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REVERSE LOGISTICS: PACKAGING AND ENVIRONMENTAL SUSTAINABILITY

By

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Abstract

Packaging is a fundamental tool for Logistics, as it also acts as marketing for the company, in addition, it has the purpose of ensuring safety in the handling and transportation of the product. It is believed that its importance is not limited to these facts, as it has a great relevance regarding the environmental responsibility of companies and therefore its constitution must be thought of in a way that allows better disposal with the environment. In this way, it is intended to answer the question "what is the reverse logistics process in the use and reuse of packaging, taking into account the dimension of environmental sustainability"? The research follows the general purpose of understanding the reverse logistics process, with a special focus on the use and reuse of packaging, taking into account the dimension of environmental sustainability. It is from The systematic review and in fact it differs from the traditional narrative review in that it is a comprehensive and unbiased research. The results indicate that reverse logistics by its nature is environmentally sustainable. The manufacture of reusable packaging has gained prominence today, taking into account that reverse logistics, in this sense also called Green Logistics, is related to the destination of products and materials already discarded by the final consumer, thus contributing to the preservation of the environment. This contribution is made by the return of post-consumer goods to the production cycle, which reduces the accumulation of industrial waste in nature. Therefore, reverse logistics can be related as an important tool for environmental preservation.

Keywords: Packaging, Reverse Logistics. Use and reuse, Environment

1. Introduction

Packaging is seen as the meeting of four fundamental competencies: Marketing and Design, Logistics. Logistics deals with the issue of packaging in the way it deserves, being a container of protection, grouping and facilitator in transport and storage, in logistics the best known and applied are consumer packaging, known as marketing or primary, industrial packaging known as logistics or secondary, convention packaging used to accommodate products, facilitating packaging and Fifth Level packaging.

Monteiro et. It is believed that its importance is not limited to these facts, as it has a great relevance regarding the environmental responsibility of the company and therefore its constitution must be thought of in a way that allows better disposal with the environment, otherwise this generates negative points for the company such as loss of profit.

Finally, despite the four fundamental competencies that packaging brings together, there is another essential competence called *the environment*. The greater the possibility of recycling packaging, the greater its environmental sustainability. It can be framed in Reverse Logistics, the well-known "Green Logistics".

The main objective of this research is to understand the reverse logistics process, with a special focus on the use and reuse of packaging, taking into account the dimension of environmental sustainability.

As in the investigation by Ngomane (2023) and Banhos, Garcia and Paiva (2022), the research developed was a systematic review, with defined methodological characteristics, divided into three main stages. The first stage was the planning of the review, where the needs of the review were identified, the preparation of a proposal (the scope of the review studied the scope of the literature, delimited the topics



covered considering multidisciplinary perspectives), and the development of a protocol, which identified some specific issues: the focus population of the study, research strategy to identify relevant studies, and the criteria for inclusion or exclusion of studies in the review.

The second stage was related to the conduct of the review, including the identification and selection of studies. At this stage, the details were sufficient to ensure replicability. Initially, all studies of potential relevance were reviewed and according to the exclusion criteria were included in the search or not. The quality of the studies was also evaluated. With the intention of reducing human errors, the data from the studies (such as, for example, title, author, journal, specific information) were also extracted and synthesized.

The last stage consisted of communicating and disseminating the review in a clear way, being divided into two phases: descriptive field analysis and thematic analysis. A search for articles was carried out at a global level, by searching the Web of Science (WOS) and SCOPUS (Elsevier) platforms using the terms "Reverse Logistics; Packaging; Environmental Sustainability, and Recycling. In fact, research that was not related to the thematic object and/or the problem of the present research was disregarded.

In practical terms, it is expected that the work will serve as support material for the understanding of packaging and its reuse, taking into account environmental sustainability, as well as to raise readers' awareness of the need to think about the development of sustainable products in terms of commitment to human health and the environment. From a theoretical point of view, it is expected to contribute to the advancement and development of knowledge in an area that is still poorly structured and scarce, from the point of view of local scientific production.

2. Analysis and Discussion of Results

2.1. Reverse Logistics and environment

Environment

The expression "environment", however, can indicate any "space" in which a being lives and develops. In the interaction and energy exchanges that are established between living beings and the environment, there is transformation in both of them. In the case of the human being, in addition to the physical and biological space, there is also the sociocultural space (Leite, 2009).

In this way, the environment can be considered the place where one lives, where one works and where one studies as part of the environment. Nowadays there is a lot of talk about ecology, but few people act ecologically. All living beings relate to each other and to the environment, but only man consciously acts on it. Man has been responsible for great and rapid transformations of this "home", especially from the growing urbanization that occurred after World War II.

