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Factors influencing the return of batteries and post-consumer batteries through reverse logistics: application of a conceptual model

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ABSTRACT

Large-scale production of goods has been growing sharply as a result of the urban lifestyle. As a result of this consumption, around 44 million tons of electrical and electronic waste was registered in 2016 worldwide, with an increase of 8% since 2014. In order to minimize this problem, in this research we studied the relevance of variables that can influence the return of batteries and post-consumer batteries through Reverse Logistics. To identify them, a conceptual model based on the literature was used, considering: aspects inherent to the useful life of the products; effective compliance with environmental standards; consumer behavioral issues; and management of the reverse logistics system. The survey was validated by experts and the results obtained were quantified using statistical methods, to provide a broad and concrete view of opinions individually and jointly. In this way, this research brought as contribution new factors that influence the return of batteries and post-consumption batteries, in addition to the possible interrelationships between them, promoting scientific advancement to the study area within business logistics.

Keywords*: Reverse Logistics. Influence Factors. Post-Consumer Batteries and Batteries. Environmental Standards.*

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1. INTRODUCTION

The large-scale production of goods is progressive, resulting from the urban lifestyle, including the properties of the products have changed, presenting disposable characteristics. These factors cause the growth of servable and useless products and goods, accessible in the environment, making it possible to return these products to the production chain through recycling or reprocessing, or even to the correct destination, thus avoiding the concentration of materials in inappropriate places. (GUARNIERI *et al*., 2006).

According to the report prepared by the United Nations in partnership with the International Telecommunication Union that was released in late 2017, about 44.7 tons of electronic waste were discarded on the planet in 2016, an increase of 8% since 2014, and the expected volume for 2021 is 52.2. (ABRETE, 2016).

Electronic waste includes cell phones, computers, appliances, batteries and batteries, which, when disposed of in any way in landfills or dumps, can cause damage and risks to the environment and human health, since they are composed of toxic metals , such as mercury, lead and cadmium that contaminate the population, air, water and soil. (ABETRE, 2016).

It is known that Reverse Logistics appeared to be a protagonist in this environment, because it aims at the return of products to the production cycle or that they have their environmentally correct destination. Despite the requirement of the laws that this process be put into practice, several companies still have difficulties in conforming to the processes, or even to define what will be the reverse flow of each product, or even to make the population aware which is a very important factor for the system to work.

Figures point to the increase in the quantities of waste returned from Reverse Logistics over the years, but there is still a reference number to know how much should actually be collected annually in each reverse material flow system in force in the country (FAGUNDES, 2015). Thus, the present research is justified by the absence of a way to determine the quantity of batteries to be returned to industries through Reverse Logistics.

As a suggestion to fill this gap, a study is proposed regarding the variables that can influence the return of batteries and post-consumption batteries through Reverse Logistics, emphasizing as factors of influence, aspects inherent to the useful life of products, effective compliance with environmental standards, consumer behavioral issues and management of the reverse logistics system. (MARCOS, 2018).

Thus, this work aims to study the relevance of variables that can influence the return of batteries and post-consumer batteries through Reverse Logistics. For that, the following methodological procedures were applied: identification in the literature of the factors that may influence the amount of batteries and post-consumption batteries that are effectively returned through Reverse Logistics; use of Marcos' conceptual map (2018) to categorize and interrelate the influencing factors that are ruled and; complement and validate this conceptual map, through consultation with specialists in the area.

Thus, this work is presented in five topics, the first being an introduction to the researched subjects. In topic 2, the literature that served as a theoretical support to the work is discussed. Then, the methodological procedures are described considering the use of the survey method and an approach combined with both qualitative and quantitative aspects. In topic 4, the research results are presented and discussed. Finally, the fifth topic addresses the main conclusions about the research carried out, as well as providing insights for future investigations on the topic.

2. LITERATURE REVIEW

Law 12,305, of August 2, 2010, instituted the National Solid Waste Policy (NSWP), which was regulated by Decree 7.404, which determined the formulation of mandatory Reverse Logistics chains, bringing new legal instruments for effective operationalization of the system. This practice and tool has been used through law and regulations issued by the Government. (BRAZIL, 2012).

Environmental standards have brought with them the shared responsibility for the life cycle of products, which is automatically inserted in environmental responsibility. Thus, NSWP makes it the responsibility of all actors in the production chain the need to reduce the amount of solid waste and waste generated, and to minimize the impacts caused to human health and environmental quality. In other words, the responsibility for the management and environmentally appropriate disposal of solid waste then becomes the responsibility of all the actors that make up society. (NOGUEIRA, 2017).

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This section highlights the reverse logistics of batteries and batteries after their consumption, presenting a contextualization on the subject and then the main factors that influence the return of these products.

2.1 Reverse Logistics of Batteries and Post-consumer Batteries

Rethinking and recreating the life cycles of industrial products on more sustainable pillars is a complex and unclear work. For that, knowledge and informational data from different aspects are needed, which are not always available. With this, different specifications are sought for each product project that aims to invest, analyzing materials that are less harmful to the environment. Thus, making it the most sustainable option for professionals dealing with new product designs, such as engineers and architects. (MEDINA, 2006).

A widely used tool to systematically analyze the environmental performance of processes or products in terms of their complete life cycles is Life Cycle Analysis (LCA). Among the steps analyzed include extraction of raw material, manufacture, use and disposal of the product, and recycling or reverse logistics at the end of its useful life. (JUNIOR; MEIRA DE MORAIS *et al*, 2008).

Reverse Logistics (RL) is the area of Business Logistics that manages the flow and return information, and among this information is the flow back to the goods (products) business cycle. Returning goods can be post-sale or post-consumption, and this return occurs through Reverse Distribution Networks. During this process, value of various natures is added: corporate, logistical, legal, ecological, economic, ecological, among others. (LEITE, 2002).

According to the European Reverse Logistics Working Group – REVLOG (REVLOG *apud* BRITO; DEKKER, 2003), the main motivations that influence companies to practice LR are: environmental legislation that requires companies to return their products and take care of the necessary treatment; the economic benefits of using products that return to the production process, and the progressive environmental awareness of consumers.

The post-consumer LR acts within the time span of the product's life, which is between the time that materials have satisfactory properties of use, and the moment of disposal of the product. (GALINDO; SILVA *et al*, 2016). However, for the subject in question, the useful life will distinguish the materials being divided into subgroups in the following categories listed in Table 1. (LEITE, 2003).

Table 1 – Subdivisions of materials regarding their useful life

Materials Subdivision	Definition	Examples
Disposable Goods	Materials that have a maximum weekly or semester life	Batteries, toys, diapers, packaging, among others
Semi-Durable Goods	Materials that have a maximum useful life of 2 years	Lubricating oils, batteries, shoes, among others
Durable goods	Materials that have a useful life that can vary between a few decades	Airplanes, home appliances, automobiles, among others

Source: Adapted from Leite (2003).

