stage (in which they are sent to partners, recyclers and then become raw materials for industry). In this second flow, the project works on both the environmental and social aspects by correctly disposing of waste that would otherwise generate serious impacts.

Some of the components present in e-waste can be recycled, however, this separation must be carried out by a specialized team, as many products contain substances that are harmful to human health (such as the examples shown in Table 03) and the environment (Ferreira e Ferreira, 2008).

The records on the amount of electronic waste removed from the environment and disposed of correctly are recorded through the initial weighing (which takes place before disassembly) minus the final weighing (after disassembly, separation and compacting/packaging for shipment to the recycler). All waste sent to the recycling industry comes with a report stating how many kilos of material were sent.

From the start of the project until 2022, more than 100 tons of electronic waste have been disposed of correctly. In addition, all the materials are de-characterized so that they cannot be traced back to their origin. Data destruction is a legal requirement that has become even more pronounced with the General Data Protection Act (GDPA). Devices with data storage capacities are subjected to a destruction stage; in cases where it is not possible to destroy the data, physical destruction will take place, making it impossible to reuse the equipment. Equipment or components that are in disrepair or need minor repairs are separated, checked and overhauled. At the end of the process, they are donated to organizations, schools or public sectors that promote social actions, thus contributing to the local community.

Figure 7 shows the indicators of the environmental management action of the Lixotec Project through the number of collections, tons sent to the recycler and the number of computers donated for use by the community. **Figure 8** represents all the stakeholders directly involved in this environmental action. The community generates and benefits from the collection, since the risks to health and contamination are mitigated. The organizations receive donations while acting as collection points.

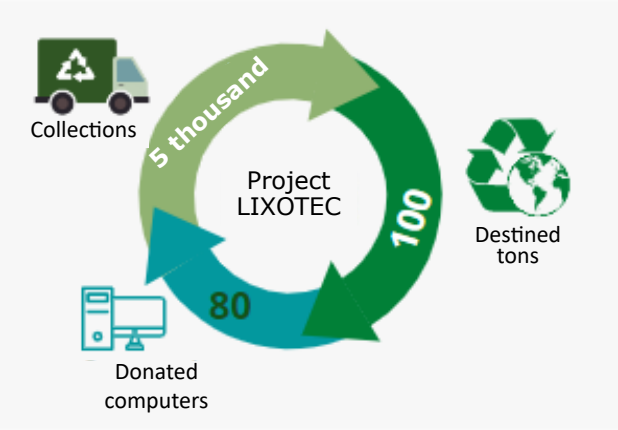

Figure 7. EMA Indicators
Source: The authors (2023)

Figure 8. Involved *Stakeholders*
Source: The authors (2023).

Educational institutions are partners in raising awareness, environmental education, receiving donations and can be collection points. Companies and industries generate and supply waste.

Finally, local public entities, although they don't send the e-waste generated in their structures to the project, because they adopt the practice of public auction, in which large recyclers buy the waste directly, benefit from the project's action through collection, which helps to keep green areas cleaner, by reducing e-waste in landfills and by donating computers and printers to public services, such as the Municipal Hospital and municipal school laboratories.

Although the project aims to close the entire cycle of stakeholders involved, the mitigation of this environmental issue is unable to accompany the accelerated growth in which waste is generated, partly due to the project having a small team, the lack of physical space to accommodate the waste after categorization until delivery to the recycler and, above all, the lack of awareness and people's consumerism to the detriment of new technologies, discarding equipment that still has a useful life.

With regard to the reach of this AGM, five thousand collections since the start of the project have been officially recorded in collection reports. However, the number of people impacted by the action is higher, since the record was made on the basis of each collection, which includes companies, schools, institutions and homes, in all of which a greater number of people live.

It is therefore inferred that at least 50,000 people have been directly or indirectly impacted by the action. It is undeniable that the actions of this project are strongly focused on social responsibility, both in terms of mitigating the impacts caused to the environment and human health and in terms of social and digital inclusion and awareness-raising, which shows that the purpose of the project is succeeding while generating income through the correct valuation of waste.

In this sense, the "Lixotec Project" can be a strategic partner for organizations in Foz do Iguaçu and the western region of Paraná in meeting the Sustainable Development Goals (SDGs) agreed in the 2030 Agenda and, more recently in Brazil, by the ABNT PR 2030 standard, launched in 2022, which provides guidance for organizations to address environmental, social and governance (ESG) issues so that they can plan their actions to mitigate the impacts caused by their operations. Among them, social responsibility through waste management and the circular economy are related to this research.

These guidelines strongly address social responsibility promoted within the aspect of governance as a transforming agent, so that organizations become more transparent in relation to the actions taken to mitigate their impacts, including information on the management of this waste in sustainability reports, which can meet the standards of the Global Reporting Initiative (GRI) guidelines, Integrated Reporting (IR) or another framework of interest to the organization.

