DECISION MAKING AND THE E-WASTE REVERSE LOGISTICS: IDENTIFING URBAN MINING IN THE RIO DE JANEIRO STATE, BRAZIL

MARIANNA DE SOUZA OLIVEIRA OTTONI
Undergraduate student of Environmental Engineering, 9th semester,
Federal University of Rio de Janeiro
PIBIC period: March 2018 to July 2018

mariannaottoni@poli.ufrj.br

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

Abstract

Waste Electrical and Electronic Equipment (WEEE or e-waste) are both hazardous, precious and a challenge to recycling managers. The present project consists of the promotion of decision support in the management of WEEE in the state of Rio de Janeiro (RJ), in compliance with the legal requirements for reverse logistics and under the urban mining concept. The methodology was based on a descriptive study on e-waste management in the state, focusing on the 21 municipalities of the Metropolitan Region of Rio de Janeiro (MRRJ), as well as the analysis of geo-referenced images and informative flowcharts. The diverse studies carried out in the project, including the publication of articles and the accomplishment of an internal seminar, resulted in the elaboration of a diagnosis of estimated e-waste generation in the municipalities of Rio de Janeiro state, by population analysis and influences of their average income, and the approximate quantification of Voluntary Delivery Points (VDPs) of WEEE needed, as well as the best routes for the implementation of a Reverse Logistics System (RLS) in the state, according to the e-waste 'urban mines' identified. It was observed, therefore, that the state of Rio de Janeiro presents high potential for the establishment of e-waste RLS, being one of the major poles of WEEE generation, and, therefore, attraction of investments aimed at the appropriate treatment of such waste, with the main objective of reintroducing them with value gain in the production chain, as established by the principles of circular economy.

Keywords: Reverse logistics,Waste Electrical and Electronic Equipment, Urban Mining, Voluntary Delivery Points.

1. INTRODUCTION

The issue of solid waste has been gaining more attention in recent years, mainly because if treated and destined in an inadequate way, it can result in serious consequences for the population and the environment. The National Solid Waste Policy (NSWP), consolidated by Law No. 12.305 / 2010, points out the guidelines and main tools for the proper management of waste, being the Reverse Logistics a means to bring such waste back to their production cycles as inputs, adding value to discarded materials. Under that law, there are six types of waste that must be followed for SLRs. Among them, are the Waste Electrical and Electronic Equipment (WEEE). Important to be of high-value mineral sources, the recovery of such wastes becomes strategic to the market, which now opts for the extraction of these minerals not by the withdrawal of subsoil resources,

most cost costly and environmentally, but the calledurban mining, that is, directly from WEEE.

Thus, it is proposed, through this project, the provision of decision support in the reverse logistics of WEEE, promoting indicators for urban mining in Brazil. The project is structured through a case study in the state of Rio de Janeiro, one of the largest population and influence centers in the country.

2. OBJECTIVES

The studies promoted through this project aim to promote subsidy to decision making in the management of WEEE in the state of Rio de Janeiro, with a view to complying with the legal requirements for reverse logistics and according to the concept of urban mining.

3. METHODOLOGY

The methodology applied to the project was based on a descriptive study on the management of WEEE in the state of Rio de Janeiro, focusing on the 21 municipalities of the MRRJ, as well as an analytical character from the elaboration of geo-referenced images on the subject. As methodological procedures, we used bibliographical survey, evaluation through geo-referenced indicators and construction of spatial models, through the elaboration of maps, arts in flowcharts and infographics, all related to the central theme of the research, in order to help the reader's understanding.

4. RESULTS AND DISCUSSION

The first activities of the scholarship holder in the project were focused on the preparation of materials and the elaboration of articles, with the objective of mapping the recovery potential of WEEE and estimating how much of this waste is generated in MRRJ. The first article, developed between March and April 2018, was entitled "Generation of Electrical and Electronic Waste in the Metropolitan Region of Rio de Janeiro", to be submitted to a national event. The methodological proposal was based on the geographic location of hot spots of WEEE consumption in MRRJ, also known as 'urban mines'.

By the literature, an average value of WEEE generation in Brazil per inhabitant in 2014, of 7 kg/hab was obtained (STEP, 2014). This number was adopted as an annual estimate for the Brazilian population. To determine the average number of Voluntary Delivery Points (VDPs) to receive WEEE, the ABDI study (2013) was used, which suggests the installation of one VDP for every 25,000 inhabitants. Based on data from the Brazilian Institute of Geography and Statistics (*IBGE*) Demographic Census of 2010, the population values of the MRRJ municipalities were multiplied by the average generation of WEEE, resulting in the estimated annual generation of WEEE in the MRRJ. With these values, the number of VDPs for each municipality was calculated, allowing the classification of the color-scale generators and the amount of VDPs required, as shown in Figure 1.