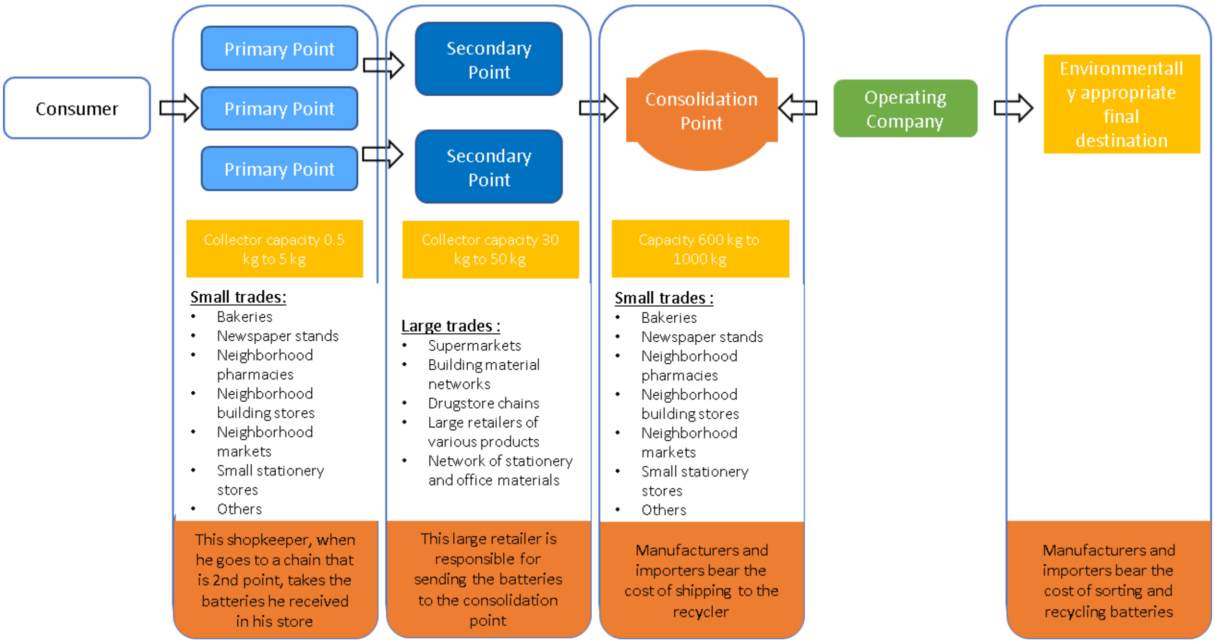
The focus of this work is on batteries, considered disposable and semi-durable goods, respectively, according to Table 1. In 2010, the Federal Government announced the interest in implementing LR systems for various products in NSWP. Among these, the objects of this study were cited in this policy. However, the appropriate destination and collection for batteries had already been determined in the Resolution of the National Environment Council (CONAMA) in 401/2008, which made the NSWP faster. (ABINEE, 2018).

Historically, it is CONAMA that regulates environmental issues related to batteries. First, in 1999, CONAMA created the regulation on the disposal of batteries, Resolution nº 257. This was changed to resolution nº 424 in 2010. This document stipulates the limits of maximum amount of heavy metals (mercury, cadmium and lead) for batteries and batteries sold in Brazil, as well as stipulating parameters to manage in an environmentally appropriate way. (CONAMA, 2010).

This resolution is in accordance with article nº 33 of the National Solid Waste Policy (NSWP), of Law nº 12.305 instituted in 2010, in which traders and distributors, even manufacturers and importers were obliged to plan and program reverse logistics networks in order to obtain cells and batteries, as well as other post-consumer solid waste autonomously to public services. Law 12.305 also defines the shared responsibility between manufacturers, public authorities and then actors in the network regarding the product life cycle. (BRAZIL, 2010).

Thus, in November 2010, manufacturers and importers came together to bring the ABINEE Receives Batteries Program to life, to comply with legislation and enable the domestic consumer to properly dispose of spent batteries (which have stopped working) present in their routine. It is estimated that the initiative has already collected around 1000 tons of these used products. The success of the Program depends on the adhesion of consumers, through the intense action in this system, when transporting their batteries to the establishments where they were purchased or to the collection points that were provided by the ABINEE Program. (ABINEE, 2012). After collecting the items, they are sent for recycling according to the dynamics shown in Figure 1.

Figure 1 - Flow of the Battery Disposal Program.



Source: *Green Eletron* (2018).

In 2018, Green Eletron became responsible for the ABINEE Collects Batteries Program, becoming responsible for the management of the entire LR process of the battery system, which begins at the collection points distributed throughout Brazil and ends with the relevant destination and environmentally friendly. (ABINEE, 2018a).

When addressing the Life Cycle of batteries and, therefore, Reverse Logistics, transportation, manufacturing, recycling, packaging and sorting costs, end up being very high, making the recycling process impractical (RUIZ *et al*., 2012). In the same line of reasoning Hinz, Valentina and Franco (2006) say that Brazil does not have enough technology to fully recycle batteries. Commonly, these materials have their elements replaced by new ones in order to provide greater product survival, or they also have some components removed and reused in other production cycles.

The companies associated with the ABINEE program then chose to outsource the recycling process, admitting Suzaquim as an official recycler and GM and Clog logistics company, which specializes in LR, after auditing by interested manufacturers (MENDES; RUIZ; FARIA, 2015). Thus, the company Suzaquim, through industrial processes (crushing, chemical process, thermal process) and recycling, produces copper and nickel salts from the collection of batteries and unserviceable batteries. (FAGUNDES *et al*., 2017).

2.2 Factors that influence the return of batteries and post-consumption batteries through reverse logistics

Marcos (2018) presents some factors of influence on the return of post-consumer products through reverse logistics. According to this author, this phenomenon can be influenced, mainly by: Product Lifetime, Environmental Responsibility and Behavioral Issues of consumers. These factors are subdivided into sub-factors: Programmed obsolescence, Warranty provided by the manufacturer, Weather, Equipment maintenance, Existence of spare parts, New technologies, Environmental awareness, Consumer style, Incentives, Access to information, Cost X Benefits of maintenance and Accidents / Breaks / Misuse. These factors and sub-factors were selected and adapted to the fields of influence on the return of batteries and post-consumer batteries.

Thus, this research considers four major factors that can influence the return of batteries and batteries: RL System Management (RLSM), Battery life (BL), Effective compliance with environmental standards (ECES) and Consumer behavioral issues (CBI). These factors can directly and indirectly interfere with the return of batteries after using the RL.

2.2.1 Reverse Logistics System Management (RLSM)

The positive outcome of a reverse logistics program depends a lot on how it will be designed and monitored. According to Lacerda (2002), there are some critical factors that contribute decisively to the positive performance of the RL system, as shown in Table 2.