Considering that all organizations, regardless of size, produce electrical and electronic waste and therefore have a social responsibility to dispose of this waste properly, the Lixotec Project is an efficient and safe alternative for disposing of electrical and electronic waste, since the OSCIP issues technical reports proving that it has been disposed of correctly. This enables the organizations and partners involved to be transparent about this environmental management action, as well as ensuring that this harmful waste is returned to the production cycle through the circular economy.

S&G Journal
Volume 18, Number 3, 2023, pp. XXX-XXX
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In terms of raising awareness about the importance of this environmental action, the project uses various strategies with the community: talks, participation in events, visits to schools, universities and organizations, tech competitions. These strategies aim to raise awareness about the risks of improper disposal and the consequences of excessive consumerism, resulting in the exploitation of more finite natural resources to manufacture new equipment. Meanwhile, the old ones still have some useful life left in them or can be reused for other purposes, such as handicrafts.

In order to measure the effectiveness of the awareness-raising promoted by the action, the numbers of the annual increase in collections made are used. However, this increase is an indication that the objectives are being partially achieved, since it also shows that the people affected have started to dispose of their waste properly, but have not changed their consumption habits very much.

FINAL CONSIDERATIONS

The purpose of this study was to analyze the contributions of the environmental action (EMA) of the Lixotec Project in mitigating the impacts caused to the environment and to the human health of the population of Foz do Iguaçu and the Western Region.

It was observed that the project is fulfilling its purpose, since it promotes the correct disposal of electronic waste, which can be seen in the 5,000 collections made, which resulted in at least 100 tons of electronic waste being recycled. They will later be returned to the production process, as well as the reuse of 80 computers and printers donated to organizations. There is a limit to the end of this environmental action, since the amount of waste generated per capita is not proportional to the amount recycled. This is due to a lack of conscious consumption.

Although the awareness-raising promoted by the action has had an effect in terms of raising awareness of the correct disposal of electronic waste, since collections have increased annually, it has not been effective in terms of changing consumer behavior.

The reinsertion of materials destined for recycling into the production cycle (circular economy) reduces the pressure to extract more natural resources and contributes to environmental sustainability, which is very positive. Another aspect is the complete use of the product's useful life through repair, maintenance and subsequent donation of computer equipment to the local community, contributing to digital inclusion at the same time. In this way, the project works towards social responsibility.

Thus, the "Lixotec Project" is a potential partner for organizations in Foz do Iguaçu and the western region of Paraná in terms of social responsibility in waste management and the circular economy. This is because, by correctly and transparently disposing of electronic waste to feed back into the production chain, it mitigates various environmental and social impacts.

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REFERÊNCIAS

Almeida, M.A., Papandrea, P.J., Carnevali, M., Andrade, A.X., Correa, F.P.V., Andrade, M.R.M. (2015), "Destinação do lixo eletrônico: impactos ambientais causados pelos resíduos tecnológicos", *Revista Científica e-Locução*, Vol. 1, No. 7, pp. 56-72.

Assunção, G.M. (2019). "Gestão ambiental rumo à economia circular: como o Brasil se apresenta nessa discussão", *Sistemas & Gestão*, Vol. 14, No. 2, pp. 223–231.

Barbieri, J. C. (2007), *Gestão ambiental empresarial: conceitos, modelos e instrumentos*, Saraiva, São Paulo.

Brasil (2010), Lei 12.305, de 2 de agosto de 2010*, Institui a Política Nacional de Resíduos Sólidos*, Diário Oficial da União, Brasília, DF.

Celinski, T.M., Celinski, V.G., Rezende, H.G., Ferreira, J.S. (2011), "Perspectivas para reuso e reciclagem do lixo eletrônico", artigo apresentado no II Congresso Brasileiro de Gestão Ambiental, Londrina, Paraná, 6-9 de nov. 2011.

El Faro, O., Calia, R.C., Pavan, V.H.G. (2012), "A logística reversa do lixo eletrônico: um estudo sobre a coleta do e-lixo em uma importante universidade brasileira", *Revista de Gestão Social e Ambiental*, Vol. 6, No. 3, pp. 142-153.

Ferreira, J.M.B., Ferreira, A.C. (2008), "A Sociedade da in-

formação e o desafio da sucata eletrônica", *Revista de Ciências Exatas e Tecnologia*, Vol. 3, No. 3, pp. 157-170.

Forti, V., Baldé, C.P., Kuehr, R., Bel, G. (2020), "Observatório Global de E-Waste – 2020: quantidades, fluxos e potencial da economia circular", Universidade das Nações Unidas/ Instituto das Nações Unidas para Treinamento e Pesquisa/ União Internacional de Telecomunicações/Associação Internacional de Resíduos Sólidos, Bonn/Genebra/Roterdã.