One of the great problems of today is garbage. Man putting garbage in the trash bin or throwing it in vacant lots solves his individual problem, not realizing that garbage areas in cities are increasingly scarce and that garbage thrown in vacant lots

favors the development of disease-transmitting animals. For the preservation of the environment, garbage must be considered as a matter for the whole of society and not an individual problem. The great

The eminent challenge of today is to promote sustainable development, the central theme of the United Nations Conference on Environment and Development, known as Rio 92. By sustainable development we can understand development capable of satisfying present needs, but without compromising the needs of future generations.

The manufacture of sustainable packaging or "green packaging" is important to reduce the damage that is caused by single-use packaging. Sustainable packaging is called that which is made from organic materials or recyclable materials. This sustainable packaging stands out as a solution for companies that want to be ecologically sustainable and still show environmental awareness through packaging with an innovative and striking appearance. In general, these packages are made from biodegradable materials and that, when discarded anywhere, they do not pose risks to the environment (Ferreira, Silva & Madeia, 2019).

Reverse Logistics

Reverse logistics is a very generic term and means, in its broadest sense, all operations related to the reuse of products and materials, encompassing all logistical activities of collecting, dismantling, and processing used products and/or materials and parts in order to ensure sustainable recovery (Reis, 2019). Reverse logistics has historically been associated with product recycling activities and environmental aspects (Leite, 2009, cited in Reis, 2019).

In practical terms, reverse logistics has as its main objective to reduce environmental pollution and waste of inputs, as well as the reuse and recycling of products. For example, organizations such as supermarkets, industrialists, and stores discard considerable volumes of material that can be recycled such as paper, cardboard, wooden pallets, plastic, among other industrial wastes with great potential for reuse or recycling.

The reuse of materials and the economy with returnable packaging have brought gains that stimulate more and more initiatives and efforts to implement reverse logistics, aiming at the efficient recovery of products, according to (Tadeu, 2012, cited in Reis, 2019).

According to LACERDA (2004), customers value companies that have product return policies, as this guarantees them the right to return or exchange products. This process involves a structure for receiving, classifying, and shipping returned products, as well as a new process in the event of a new output of that same product.

The reverse logistics process shares the responsibility for the destination of waste with consumers and companies. In reverse logistics, organizations need to return waste to its origin to be reused or, in the case of items that cannot be recycled, to be disposed of in an environmentally appropriate way, making it possible to return goods or materials that are

constituent to the production cycle, adding economic and ecological value (Sá, 2019).

Reverse logistics is related to the destination of products and materials already discarded by the final consumer, thus contributing to the preservation of the environment. This contribution is made by the return of post-consumer goods to the production cycle, which reduces the accumulation of industrial waste in nature. Therefore, reverse logistics can be related as an important tool for environmental preservation.

Reverse logistics is linked to legal, environmental and economic issues at the same time, which highlights and makes it essential to study it in the organizational context, because it is the process through which companies can become more ecologically efficient through recycling, reuse, and reducing the amount of materials used (Carter; Ellram, 1998, cited in Sá, 2019).

It is possible to observe the importance of applying reverse logistics, currently, since it generates benefits, both for the environment and for the company itself - it is a practical perspective favorable to sustainability, in the market, compared to its competitors. The most well-known types of reverse logistics are post-sales and post-consumption, as detailed in the next topic (Goncalves & Ferreira, 2021).

2.2. Environment and Waste Treatment

Garbage is any and all solid waste resulting from human activities. Garbage is any and all solid waste resulting from human activities. In Brazil, garbage is mostly composed (60%) of food scraps.

This waste could be avoided with the use of proper packaging and better handling. It is important to note that packaging protects food, medicines, appliances and the most varied goods, allowing the sale of these products anywhere or at any time of the year.

Figure 1: Types of Garbage



Source: Adapted by the author

Chemical Composition of Garbage

The chemical composition of garbage is distinct, including organic and inorganic materials. Organic waste, such as food scraps and plant waste, is biologically degradable (biodegradable) and can be broken down by microorganisms. While inorganic waste includes materials such as glass, metals, and plastics, which can be recyclable or not.

Garbage, according to its chemical composition, can be classified into Organic and Inorganic. When resulting from the remains of a living animal or vegetable being, garbage is

called organic. When it is the result of lifeless, inorganic material.

Inorganic waste is mainly composed of packaging materials. Glass, metal and plastics in general correspond to 10% of inorganic waste. Paper and cardboard, because they can be recycled, are considered inorganic here and represent 25% of the total of this type of waste.