Table 2 - Contextualization of the Reverse Logistics System Management

CRITICAL FACTORS	DESCRIPTION
Good input controls	The correct identification of the state of the materials found in the system is of vital importance because in this way it avoids the collection and transportation of products that are not part of the system, and it also avoids rework and future friction (customer and suppliers) in relation to the reliability of the system.
Standardized and mapped processes	The community in general does not consider reverse logistics to be a regular process, but rather a contingent and sporadic process. The mapping of processes, and registered procedures is one of the steps to obtain greater control and improvements.
Reduced cycle times	It refers to the time from the beginning of the cycle to the end of the operation, the beginning is when the importance of recycling is recognized, the return to the product system, and consequent processing. When they take too long, they incorporate unnecessary costs, as they delay the generation of cash and take up space.
Information systems	They are extremely important because they are able to measure supplier performance and cycle time. The return capacity makes it possible to obtain information for negotiations, and allows the identification of consumers' excesses in the return of the product. Information systems capable of handling the flexibility and variations required by reverse logistics are almost non-existent.
Planned Logistics Network	An infrastructure is needed to control the inflows (used materials) and outflows (processed materials), development of efficient transport that links the points of consumption, collection and facilities where these materials will be reprocessed and reused in the future.

Source: Adapted from Lacerda (2002).

2.2.2 Battery Life (BL)

The useful life of a product begins from its manufacture, it is said that the useful life of a product ends when it starts to slow down, or does not present the same efficiency presented at the time of purchase (SOUZA *et al*., 2018). To calculate the useful life of a product, it is necessary to consider several coefficients such as the production process, the quantity and quality of the raw material used in the production process, human use, exposure of the product to natural (environmental) conditions, and wear inherent in the good itself.

Table 3 presents the context in which the sub-factors are decisive in the return of batteries and post-consumer batteries through RL.

Table 3 - Contextualization of the useful life of batteries

CRITICAL FACTORS	DESCRIPTION
Scheduled obsolescence	Programmed obsolescence is understood as "a strategy to influence the shape of the product or the consumer's mental attitude." Therefore, the products are purposely planned and produced with a limited useful life, eventually becoming obsolete or non-functional. (PACKARD, 1960).
New technologies	Lithium-ion is the most current and least polluting battery technology on the market with less aggressive products. This technology provides greater energy

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	densities and meets the needs of almost all sizes of equipment (REIDLER; GÜNTHER, 2002).
Guarantees	In accordance with Article 26 of Law No. 8,078, the consumer can claim from the purchase or delivery for visible problems or simple verification of the product purchased. In the case of durable products, you have 90 days and non-durable ones have 30 days to claim (BRAZIL, 1990).
Weather	The term weather comes from the Latin word weather. Since weather alludes to the ideal temperature. Consequently, a weather is qualified as an anomaly of weather conditions (SIGNIFICADOS, 2018). It is informed by Duracell (2016) that extreme temperatures reduce the functioning of the batteries. When exposed to high temperature, they may end up leaking, causing the formation of a crystalline structure on the outside.

Source: Research data (2019).

2.2.3 Effective compliance with environmental standards (ECES)

The CONAMA resolution concerning batteries and batteries was released in 2008. In this, merchants of these products were given two years to collect the products discarded by consumers. The points of sale were responsible for addressing the material that was collected to importers, and manufacturers were tasked with environmentally correct disposal. In parallel, resolution No. 401 establishes the limitations on the quantities of acceptable heavy metals in batteries and batteries transacted in the national territory and rules for the environmentally correct management of these products. (CONAMA, 2008).

Depending on the material guidelines for dissemination and dissemination, the packaging of batteries developed in Brazil or internationally must present the symbols that indicate the risks to human health and nature, as well as where and how the disposal written in Portuguese language visibly and clearly (CONAMA, 2008).

Importers, traders, manufacturers and distributors of batteries and batteries are required to program and structure RL systems, in accordance with Law No. 12 305/10, Article 33 (BRAZIL, 2010).

2.2.4 Consumer behavioral issues (CBI)

From the analysis of consumer behavior, it is possible to determine factors that support the development and creation of a behavioral profile. Such a profile is evidenced by external and internal factors. External factors are those that depend on the expectations of a certain group, and may influence consumer choice. The internal factors are more focused on the consumer in a personal way, as it stems from their curiosity to seek information about products or services, or depends on the consumer's own lifestyle, among others. (BLACKWELL; MINIARD; ENGEL, 2005; PINHEIRO, 2016).

Bedante (2004) describes sustainable consumption as the grouping of broad concepts such as life cycle perspective, reduction in the use of traditional energy sources and increase in renewable sources, reduction of waste production. Table 4 presents the context in which the sub-factors should be analyzed.

Table 4 - Contextualizing Consumer Behavioral Issues

CRITICAL FACTORS	DESCRITION
Environmental Awareness	Experts say that the obstacles that companies face to implement programs for recycling batteries, are due to the government, or due to the lack of incentive to recyclers, and lack of encouragement and incitement to campaigns to raise awareness of the proper disposal of these materials. for the population, who end up neglecting these erroneously and harming the environment (OLIVEIRA, 2013).
Incentives	Other difficulties related to the government refer to the lack of coherence, interest and agility on the part of Organs environmental agencies in the process of regulating recycling companies. According to Oliveira, “Environmental agencies should give priority to companies that work for the environment. They should prioritize documentation to license recycling companies so that they can work faster, that is, reducing bureaucracy”. As an example, the five-year delay in licensing to build a new Suzaquim plant (OLIVEIRA, 2013).
Accidents / Breakages / Misuse	According to Guiltinan (2009), batteries have repair limitations in their design, they are basically disposable products that were designed to be non-repairable or aligned with disproportionate repair costs. For each device you have the appropriate battery, so it is important to stick to these specifications, in addition to inserting them correctly in the devices, with terminals - (negative) and + (positive) properly positioned. (DURACELL, 2016a).
Access to information	Currently, there is a portal that manages to map the collection stations available throughout Brazil for consumers to return these materials (THIMM, 2017). The creation of the LR Portal was made by FECOMERCIOSP; and within this portal you will find various information regarding LR in Brazil. On the portal there is a link to access the Green Eletron page (FECOMERCIOSP, 2018), which shows the total weight (kg) of batteries already collected, and the addresses of the 1509 collection points available to receive batteries in Brazil in 2018 (GREEN ELETRON, 2018).

Source: Research data (2019).

Based on the contextualization of reverse logistics of batteries and the main factors that influence the return of these products, the following are the methodological procedures of this work.

3. METHODOLOGICAL PROCEDURES

The realization of this research was based on the scientific Survey method. Table 5 shows the steps for its development, adapted from Martins, Mello and Turrioni (2014). In order to achieve the results, the data obtained were quantified by means of a five-point semantic scale, after which a descriptive statistical quantitative analysis and inferential factorial were performed.

The approach used in this study was the combined one, in which aspects of quantitative and qualitative approaches are used together. (MIGUEL *et al.*, 2012). This combination seeks to provide a broader and more complete view of the problem, aiming at better results in the combined format than working individually on each research approach. As for the objectives, this work has a predominantly exploratory characteristic, as it seeks to establish familiarity with the phenomenon under study (factors that influence the reverse logistics of batteries), aiming to better understand it and generate possible hypotheses in the future. (GIL, 2002).

Table 5 - Demonstration of the steps for the development of the research.