Kasper, A.C., Costa, R.C., Andrade, P.A., Veit, H.M., Bernardes, A.M. (2009), "Caracterização de sucatas eletrônicas provenientes de baterias recarregáveis de íons de lítio, telefones celulares e monitores de tubos de raios catódicos", *Revista Brasileira de Ciências Ambientais*, Vol. 1, No. 12, pp. 9-17.

Lima, A.F.O., Sabiá, R.J., Teixeira, R.N.P., Sobreira Junior, F.A.V. (2015), "Gestão de resíduos eletroeletrônicos e seus impactos na poluição ambiental", *Latin American Journal of Business Management*, Vol. 6, No. 2, pp. 109-126.

Lima, M.L.M., Silva, J.B., Lima, J.E. (2008), "Manufatura reversa e o gerenciamento adequado do lixo eletrônico", artigo apresentado no IX Seminário Nacional de Resíduos Sólidos, Palmas, Tocantis, 22-25 de out. 2008.

Maciel, A. C. (2011), "Lixo eletrônico", *Anais do Seminário ENIAC*, Vol. 1, No. 2, pp. 1-4.

Martins, G.A. (2008), "Estudo de Caso: Uma Estratégia de Pesquisa", 2a ed., Grupo GEN, São Paulo.

Martins, L.F.B., Bortoli, L.Â.D., Silva, P.N., Oliveira, É.L.D., Zanolla, T. (2013), "Lixo eletrônico: uma questão ambiental", artigo apresentado no IV Congresso Brasileiro de Gestão Ambiental, Salvador, Bahia, 25-28 de nov. 2013, pp. 1–5.

Mattar, F.N. (2001), "Pesquisa de marketing", 3a ed., Editora Atlas, São Paulo.

Moi, P.C.P., Souza, A.P.S., Oliveira, M.M., Faitta, A.C.J., Rezende, W.B., Moi, G.P., Freire, F.A.L. (2012), "Lixo eletrônico: consequências e possíveis soluções", *Connection Line*, Vol. 1, No. 7, pp. 37-45.

Natume, R.Y., Sant'anna, F.S.P. (2011), "Resíduos eletroeletrônicos: um desafio para o desenvolvimento sustentável e a nova lei da Política Nacional de Resíduos Sólidos", artigo apresentado no 3rd International Workshop on Advances in Cleaner Production, São Paulo, 18-20 de maio 2011.

Rocha, A.C., Ceretta, G.F., Carvalho, A.P. (2010), "Lixo eletrônico: um desafio para a gestão ambiental", *Revista TechnoEng - Tecnologia, Meio Ambiente e Sustentabilidade*, Vol. 1, No. 2, pp. 35-49.

Sakai, P.K., Gomes, M.L., Bastos, C. E. (2009) "Logística reversa e produtos eletrônicos: um estudo de caso no mercado de telefonia celular". *Reverte – Revista de Estudos e Reflexões Tecnológicas da Faculdade de Indaiatuba*, Vol. 1, No. 7.

Sant'anna, H.B.S, Moura, F.J., Veit, H.M. (2013), "Caracterização físico-química de placas de circuito impresso de aparelhos de telefone celular", *Revista Tecnologia em Metalurgia, Materiais e Mineração*, Vol. 10, No. 3, pp. 231-238.

Selpis, A.N., Castilho, R.O., Araújo, J.A.B. (2012), "Logística reversa de resíduos eletroeletrônicos", *Revista Tékhne & Lógos*, Vol. 3, No. 2, pp. 111-128.

Seo, E.S.M., Fingerman, N.N. (2011), "Sustentabilidade na gestão de resíduos sólidos: panorama do segmento eletroeletrônicos", *InterfacEHS – Revista de Saúde, Meio Ambiente e Sustentabilidade*, Vol. 6, No. 3, pp. 3-15.

Silva, J.R.N. (2010), "Lixo eletrônico: um estudo de responsabilidade ambiental no contexto do instituto de educação ciência e tecnologia do Amazonas – IFAM campus Manaus centro", artigo apresentado no I Congresso Brasileiro de Gestão Ambiental, Bauru, São Paulo, 21-24 de nov. 2010.

Tanaue, A.C.B., Bezerra, D.M., Cavalheiro, L., Pisano, L.C. (2015). "Lixo eletrônico: agravos a saúde e ao meio ambiente", *Revista Ensaios e Ciências*, Vol. 19, No. 3, pp. 130–134, disponível em: https://ensaioseciencia.pgsskroton.com.br/article/view/3193

Ushizima, M.M., Marins, F.A.S., Muniz Junior, J. (2014), "Política Nacional de Resíduos Sólidos: cenário da legislação brasileira com foco nos resíduos eletroeletrônicos", artigo apresentado no XI SEGeT: Simpósio de Excelência em Gestão e Tecnologia, Resende, Rio de Janeiro, 22-24 de out. 2014.

Zanelli, J.C. (2002), "Pesquisa qualitativa em estudos da gestão de pessoas", *Revista Estudos da Psicologia*, No. 7, pp. 79-88.

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