Waste management

The issue of garbage is relevant that it has also been incorporated within several goals of the 2030 Agenda, which is a global agenda for the construction and implementation of public policies that aim to guide humanity until the year 2030. The 2030 Agenda was created at the UN United Nations Summit in 2015 and established the 17 Sustainable Development Goals (SDGs) (Evangelista, 2021). The principles of the agenda state that by separating waste correctly you contribute directly to 5 key objectives:

- Health and well-being: by reducing the amount of garbage in landfills and dumps.
- Decent work and economic growth: promoting the continuation and increase of existing jobs because of the increase in the supply of recyclable materials.
- Sustainable and resilient cities: making selective collection and increasing the life cycle of materials.
- Sustainable consumption and production: encouraging environmentally sound practices by companies and consumers.
- Action against global climate change: increasing knowledge and ways to mitigate and compensate for impacts.

To solve the problem of dumps, it is necessary to have the Integrated Management of Urban Waste, which involves different forms of action, such as: reduction of organic waste generated, landfills, composting, incineration and recycling.

In the landfill, the garbage is placed inside ditches lined with plastic sheeting, compacted several times by a tractor and then covered with a layer of 15 to 30 centimeters of earth, preventing it from attracting flies, rats and vultures. The gases and leachate resulting from the decomposition of the garbage are collected and treated so as not to cause bad smells and contamination of the water table. Sanitary landfills, however, have a short-term useful life and cities have a shortage of areas available for this purpose.

Figure 2: Sanitary landfills



Source: Adapted by the author

Composting is a way of treating the organic matter contained in the garbage. Through this process, organic matter is decomposed and the resulting product can be mixed with the earth, leaving it softer and with a greater capacity to retain water, favoring plant growth. The use of composting reduces the volume of garbage, contributing to increase the useful life of landfills. The cost of transportation limits the commercialization of organic compost, so its production cannot be too far from the consumer.

Figure 3: Composting



Source: Adapted by the author

Incineration or burning of garbage is one of the appropriate ways to treat urban waste, hazardous waste such as medical waste, spoiled food and expired medicines. The steam produced by incineration turns a turbine in order to generate electricity. Incineration also reduces the amount of waste in landfills. This process, however, requires total control of the emission of polluting gases.

Figure 4: Incineration



Source: Adapted by the author

Recycling treats garbage as raw material to be reused to make new products and brings several benefits to the population:

1. Decreases the amount of garbage sent to landfills;
1. Decreases the extraction of natural resources;
2. Decreases energy consumption;
3. Reduces pollution;
4. Contributes to the cleanliness of the city;
5. Makes citizens aware of the destination of garbage;
6. It generates more jobs.

Figure 5: Recycling



Source: Adapted by the author

The recycling process has a high cost in the implementation of Selective Collection programs. There is a need for permanent awareness and adherence of the population to increase the amount of material collected and thus reduce the costs of Selective Collection.

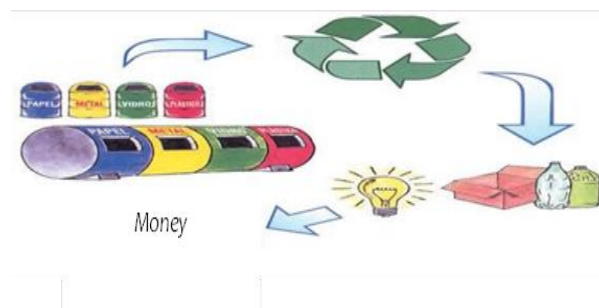
2.3. Selective Collection and Recycling

Selective Collection is the activity of collecting recyclable materials, such as paper, plastic, glass, and metals that have been previously separated at the source. That is, they are materials that, after being sorted, can go through a processing process in companies in the sector, sold and reused by the industry through recycling. Recycling is done through various techniques and activities with the aim of reusing and reusing waste from selective collection again in production cycles (Evangelista, 2021).

Selective Collection serves to organize, in a differentiated way, the solid waste that can be recycled. This collection can be done by trucks that pass weekly at homes or at Voluntary Delivery Stations (PEV) scattered throughout the city.

At these points there are collectors with different divisions, or colored drums for each type of packaging material. It is important to note that packaging materials must be cleaned before being placed in collectors or drums. The collected materials are taken to a certain sorting center. The belt has an electromagnet to help separate the metals. After being separated, the materials are compacted, tied into bales and sold to recycling factories.