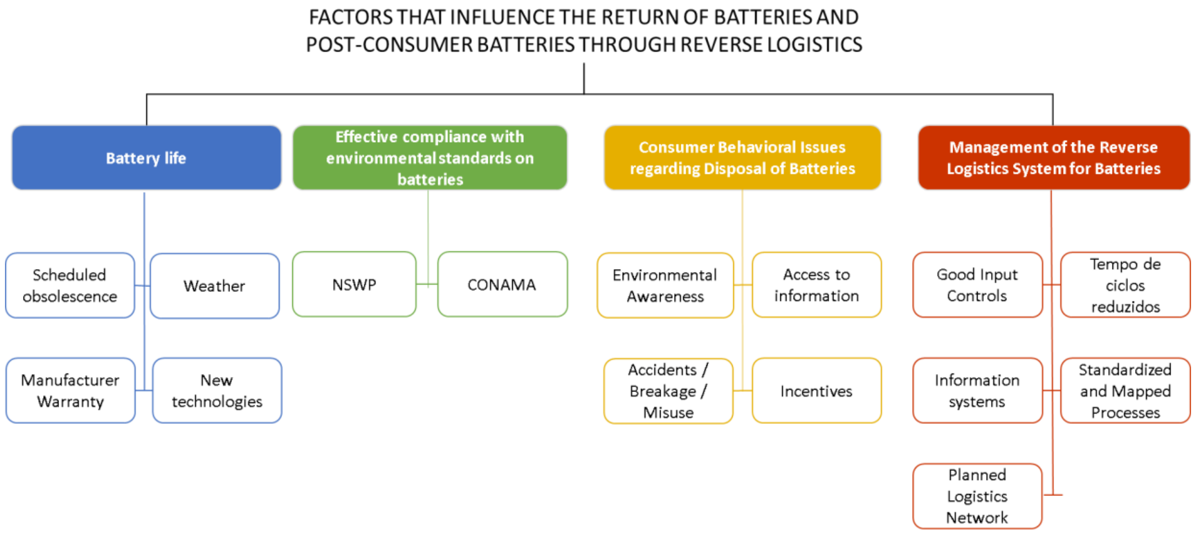
	Research development steps
I	Bibliographic survey for the construction of factors influencing the return of post-consumer products through reverse logistics.
II	Definition of the Theoretical Model based on Marcos (2018)
III	Elaboration and testing of the data collection questionnaire
IV	Sending the questionnaire via internet to specialists in the field
V	Refinement and Analysis of the results obtained
VI	Conclusion

Source: Adapted from Martins, Mello and Turrioni (2014).

The first step in the development of this work was the bibliographic survey. The search was carried out seeking to find articles, theses and dissertations on the topic, in the main databases in Brazil. The CAPES Portal was used as a priority source in this survey because it has a large collection of journals, theses, dissertations and other materials available online. To build the conceptual basis for this work, specific rules and laws were also consulted on the subject of material disposal.

Based on the bibliographic survey, a theoretical-conceptual model was presented, as shown in Figure 2, which identifies and interrelates factors that may interfere in the process of returning batteries and post-consumption batteries. This model was based on Marcos (2018) and will be considered for validation purposes in this work.

Figure 2 - Factors that influence the return of batteries and post-consumer batteries through reverse logistics.



Source: Adapted from Marcos (2018).

Thus, to validate the conceptual theoretical model presented (Figure 2), a questionnaire was prepared in order to verify the relationship between the factors previously proposed. The four factors mentioned in Figure 2 will be the constructs evaluated in the questionnaire. This was sent electronically to a group of specialists, scientists, masters, doctors and professionals in the areas of Environmental Management, Waste Management and Reverse Logistics. To evaluate the relationship of the factors proposed in the model, the Likert semantic scale was used, in which the respondent has the responsibility to indicate the degree of agreement on a 5-point scale: 5 (high relevance) to 1 (null relevance).

Thus, in the data collection instrument, experts should answer the degree of relevance of each sub-construct in the assessed factor; and what is the degree of relevance of each of the four factors in the disposal of batteries, according to the model in Figure 2.

A pre-test was carried out with three researchers to assess the structure and format of the proposed questionnaire. After the improvements made, the questionnaires were sent electronically to the largest group of 117 specialists and professionals in the research area. The data collection period was between April and May 2019.

After returning the forms, a statistical analysis of the data was carried out in order to understand the relevance of the factors listed in the proposed conceptual model (Figure 2) using the Statistical Package for the Social Scienses (SPSS) software. This software is used for interactive or batch statistical analysis, and can be applied in the most diverse types of analysis. For this work, it was decided to perform descriptive analyzes and multivariate tests, through factor analysis, according to the acquired sample, in order to interpret the data efficiently and accurately. (MARQUES, 2009).

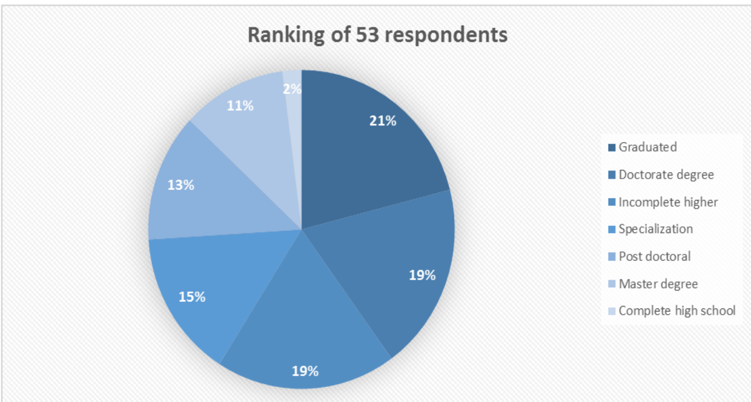
4. RESULTS AND DISCUSSION

The results and discussions of the research are treated and analyzed in more detail in the following topics, based on descriptive analysis of the data, as well as the factor analysis and its correlations.

4.1 Sample Characterizations

117 specialists and aspirants in the environmental area were selected, in addition to industry experts; of which 53 answered the proposed questionnaire. Thus, the rate of return for the Survey applied was 45.3%. The sample was characterized by 7 post-doctors, 10 doctors, 6 masters, 8 specialists in the industry, 22 students of the Reverse Logistics theme as shown in Graph 1. The sectors of activity and the level of education of the specialists contributed to the credibility of the opinions ruled.

Graph 1 - Sample characterized by specialists.



Source: Field research data (2019).

After the result of the questionnaire, the data were analyzed and listed in the Google Sheets software, as it was already linked to the Survey tool. As for the statistical analyzes, the data mentioned were calculated using the Statistical Package for the Social Scienses (SPSS) software.

4.2 Constructive Descriptive Analysis

Based on the four main constructs (factors), averages were obtained in the survey, as shown in Table 6.

Table 6 - Means and Standard Deviations of the main Constructs.

Dimension	Average	Variable	Average	Standard deviation
Factors that Influence the Return of Batteries and Post-Consumption Batteries through Reverse Logistics	4.2059	Battery Life	3.902	1.0051
		Effective compliance with environmental standards on batteries	4.1961	0.8004
		Consumer Behavioral Issues regarding Disposal of Batteries	4.451	0.7567
		Management of the Reverse Logistics System for Batteries	4.2157	0.7667

Source: Field research data (2019).