The unequal distribution of WEEE in the study area has evidence of a link with population density, which in turn reflects consumption patterns and consequent pattern of waste disposal. Therefore, the distribution of the VDPs, in proportion to one point for every 25 thousand inhabitants, does not seem to satisfactorily meet the dispersion verified for the waste generation areas and is not the only criterion to be considered for the location of the collection points of the WEEE. Future studies may consider GDP,

per capita income and other aspects that may better represent the distribution of waste generation in space.

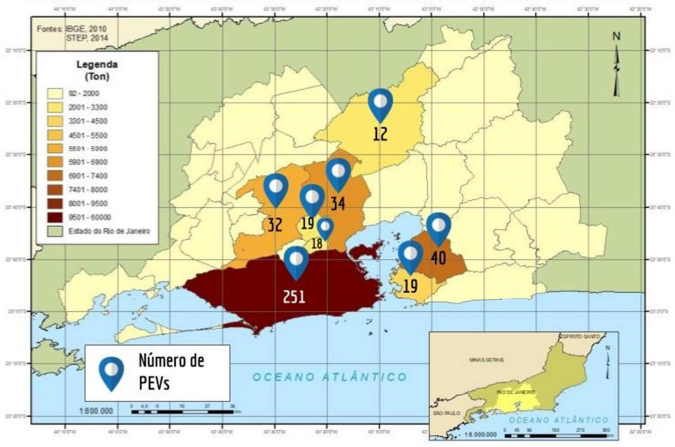

Figure 1. Generation of Waste Electrical and Electronic Equipment in the MRRJ.

Source: Own elaboration.

The second article generated in the research, entitled "Generation of Electrical and Electronic Waste in the State of Rio de Janeiro: Reverse Logistics from Voluntary Delivery Points", adopted a similar methodology, being an expansion of MRRJ for the entire state. As a result, a map with the data of WEEE generation in the state of RJ was generated, and an infographic, containing information on the management of WEEE according to the NSWP, as shown in Figure 2.

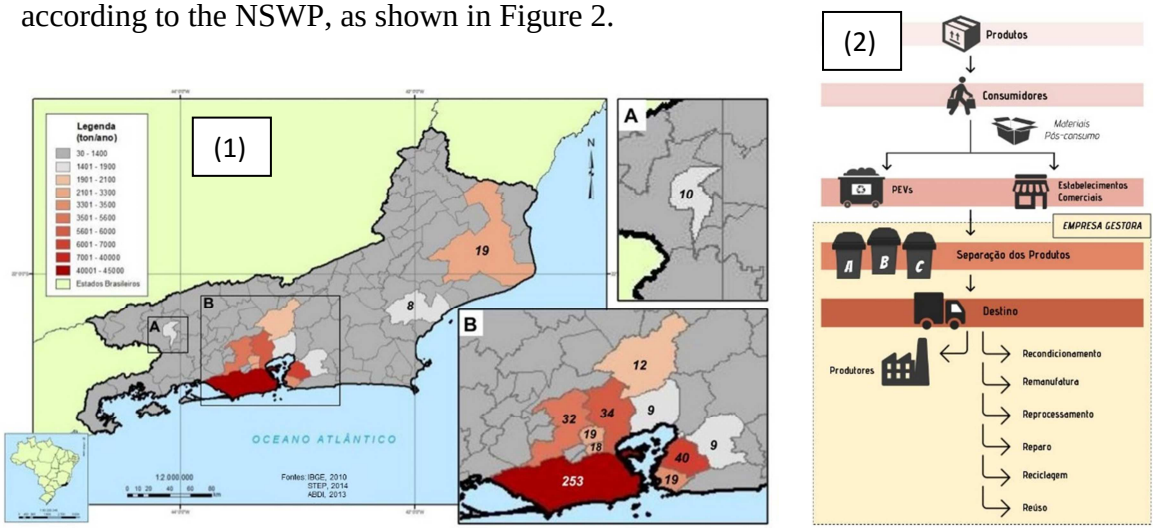

Figure 2. (1) GeneratedquantityofWEEE (in color) in 2014 and number of VDPs (to the center of the municipalities) required in the municipalities of the state of Rio de Janeiro. (A) The municipality of Volta Redonda. (B) Metropolitan Region of Rio de Janeiro. (2) The flow of the destination of WEEE in Brazil according to the NSWP. Source: Own elaboration.

Studies on the relation of income of the population with the generation of WEEE were carried out during the project, taking as a case study of the Brazilian states and MRRJ. The data of WEEE generation were obtained by the same methodology of the previous studies, and, for the values of income, the GDP of each place analyzed was taken as the base. The results for the states and the MRRJ can be seen in Figure 3, where the circles represent the GDP and the greyscale colors, the generation of WEEE.

