

CIRCULARITY IN THE MANAGEMENT OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (E-WASTE): CONTRIBUTIONS TO URBAN MINING IN BRAZIL

Marianna de Souza Oliveira Ottoni

Undergraduate student of Environmental Engineering, 10th semestre
Federal University of Rio de Janeiro
PIBIC period: March 2018 to June 2019
mariannaottoni@poli.ufrj.br

Lúcia Helena Xavier

Advisor, PhD in Production Engineering
lxavier@cetem.gov.br

ABSTRACT

The Circular Economy (CE) concept emphasizes the minimization of waste by reusing it as a resource for other activities. Regarding the management of Waste Electrical and Electronic Equipment (e-waste) – those originated from devices that demand energy to work –, the increase of circularity means the valuation of e-waste as resources through the Urban Mining concept, being achieved by the Reverse Logistics, a tool that enables the return of these materials to the productive chain. The present document aims to contribute with the studies to increase the circularity of e-waste management in Brazil. The specific goals of this document are the generation of a better understanding on e-waste particularities and its fluxes in Brazil, and purpose solutions to increase its circularity. The methodology applied to the studies was based on collecting information by literature review, questionnaire and laboratory experiment, organizing them, and presenting the results in this paper. It was verified by an experiment that e-waste is multi-material. Also, it was observed that 85% of consumers in Brazil keep their e-waste at home. These results combined with the lack of clarity regarding recycling rates demonstrate that e-waste management and circularity in Brazil face some obstacles. As solutions, we proposed studies to contribute to Reverse Logistics in Brazil, identifying 152 companies that act within the segment of e-waste management. Besides, we proposed a list of adequate companies in the state of Rio de Janeiro to receive e-waste from consumers, and a new categorization for e-waste, based on recycling needs. Lastly, we proposed the creation of R3MINARE, a group of studies and research in terms of e-waste and its circular approach. Thus, the circularity in e-waste management will only be a reality in Brazil if the Reverse Logistics System works, and the scientific researches can contribute to implement it in the country.

Keywords: Waste Electrical and Electronic Equipment (e-waste), Circularity, Circular Economy, Urban Mining, Reverse logistics.

1. INTRODUCTION

Waste Electrical and Electronic Equipment (e-waste or WEEE) are those originated by products which demand energy to work. One of the most significant issues related to this category of waste is that e-waste present hazardous elements, such as heavy metals and Persistent Organic Pollutants (POPs), in their composition (KIDEE et al., 2013). Therefore, they represent risks of individual contamination and potentials for negative environmental impact (EEA, 2002). On the other hand, this type of waste is also composed by valuable substances, like copper, aluminum and gold (ONGONDO et al., 2011), which justify the potential efforts employed for their adequate destination. The management of e-waste faces some obstacles, since this category of waste is considered multimaterial (composed by many distinct materials), hazardous substances and different origins. According to EEA (2002), “WEEE is one of the most complex waste streams requiring management”, mainly due to the fact that Electrical and Electronic Equipments (EEE) cover a wide variety of products. Thus, the adequate e-waste management must consider the reuse of these materials to generate value from them, avoiding their disposal in the environment and other incorrect destinations that contribute to contaminate human beings and the ecosystems.

One of the main strategies of the concept of the Circular Economy is consonant to this idea, referring to waste prevention (STAHEL, 2016; GEISSDOERFER et al., 2017; SARIATLI, 2017). In the case of e-waste, the goal is the extraction of valuable substances from these wastes, as known as the Urban Mining approach, which promotes the reducing of the need for mining in the virgin mines, its consequent negative impacts, and the exploration of natural resources. This approach is also known by the scientific community as Waste to Resources (WtR).

In the practice, “mining” e-waste can only be performed if these materials return to the productive chain, being treated and reused as new products or as inputs to produce other materials, with their consequent value recovery. This process of return is called by literature as Reverse Logistics. Thus, increasing circularity in the chain of EEE means, for the proposes of this article, reusing the e-waste as resources through Urban Mining, being achieved by the Reverse Logistics.

2. OBJECTIVE

The present document aims to contribute with the studies to increase the circularity in matter of e-waste management in Brazil, focusing on strategies to reduce waste and negative impacts derived from the inadequate e-waste destinations, for supporting the decision-making in the country. Therefore, the specific goals of this document are the generation of a better understanding on e-waste particularities and its fluxes in Brazil, and purpose solutions to increase the circularity of e-waste management.

3. METHODOLOGY

This document gathers the results of the projects developed from July 2018 to June 2019 by the scholarship holder. The methodology applied to the present article was based on three phases: (i) collecting information; (ii) organizing information; (iii) presenting solutions and results.

The first was done through a variety of strategies, such as bibliographical research, experiments in laboratory, technical visits to recycling companies and other institutions related to e-waste management, elaboration of a questionnaire, and internal seminars, so that the members of the project team could exchange information.

In the next phase, the material collected was organized in an internal database, and represented through graphs, maps and tables, so that the main information could be used as a material for publishing in articles, lectures, workshops, and similar. In this last phase, these results should allow the dissemination of the strategies developed by the project.