The highest average among the constructs was the QCC (X = 4.4510), showing the influence of the consumer's role regarding the return of post-consumer batteries and batteries through the LR, since they have a key role regarding batteries and batteries reach collection points.

The second value to call attention reflects directly on the GSLR process (X = 4.2157), a factor that was not considered in the model of Marcos (2018), but added to the model proposed in this research. Thus, it is possible to perceive the specialists' view of the importance of efficient management, which demonstrates that management is a key part of this study. These two constructs mentioned earlier have the smallest standard deviations, demonstrating a high level of agreement between the respondents' responses.

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The lowest average was relative to the TVU construct (X = 3.9020), however, such an average can probably be attributed to the standard deviation which has a high value (σ = 1.0051) which shows a low level of agreement between the responses of the respondents.

4.2.1 Descriptive Analysis of the Constructs of the GSLR Dimension of Batteries

The subconstructs of the Reverse Logistics System Management dimension are shown in Table 7, showing the variables that make up the construct together with their means and standard deviations. This dimension had the highest overall average (X = 4.2745).

Table 7 - Averages and Standard Deviations of Constructs of the Dimension Reverse Logistics System for Batteries and Batteries

Dimension	Average	Variable	Average	Standard deviation
Management of the Reverse Logistics System for Batteries	4.2745	Good Input Controls	4.2745	0.6656
		Standardized and Mapped Processes	4.2941	0.7012
		Reduced cycle times	3.902	1.0441
		Information systems	4.2157	0.7567
		Planned Logistics Network	4.4902	0.6123

Source: Field research data (2019).

The highlight of the highest average (X = 4.4902) points to the Planned Logistics Network, which is nothing more than the infrastructure to control the flows of input or input (materials used) and output or output (materials processed), transporting efficiently to form a network connected to the collection points. This sub-construct has the smallest standard deviation of the dimension (σ = 0.6123), demonstrating that the respondents obtained a higher level of agreement when evaluating this item compared to the others in this dimension.

With the second highest average (X = 4.2941) we have the Standardized and Mapped Processes that show that the Reverse Logistics Process of Batteries and Batteries has to be more emphasized as something everyday and not sporadic, the mapping of the processes is the first step towards reliable system management.

It is worth mentioning that the lowest average (X = 3.9020) belongs to the Variable Cycle Times variable; reflecting that perhaps not so much agility is needed between the cycle start time until the end of the operation, as long as these are done in an effective, efficient and standardized way, long cycle times are not seen as a problem.

4.2.2 Descriptive Analysis of the Subconstructs of the BL Dimension of Batteries

The sub-constructs of the TVU dimension are shown in Table 8, together with their means and standard deviations.

Table 8 - Means and Standard Deviations of Constructs of the Dimension Lifetime of Batteries and Batteries

Dimension	Average	Variable	Average	Standard deviation
Battery Life	3.9314	Scheduled obsolescence	4.1176	1.0056
		Manufacturer Warranty	3.549	1.2699
		Weather	38.039	11.493
		New technologies	4.0588	0.9882

Source: Field research data (2019).

The analysis of the highest averages came from the Programmed Obsolescence sub-construct with the best result (X = 4.1776), and the best second result came from the New Technologies sub-construct (X = 4.0588).

The first variable may reflect the market as the strategy of making a product obsolete in a short time is not well regarded in society, since batteries are not products that have replacement parts for maintenance when they stop working, they need to be discarded. The second sub-construct, on the other hand, leverages the relevance of conducting research that promotes the creation of more durable and less polluting products for the environment and human health, since the product in question contains toxic materials.

4.2.3 Descriptive Analysis of Constructs of the ECES Dimension on Batteries and Batteries

The sub-constructs of the ECES dimension are shown in Table 9, together with their means and standard deviations.

Table 9 – Averages and Standard Deviations of Constructs of the Dimension Effective Compliance with Environmental Standards on Batteries.

Dimension	Average	Variable	Average	Standard deviation
Effective compliance with environmental standards on batteries	4.2353	National Solid Waste Policy (NSWP) regarding the disposal of batteries	4.1569	1.0271
		National Environment Council (CONAMA) regarding the disposal of batteries	4.3137	0.8122

Source: Field research data (2019).

For this dimension, which had the second highest overall average (X = 4.2353), it can be seen in Table 4 that the highlight of the highest average (X = 4.3661) points to the CONAMA sub-construct, since this resolution is older than the PNRS and therefore better known.

This body considers the need to minimize the negative impacts brought on the environment by the improper disposal of batteries; was responsible for regulating the disposal of batteries and batteries, bringing in its maximum resolutions limits for heavy metals that comprise batteries and batteries. Its low standard deviation shows a higher level of agreement among respondents.

4.2.4 Descriptive Analysis of Constructs of the QCC Dimension

The sub-constructs of the QCC dimension are shown in Table 10, showing the variables that make up the construct together with their means and standard deviations.

Table 10 - Means and Standard Deviations of Constructs of the Dimension Consumer Behavioral Issues

Dimension	Average	Variable	Average	Standard deviation
Consumer Behavioral Issues regarding Disposal of Batteries	4.2157	Environmental awareness regarding the disposal of batteries	4.3137	0.8364
		Incentives	4.3137	0.7613
		Access to information	4.1176	1.0516
		Accidents / Breakage / Misuse	3.6862	1.0294

Source: Field research data (2019).

For this dimension, the data point to a tie between Environmental Awareness and Incentives as the most influential variables, assuming (X = 4.3137). Both are also the ones with the smallest standard deviations, Incentives with (σ = 0.7613) and Environmental awareness with (σ = 0.8364), validating the highest level of compatibility of the experts' opinions.

In addition to the lack of government incentive to open more recyclers in Brazil and to add value to products for recycling, it is indicated as one of the main difficulties for Reverse Logistics to be well executed.

The disposal of products is a task that is not easy, so the population ends up disposing of the products incorrectly, this happens in most cases due to the lack of environmental awareness or the absence of information or collection points.

The Accidents / Breakdowns / Misuse sub-construct, on the other hand, had the lowest average (X = 3.6862), which can be explained by the limitations of battery and battery repair design since they were designed to be non-repairable. However, the high standard deviation (σ = 1.0294) shows a divergence in the view of respondents in this research regarding this construct.

4.3 Construct Factor Analysis

Based on the use of multivariate analysis techniques, the SPSS program demonstrates the variables that stand out the most at the moment of better explaining the proposed phenomena, being said as a factor analysis. Chart 1 shows the variance of the variables and the accumulation of the main research constructs.

Chart 1 – Factor Analysis of the Main Constructs

Dimension	Variable	%variance	%cumularive
Factors that Influence the Return of Batteries and Post-Consumption Batteries through Reverse Logistics	**Effective compliance with environmental standards on batteries**	**53.318**	**53.318**
	Management of the Reverse Logistics System for Batteries	22.237	75.555
	Consumer Behavioral Issues regarding Disposal of Batteries	13.462	89.018
	Battery Life	10.882	100

Source: Field research data (2019).