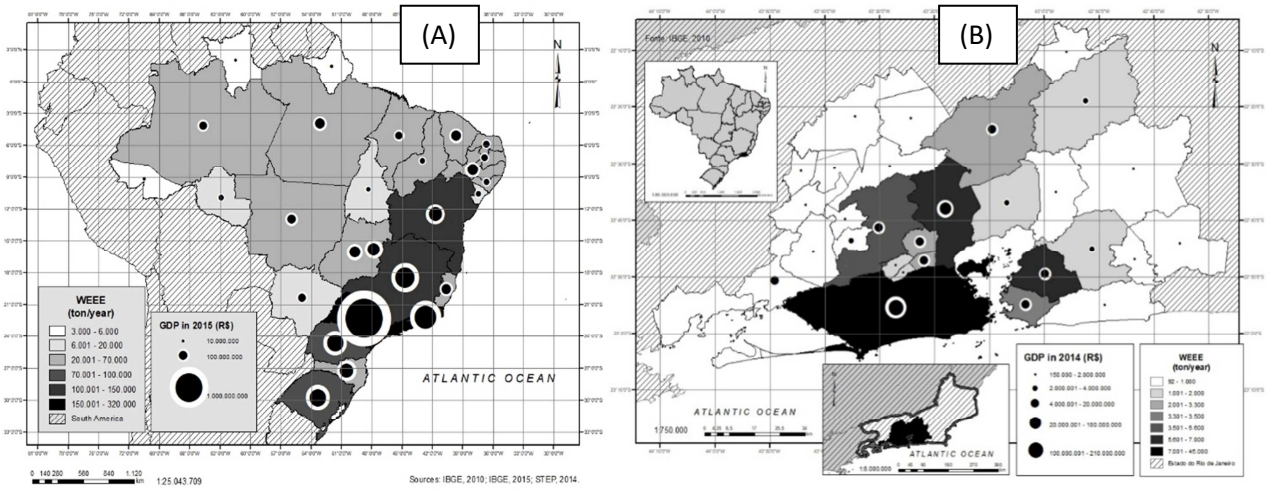

Figure 3. Generation of WEEE and GDP in the Brazilian states, in (A), and in MRRJ, in (B). Source: Own elaboration.

In this way, the correlation between the generation of WEEE and the GDP is verified, showing that the greater the purchasing power, the greater the generation of WEEE, as shown in Figure 3.

A fourth article, which is being finalized, under the title "Proposal for Distribution of Voluntary Delivery Points (VDPs) of Waste Electrical and Electronic Equipment in the Metropolitan Region of Rio de Janeiro by Georeferencing", brought the proposal of quantifying and distributing VDPs of WEEE along the MRRJ by analyzing the main road transport routes, the municipalities most generating WEEE and the geographic location of the main segments of reverse logistics, such as recyclers, collectors cooperatives, sorting centers, among others.

Thus, it is observed that both the generation of WEEE and the main representatives of the RLS segments are located near the city of Rio de Janeiro, the main municipality of MRRJ. This way, logistics strategies should be directed towards this center, where hot spots or 'urban mines' of technological waste converge.

5 CONCLUSIONS

Despite the student's only four-month participation in the project, this resulted in several visual products and technical articles with practical and meaningful content for decision-making regarding an optimal SLR model for the state of RJ, taking the MRRJ as a pilot for the identification of 'urban mines'.

6 ACKNOWLEDGMENT

The scholarship recipient thanks CETEM and CNPq for the scholarship grant awarded, as well as the advisor Lúcia Xavier and scholarship holder Hermann Fernandes for all support. Edital Universal project 406263 / 2016-7.

7 REFERENCES

AGÊNCIA BRASILEIRA DE DESENVOLVIMENTO INDUSTRIAL (ABDI). **Logística Reversa de Equipamentos Eletroeletrônicos. Análise de Viabilidade Técnica e Econômica.** 2013. Available in: http://www.abdi.com.br/Estudo/Logistica%20reversa%20de%20residuos_.pdf.

AWASTHI A.K., CUCCHIELLA F., D´ADAMO I., LI J., ROSA P., TERZI S., WEI G., ZENG X., (2018). **Modelling the correlations of e-waste quantity with economic increase. Science of the Total Environment**, 613-614, 46-53.

DE SOUZA, R. G.; CLÍMACO, J. C. N.; SANT'ANA, A. P.; ROCHA, T. B.; DO VALLE, R. A. B.; QUELHAS, O. L. G.**Sustainability assessment and prioritization of e-waste management options in Brazil**. Waste management, v. 57, p. 46-56, 2016.

STEP. **Brazil: Overview of e-waste related information.**2014. Available in: http://www.step-initiative.org/Overview_Brazil.html. Access in: 12.April.2018.

XAVIER, L.H., LINS, F.A.F., NASCIMENTO, H.F.F., BELLAN, I. O., RIBEIRO, F., CALDAS, M.B., SILVA, L.O.S., ZOMER, B., ARAUJO, R.A., FILHO, O.O.D., REINOL, P. C., FAGUNDES, R.L., GUSMÃO, A.C.F.**Manual para a destinação de resíduos eletroeletrônicos: orientação ao cidadão sobre como dispor adequadamente os resíduos eletroeletrônicos na cidade do Rio de Janeiro.**1st Ed. Rio de Janeiro: Cetem, 2017.Available in: http://www.cetem.gov.br/livros**.**