4. RESULTS AND DISCUSSION

4.1. Understanding the Particularities of e-waste

The comprehension of the particularities of e-waste was developed in the project mainly by the literature review and complemented by three experiments in laboratory with seven samples provided by Vertas, a Brazilian company of recycling that works with e-waste. In the first one, the samples were analyzed with the Binocular Loupe, so that the physical characteristics (diameter of the molecules, for example) of these samples of e-waste could be understood, process known as characterization of materials. The next two experiments, the Diffraction of X-Ray and the Scanning Electron Microscopy (SEM), are planned to be developed in the next phase of the project. As expected from the literature, it was found that e-waste samples were multi-material, i.e., formed by different types of materials, with different diameters, thicknesses, colors and textures.

4.2. Understanding the Fluxes of e-waste

The study of e-waste fluxes is complex, due to the variety of origins for this type of waste and its multi-material characteristic, implying in flows for different destinations. To understand how the consumers of EEE, and consequent generators of e-waste, deals with their e-waste, a questionnaire¹ was elaborated with Google Forms tool, and applied online in all the states of Brazil in 2018, with 1.004 answers. There were five questions, related to the knowledge of the EEE individual consumers about dealing with e-waste, their risks for health and for the environment, their adequate destination, and if they keep at home any EEE which is not functioning anymore (Retention Index). As a result, it was observed that 85% of the answers indicate that these consumers keep at home their broken or obsolete appliances, and that most of them would like to discard telephone devices and batteries. Among that, it could be found that almost 70% of these consumers intent to discard their e-waste in recycling points, and 95% of them answered that the adequate destination to e-waste is very important. Also, 85% of the answers confirm that the biggest risk related to e-waste inadequate management is the contamination by heavy metals. An article with the results of the questionnaire was approved in the event 2019 International Conference on Resource Sustainability - Cities (ICRS Cities 2019).

Another project developed for understanding e-waste fluxes was the article for the regional event ANPPAS 2018, with the theme around the challenges for Reverse Logistics in Brazil (CARDOSO et al, 2018). There are still several obstacles to the adequate destination of waste, from the level of education and environmental awareness of the population to the lack of investments of the government. These fluxes should be oriented by Brazilian Policy on Solid Waste, that implemented tools for management, such as “the Reverse Logistics Systems (SLR), as well as the licensing of polluting activities, both significant in terms of waste recovery and pollution control requirements, but insufficient” (CARDOSO et al, 2018). One of the major difficulties is the lack of clarity regarding recycling rates, as a result of the analysis of this article.

In the study published for the event 2° CONRESOL 2019 (South American Congress on Waste and Sustainability), Xavier et al. (2019) developed a research on finding the companies acting with e-waste fluxes, popularly called as recyclers, although many of them do not properly work with recycling processes. In total, it was found that 152 companies are acting in this segment in Brazil, and 19 of them are in the Rio de Janeiro (RJ) state, one of the most expressive in terms of quantity of this category of company.

¹ The Questionnaire “5 questions in 5 minutes” was developed by the researcher Lúcia Xavier and the previous scholarship holder Hermann Nascimento, and edited by the scholarship holder Marianna Ottoni.

4.3. Solution proposals for Circularity in e-waste Management

As proposals related to e-waste management, we published in 2018 the second edition of the Manual for Destination of E-waste in the state of Rio de Janeiro (XAVIER et al. 2018). The document presents some definitions, information on the recent context of RJ on e-waste management, and a list of previously selected companies which receive e-waste from consumers for further treatment and adequate destination. This manual contributed to the progress and assistance in the future implementation of SRL in RJ, proposing also a new categorization for e-waste (large household appliances, small household appliances and electronics, monitors, information and communication technology equipment, cables, batteries, and lamps) aimed at the recycling market and not anymore that of production, as the current classification is focused on.

In 2019, a portfolio of the projects and actions developed in terms of e-waste by CETEM was elaborated, containing some solutions and next studies for increasing the circularity of e-waste and collaborating for decision-making. This document formalizes the creation of the group R3MINARE, which aims to contribute, under the Circular Economy concept, with research in the scientific and technological field of Urban Mining, and to provide solutions to recover the value of e-waste and its reinsertion in the market with a view to sustainable development.

The Figure 1 shows the main results of this article through the projects developed.