The variable that stands out the most, that is, the one that best explains this phenomenon of Influence on the Return of Batteries and Post-Consumption Batteries through LR is the Effective Compliance with Environmental Standards on Batteries (var = 53.318%) in the opinion of experts surveyed.

In the case of Brazil (an underdeveloped country), where companies have not yet developed the culture of taking preventive measures in relation to environmental issues, this factor is important because the laws are what really compel companies to do the LR of their products. Most likely in developed countries the result for the phenomenon would be different, as the culture in these countries causes companies to take proactive attitudes on environmental issues.

4.3.1 Factor Analysis of the GSLR Constructs of Batteries and Batteries

Considering the variables that constitute the phenomenon (construct), in the context of this study, the following levels of explanation were achieved by the variables that circumscribe the construct, as expressed in Chart 2.

Chart 2 - Factor Analysis of Constructs of the Time Dimension Management of the Reverse Logistics System for Batteries and Batteries

Dimension	Variable	%variance	%cumularive
Management of the Reverse Logistics System for Batteries	**Good Input Controls**	**50.392**	**50.392**
	Standardized and Mapped Processes	18.717	69.109
	Reduced cycle times	15.092	84.201
	Information systems	10.129	94.329
	Planned Logistics Network	5.671	100

Source: Field research data (2019).

The variable that best explains the GSLR phenomenon is the one that refers to Good input controls (var = 50.392%). In fact, as stated by Lacerda (2002), the positive result of a reverse logistics program depends a lot on how it will be designed and monitored, and the identification of the state of the materials found in the system is essential to avoid errors and ensure the efficiency of operations. In this way, this construct assists in the reliability of the system, connecting to the descriptive analysis of this factor that exalts the Standardized and Mapped Processes and the Planned Logistics Network as the most influential in the opinion of the experts.

4.3.2 Factor Analysis of Constructs of the LB Dimension

Considering the variables that constitute the phenomenon (construct) Lifetime of Batteries, in the context of this study, the following levels of explanation were reached for these variables that circumscribe the construct, as expressed in Chart 3.

Chart 3 - Factor Analysis of Constructs of the Product Lifetime Dimension

Dimension	Variable	%variance	%cumularive
Battery Life	**Scheduled obsolescence**	**37.306**	**37.306**
	Manufacturer Warranty	**26.248**	**63.554**
	Weather	22.664	86.218
	New technologies	13.728	100

Source: Field research data (2019).

This construct was the only one to present two variables that together better explain the TVU phenomenon, the variables are Programmed Obsolescence = 37.306 and Warranty provided by the manufacturer = 26.248, which together add up to more than 50% of the variance.

Therefore, since Programmed Obsolescence is directly linked to a characteristic that manufacturers place on products so that they have a shorter shelf life (PACKARD, 1960); the guarantee is used as support by the manufacturers, seeking to pass on to consumers greater product reliability, which in the consumer's view is a positive point, making it attractive.

According to Souza (2017), modern society quickly turns products, especially electronics (such as computers, cell phones, and others that use batteries) into technological scrap. For this author, factors such as planned obsolescence contribute to this process, together with changes in the consumption pattern and accelerated innovation. Thus, products still under warranty can become obsolete and these factors influence the return of batteries to the Reverse Logistics system.

4.3.3 Factor Analysis of Constructs of the ECES Dimension

Considering the variables that constitute the phenomenon Effective Compliance with Environmental Standards, in the context of this study, the following levels of explanation were achieved by these variables that circumscribe the construct, as expressed in Chart 4.

Chart 4 - Factor Analysis of Constructs of the Dimension Effective Compliance with Environmental Standards on Batteries.

Dimension	Variable	%variance	%cumularive
Effective compliance with environmental standards on batteries	**National Solid Waste Policy (NSWP) regarding the disposal of batteries**	**84.154**	**84.154**
	National Environment Council (CONAMA) regarding the disposal of batteries	15.846	100

Source: Field research data (2019).

The variable that best explains the ECES phenomenon is the one referring to the National Solid Waste Policy (var = 84,154).

From the time this legislation was in force, traders and distributors, even manufacturers and importers, were required to plan and implement LR chains in order to obtain autonomous post-consumer batteries and batteries from public services (without depending on the public service for do). Defining the shared responsibility between the manufacturers and the public authorities regarding the CVP. (BRAZIL, 2010).

Despite being the variable that best explains the construct, in the survey with specialists, resolution N. 401 of CONAMA (2008) was the variable identified as the greatest influencer. This is possible, as the resolution is older and established good guidelines for the disposal of batteries. NSWP helped to structure the RL systems based on these guidelines that have already been implemented.

4.3.4 Factor Analysis of the Constructs of the CBI Dimension

Considering the variables that constitute the Consumer Behavioral Issues phenomenon, in the context of this study, the following levels of explanation were achieved by these variables that circumscribe the construct, as expressed in Chart 5.

Chart 5 - Factor Analysis of Constructs of the Dimension Behavioral Issues of Consumers regarding the Disposal of Batteries

Dimension	Variable	%variance	%cumularive
Consumer Behavioral Issues regarding Disposal of Batteriess	**Environmental awareness regarding the disposal of batteries**	**48.688**	**48.688**
	Incentives	24.178	72.866
	Access to information	14.924	87.79
	Accidents / Breakage / Misuse	12.21	100

Source: Field research data (2019).

It is possible to infer that the perspective of environmental awareness regarding the disposal of batteries (var = 48.688%) is the variable that best explains the CBI phenomenon. In fact, despite numerous campaigns and incentives, it is a Herculean task to make consumers aware of how to correctly dispose of batteries. Some authors, such as Gasparini; Gasparini; Frigieri (2011) and Oliveira (2013), consider that the problem is the lack of information and / or collection points.

This sub-construct was also pointed out by experts as the factor that most influences consumers' behavioral issues, since this is due to the fact that consumers must seek a middle ground between sustainability and personal satisfaction. In addition, environmental awareness helps the consumer to prioritize companies that strive to offer products that respect the planet (COSTA; IGNÁCIO, 2011; MESQUITA JUNIOR *et al.*, 2013).

Based on the analysis of the sample responses, it is noted that among the four main constructs, the most influential in the return of batteries through Reverse Logistics were the Consumer Behavior Questions and the one with the least influence is the Battery Life. According to Pinheiro (2016), the consumer's lifestyle has great weight in his actions, and as today a large portion of the population has become increasingly consciously sustainable, the result of the research becomes valid, a since the consumer is the vital element for the product cycle from the time of purchase, use and disposal.

In addition, the Reverse Logistics System Management factor was the factor that came in second among the most influential factors, and this entered the proposed model differentiating it from the model of Marcos (2018). This construct is in line with what was pointed out by Leite (2002), and expresses that in order for there to be an assertive result in the Reverse Logistics program, it is necessary that it is efficiently planned and supervised, and for this to happen, there are sub-factors that directly influence the result to be positive.

It should be noted that all factors had some relevance in the influence on the return of batteries and post-consumer batteries to the Reverse Logistics system, however with different weights. That is, according to the respondents, the model proposed in Figure 2 is considered valid, however, it deserves reservations regarding the impact of each proposed variable.

5. CONCLUSIONS

The article in question presented as a general objective to study the relevance of variables that can influence the return of batteries and post-consumption batteries through Reverse Logistics. In this way, a bibliographic survey was made to identify possible influencing factors. For that, the conceptual model of Marcos (2018) was adapted, including the factors found in the researched bibliography. The model was validated by consulting the opinions of specialists, scientists, masters, doctors and professionals in the environmental and reverse logistics area. This validation took place using the results achieved through the application of Survey, aiming to obtain greater agreement of the experts' opinions in relation to the proposed subject.

From the dimensions that have relevance to the return of batteries and post-consumption batteries through RL, it was possible to verify that the factors studied have a certain influence on the phenomenon. Thus, it can be concluded that, according to the experts consulted in this research, the constructs Effective Compliance with Environmental Standards (ECES), Reverse Logistics System Management (RLSM), Consumer Behavioral Issues (CBI), Lifetime (LB) influence companies and consumers in the return of these products.

Therefore, experts evaluated the influence of the ECES, RLSM, CBI and LB dimensions from two perspectives: Cartesian Trend, in which the elements that make up this trend are weighted in a unique way; and Systemic Trend that considers the elements together. It was noticed that LB was the least relevant construct for this sample; this factor seeks to stimulate the creation of new technologies that are not so harmful to the environment, consumer awareness of planned obsolescence and clarify issues that refer to the guarantees provided by manufacturers.

For this reason, it was possible to understand that the variables mentioned above contribute as factors of influence in the Return of Batteries and Post-consumption Batteries through Reverse Logistics, since, the concepts expressed in this research demonstrate that the Effective Compliance with Environmental Standards plays a key role, since such a construct together with the Consumer Behavioral Issues are the main influencing factors, since through environmental responsibility alternatives could be sought so that there is a balance between accelerated consumption and the environmentally correct disposition after life battery life. Thus, these factors must be considered when quantifying an estimate of products that must be returned by the reverse cycle.

Among the obstacles encountered during the research, it is worth mentioning the difficulty and restriction in obtaining answers from a larger sample of specialists with influence in the environmental area.

Finally, in order to contribute to the academic and industrial environment, it is important to highlight the data collected and the similarities found with the research by Marcos (2018), even though he did not use the same sample. Thus, it can be concluded that the factors that influence the return of batteries are similar to the factors that influence the return of products in general. Thus, a survey with greater adherence among specialists in the area is suggested, in order to achieve more generalizable rates.

Based on the foregoing, it is recommended that further studies be progressed in order to enable a more comprehensive diagnosis of pertinences and implications. With this, the possible applicability of this model in other countries and for other products is expressive. Different cultures also stand out regarding the environmentally appropriate disposal of batteries, thus establishing more comprehensive readings on the factors influencing the return of batteries and post-consumer batteries and highlighting the different views. It is also worth mentioning that the information obtained in this work can contribute to future legislation in the area.

References

ABINEE. Brazilian Electrical and Electronic Industry Association. **The electrical and electronics industry driving the green economy and sustainability**. jun. 2012. Available at: <http://www.abinee.org.br/noticias/com242.htm>. Access in: 30 oct. 2018.

ABINEE. Brazilian Electrical and Electronic Industry Association. **Annual Report 2017**. Published in: feb. 2018. Available at: <http://www.abinee.org.br/noticias/com242.htm>. Access in: 30 oct. 2018.

ABINEE. Brazilian Electrical and Electronic Industry Association. **Green Eltron starts to manage batteries program**. Apr 20 2018a. Available at: <http://www.abinee.org.br/noticias/com242.htm>. Access in: 30 oct. 2018.

ABRETE. **UN report on electronic waste reveals deficiency in reverse logistics**. says Abrete, 2016. Available at: <http://www.abetre.org.br/blog/relatorio-da-onu-sobre-lixo-eletronico-revela-deficiencia-na-logistica-reversa-diz-abetre>. Access in: 30 oct. 2018.

BEDANTE, G. N. **The influence of environmental awareness and attitudes towards sustainable consumption in the intention to purchase ecologically packaged products**. Dissertation. 154f. 2004. (Master in Business Administration) - Graduate Program in Business Administration, Federal University of Rio Grande do Sul – UFRGS. Porto Alegre, 2004.

BLACKWELL, R. D.; MINIARD, P. W.; ENGEL, J. F. **Consumer behavior**. 9. ed. Sao Paulo: Pioneer Thomson Learning, 2005.

BRAZIL. Law 12,305 of August 2, 2010. **Institutes the National Solid Waste Policy**. Amends Law No. 9,605, of February 12, 1998; and makes other arrangements. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm>. Access in: 20 oct. 2018.

BRAZIL. **National Solid Waste Policy**. 2nd. ed. Brasília: Chamber of Deputies, Camera Editions, 2012. p. 73 (Legislation series: n.81). Available at: <https://fld.com.br/catadores/pdf/politica_residuos_solidos.pdf>. Access in: 20 nov. 2019.

BRAZIL. Law No. 8,078 of September 11, 1990. **Provides for consumer protection and other measures**. Available at: <http://www.planalto.gov.br/ccivil_03/leis/l8078.htm>. Access in: 20 oct. 2018.

BRITO, M. P.; DEKKER, R. **Reverse logistics**: a framework. Econometric Institute Report EI 2002-38, Erasmus University, Rotterdam, p. 1-25, oct. 2002.

CONAMA. **National Environment Council**. Resolution No. 401, of November 4, 2008. Official Diary of the Union, nº 215, section 1, p. 108-109, 5 nov. 2015.

CONAMA. **National Environment Council**. Resolution No. 424, of April 22, 2010. Published in the Official Gazette, No. 76, of April 23, 2010, page 113.

COSTA, L. A. V. D; IGNÁCIO, R. P. Consumer x Environment Relationships: In search of Sustainable Development. **Legal Scope**. Rio Grande, v.14, n. 95, 2011.

DURACELL. **How batteries are made**, 2016. Available at: <https://www.duracell.com.br/technology/como-pilhas-sao-feitas/>. Access in: 10 set. 2018.

DURACELL. **Responsible use, care and disposal of batteries**, 2016 (a). Available at: <https://www.duracell.com.br/technology/uso-cuidados-e-descarte-responsavel-de-pilhas/>. Access in: 6 oct. 2018.

FAGUNDES, A. B. **Fuzzy modeling for environmental performance assessment of industrial solid waste management.** 1v. TESE. 275f. 2015. (Doctorate) - Doctoral Course in Technology, Federal Technological University of Paraná, Curitiba, 2015.

FAGUNDES, A. B.; TOKARZ, B.; PEREIRA, D.; BEUREN, F. H.; CAMPOS, D. B. Reverse logistics of batteries in Brazil: a contextualization considering the ABINEE Program Receives Batteries (PARP). In: INTERNATIONAL MANAGEMENT CONGRESS, 30., 2017, Ponta Grossa. **Anais**… Electronic Proceedings ...Ponta Grossa: UEPG,2017.

FECOMERCIOSP. **Reverse logistics changes the final destination of electronics and benefits the whole society**. 26 out. 2018.