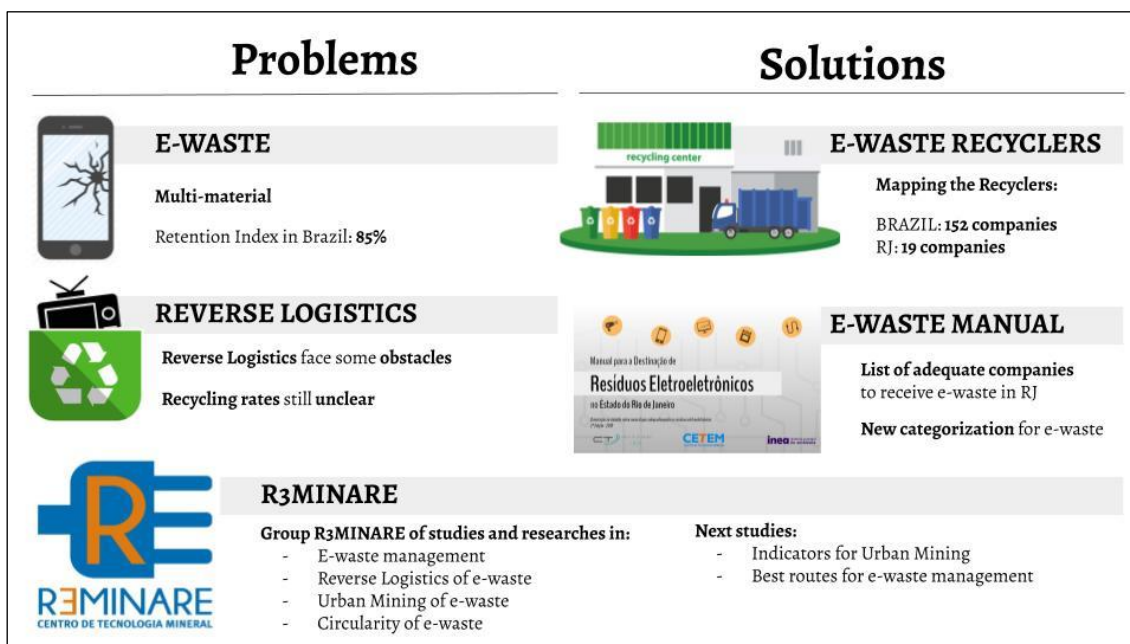


Figure 1: Main results of this article, obtained through the projects developed for this scholarship.

5. CONCLUSIONS

The results of the projects developed in the year of duration of this scholarship helped with the contributions to scientific knowledge in terms of circularity in e-waste management, especially regarding to the Brazilian conditions, that faces some obstacles to implement a system for Reverse Logistics of e-waste. The Circular Economy in e-waste management will only be a reality in Brazil if Reverse Logistics System works, since it provides the resources to concretize Urban Mining.

The next studies will be focused on finding indicators for Urban Mining and studying the best routes for e-waste management in Brazil.

6. ACKNOWLEDGMENT

The scholarship recipient thanks CETEM and CNPq for the scholarship grant awarded, as well as the advisor Lúcia Xavier and scholarship holders Renata Barreto, Letícia Bacellar, Raíssa Araújo, Breno Coll and Matheus Avellar for all support. Universal announcement project 406263 / 2016-7.

7. REFERENCES

CARDOSO, E.; VALLE, T.F.; OTTONI, M.S.O.; NASCIMENTO, H.F. **Desafios da Logística Reversa de Equipamentos Eletroeletrônicos**. 1º Encontro Regional Sudeste da ANPPAS - Sudeste. São Paulo/SP. 2018.

EUROPEAN ENVIRONMENT AGENCY (EEA). **Waste from electrical and electronic equipment (WEEE) – Quantities, dangerous substances and treatment methods**. Copenhagen, 2002. Available in: <<http://www.resol.com.br/textos/Waste%20from%20electrical%20and%20electronic%20equipment%20part%201.pdf>>. Access in: 2. Jul. 2019.

GEISSDOERFER, M.; SAVAGET, P.; BOCKEN, N.M.P.; HULTINK, E.J. **The Circular Economy e A new sustainability paradigm?** Journal of Cleaner Production 143, 757-768, 2017.

KIDEE P.; NAIDU R.; WONG M.H. **Electronic waste management approaches: an overview**. Waste Management 33, 1237-1250, 2013.

ONGONDO, F.O.; WILLIAMS, I.D.; CHERRETT, T.J. **How are WEEE doing? A global review of the management of electrical and electronic wastes**. Waste Management 31, 714-730, 2011.

SARIATLI, F. **Linear Economy versus Circular Economy: A comparative and analyzer study for Optimization of Economy for Sustainability**. Visegrad Journal on Bioeconomy and Sustainable Development 6, nº1, 31-34, 2017.

STAHEL, W.R. **Circular Economy: A new relationship with our goods and materials would save resources and energy and create local jobs, explains Walter R. Stahel**. Nature 531, 435-438, 2016.

XAVIER, L.H.; OTTONI, M.S.O.; NASCIMENTO, H.F. **Metodologia para a identificação e categorização das empresas atuantes na gestão de resíduos de equipamentos eletroeletrônicos**. 2º Congresso Sul-americano de Resíduos Sólidos e Sustentabilidade. Foz do Iguaçu/PR, 2019.

XAVIER, L.H.; LINS, F.A.F.; NASCIMENTO, H.F.F.; OTTONI, M. S.O.; SUEMITSU, W. I.; CALDAS, M.B.; SILVA, L.O.S.; ARAUJO, R.A.; SANTOS, R.M.; MANÇANO, M.R.; CARDOSO, E.R.; REINOL, P. C.; GUSMÃO, A.C.F. **Manual para a destinação de resíduos eletroeletrônicos no estado Rio de Janeiro. Orientação ao cidadão sobre como dispor adequadamente os resíduos eletroeletrônicos**. 2ª Edição. Rio de Janeiro: Cetem, 2018.