GALINDO, H; SILVA, K.; XAVIER, L.; SILVA, L. Exploratory Study on Post-Consumer Reverse Logistics in the Optical Products Market: Proposition of Practices. **Management, Innovation and Sustainability Magazine** - Brasília, v. 2, n. 1, p. 175-190, 2016.

GASPARINI, J. D. C.; GASPARINI, A. R.; FRIGIERI, M. C. Study of Disposal of Medicines and Environmental Awareness in the Municipality of Catanduva-SP. **Science & Technology**: FATEC-JB, Jaboticabal, v. 2, n.1, p. 38-51, 2011

GIL, A. C. **How to design research projects**. 4. ed. Sao Paulo: Atlas, 2002.

GREEN ELETRON. **Locate where are the points of voluntary delivery of the Disposal GREEN program**. 2018. Available at: <http://www.gmcons.com.br/gmclog/admin/VisualizarPostosMapaCliente.aspx>. Access in: 13 may 2019.

GUARNIERI, P; CHRUSCIACK, D.; OLIVEIRA, I.; HATAKEYMA, K.; SCANDELARI, L. WMS – Warehouse Management System: proposed adaptation for the management of reverse logistics. **Production Magazine**, v. 16, n.1, p. 126-139, 2006.

GUILTINAN, J. Creative destruction and destructive creations: environmental ethics and planned obsolescence**. Journal of Business Ethics**, v. 89, p. 19–28, 2009.

HINZ, R. T. P.; VALENTINA, L. V. D.; FRANCO, A. C. Environmental sustainability of organizations through cleaner production or life cycle assessment. **Technological Studies in Engineering**, v. 2, n. 2, p. 91-98, 2006.

JUNIOR, AFONSO; MEIRA DE MORAIS, RAFAEL; EMERENCIANO, VIRGINIO; DIAS, CLAÚDIO; PEREIRA, REIDSON. Life Cycle Analysis (LCA) concepts and applications in Brazil. **Ibero American Strategy Journal**, v. 7, n. 1, p. 39-44, 2008.

LACERDA, L. **Reverse logistics**: an overview of the basic concepts and operational practices. Rio de Janeiro: COPPEAD/UFRJ, 2002.

LEITE, P. R**. Reverse Logistics**: environment and competitiveness. Sao Paulo: Prentice Hall, 2003.

LEITE, P. R. Reverse logistics: new area of business logistics**. Tecnologistica Magazine**. Sao Paulo, may 2002.

MARCOS, J. **Factors influencing the return of post-consumer products through reverse logistics: a conceptual model**. 2018, 27 p. Course Conclusion Paper (Graduation in Production Engineering - Mechanical Qualification) - State University of Santa Catarina, São Bento do Sul, 2018.

MARQUES, S. G. **Industrial maintenance and life cycle cost - oilseed extraction**. Monte da Caparica, Faculty of Science and Technology, 2009. Dissertation. 187f. 2009. Originally presented as a master's dissertation, University of Lisbon, 2009.

MARTINS, R.A., MELLO, C.H.P; TURRIONI, J.B. **Guide for preparing monograph and CBT in production engineering**. Sao Paulo: Atlas, 2014. 212 p.

MEDINA, H. V. Sustainable material production: environmental management and life cycle analysis. In: ABM ANNUAL CONGRESS, 61, 2006, Rio de Janeiro. **Electronic Proceedings**...Rio de Janeiro: ABM, 2006.

MENDES, H. M. R.; RUIZ, M. S.; FARIA, A. C. ABINEE program receives batteries (PARP): the implementation and current stage of the reverse logistics of batteries and batteries. In: NATIONAL MEETING ON BUSINESS MANAGEMENT AND THE ENVIRONMENT, 17, 2015, Sao Paulo. **Electronic Proceedings**... Sao Paulo: ENGEMA, 2015

MESQUITA JUNIOR, J. A. A.; GARCIA, R. C.; CUSMA, R. D. L.; FERREIRA, D. B.; TONETTI, D. A. Parallel between generations of engineers: environmental awareness and ecologically correct consumption. **Environmental Sciences Magazine On-Line**, v. 9, n. 1, 2013

MIGUEL, P. A. C.; FLEURY, A.; MELLO, C. H. P.; NAKANO, D. N.; LIMA, E. P. D.; TURRIONI, J. B.; HO, L. L.; MORABITO, R.; MARTINS, R. A.; SOUSA, R.; COSTA, S. E. G. D.; PUREZA, V. Research methodology in production engineering and operations management. 2. 2012. **Electronic Proceedings…** Rio de Janeiro: Elsevier: ABEPRO, 2012.

NOGUEIRA, F. F. A. C. **Shared Responsibility for the Life Cycle of Products and Legal Instruments of Reverse Logistics**: new modalities of the National Solid Waste Policy and applications. Dissertation (Master in Law) - University Center of Brasilia – UNICEUB. Brasília, 2017.

OLIVEIRA, R. de C. **Methodology for the analysis of post-consumer reverse logistics**: an application to the case of batteries. Florianópolis, Federal University of Santa Catarina, 2013. Originally presented as a doctoral thesis, Federal University of Santa Catarina, 2013.

PACKARD, V. **The Waste Makers**. New York: David McKay, 1960.

PINHEIRO, A. F. A. The interference of the economic crisis in consumer behavior, in relation to small local businesses. **South American Development Society Journal**, v. 2, n. 5, p. 27-41, 2016.

REIDLER, N. M. V. L; GÜNTHER, W. M. R. Health and environmental impacts due to waste generated by batteries and used batteries. In: INTER-AMERICAN CONGRESS OF INGENIERÍA SANITARIA Y AMBIENTAL, 28, 2002, Cancún. **Electronic Proceedings**... Cancún: AIDIS, 2002.

RUIZ, M. R.; RUIZ, L. I. R; CHRSITOFOLETTI, R. A.; SILVA, E.L. Challenges for the management of batteries and post-use batteries: proposal for a bill on e-waste in the city of Rio Claro - SP. **Environmental and Sustainability Management Magazine**, v. 1, n. 2, p. 29-50, 2012.

SIGNIFICADOS. **Meaning of weather**: What is an weather. 2013-2018. Available at: <https://www.significados.com.br/intemperie/> Access in: 02 sep. 2018.

SOUZA, A. R. **Scheduled obsolescence and the issue of electronic waste related to reverse logistics**. JurisWay, 2017. Available at: <https://www.jurisway.org.br/v2/dhall.asp?id_dh=19375>. Access in: 16 oct. 2018

SOUZA, C; CRUZ, A. F; MARCHI, B; BARBOSA, M. T. Analysis of the useful life of sustainable materials. In: BRAZILIAN CONGRESS OF CONSTRUCTION PATHOLOGY. **Electronic Proceedings**... CBPAT 2018.

THIMM, D. **Portal maps battery and battery collection points in Brazil**. Third sector observatory. September 18, 2017. Available at: <https://observatorio3setor.org.br/noticias/portal-mapeia-pontos-de-coletade-pilhas-e-baterias-no-brasil/> Access in: 28 oct. 2018.