Figure 6: Selective Collection



Source: Adapted by the author

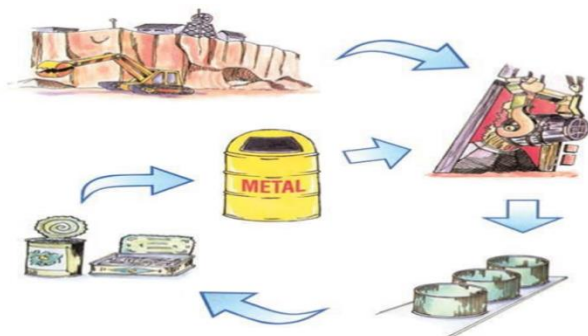
Metals are extracted from nature in the form of ores. Thousands of years ago, man discovered that when heating an ore, the metal contained in it liquefied and could be transformed to make various objects. This metal was iron (Evangelista, 2021).

By heating iron with carbon (coal) we have steel, widely used to make household utensils, tools, cars and packaging. Canned food cans are made of steel. In order not to rust in contact with air and not spoil food, the steel contained in them is coated with a thin layer of tin or chromium.

Aluminum is another metal widely used for food packaging, especially beverage cans. Aluminum, extracted from an ore called bauxite, is light, resistant, and does not rust in contact with air. When thrown into landfills, some metals disintegrate and become ore again. The process takes two to four years for steel, and in the case of aluminum the time is much longer, and its disintegration may not be complete. In addition, rusty cans can injure animals or people who have contact with garbage (Tadeu, 2021; Banhos, et al, 2022).

At the Sorting Center, the steel cans are crushed, compacted into blocks called scrap, and sent to the steel or aluminum recycling plant. The scrap is melted to form steel or aluminum plates that are transformed, again, into cans.

Figure 7: Metal Life Cycle



Source: Adapted by the author

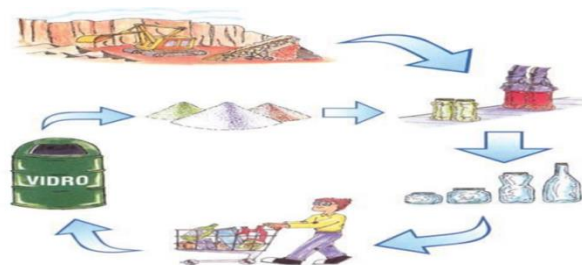
Glass

Glass was discovered thousands of years ago by the Phoenicians, who, by joining hot sand with ashes, managed to obtain a transparent material, which we now call glass. Currently, glass is manufactured practically from the same raw material, that is, sand from which the silica is removed. The barrel, where the sodium comes from, and the limestone, from which the calcium is removed, are also added.

Banhos, et al, (2022) report that glass when taken to landfills does not decompose, which reduces the useful life of the landfill. The raw material used in the manufacture of glass is cheap and easy to find, but its extraction causes damage to the environment. In addition, a lot of energy is spent to collect the sand and a lot of fuel for it to reach the glass industries. Energy is also used to heat the furnaces to the high temperatures required in the production of glass

At the Sorting Center, the glass packages are crushed and transformed into small shards, placed in drums to be melted at an average temperature of 1300oC. After melting, the dough is poured into the various molds of the glass industries and, by an automatic process, transformed into new packaging.

Figure 8: Glass Life Cycle



Source: Adapted by the author

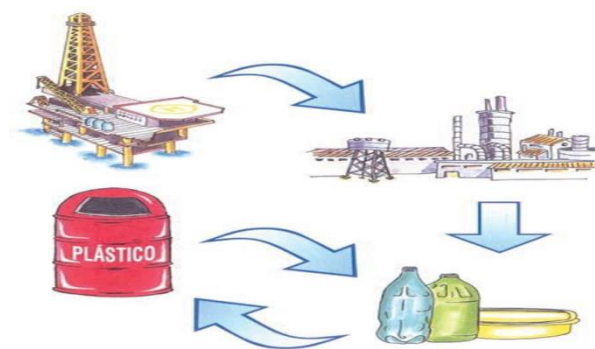
Plastic

For Reis (2019), plastics, for the most part, are produced from petroleum. Although oil is a non- renewable natural resource, only 4% of the oil consumed in Brazil is used for plastic production. Products extracted from petroleum to manufacture plastic materials are transformed into plastic resins. These resins can have their chemical composition modified and give rise to different types of plastic. That's why some plastics are more transparent than others or melt more easily.

The plastic materials used to make packaging are called thermoplastics, which soften when heated and can be transformed into new products. Plastic remains, when buried, do not decompose. Although biodegradable plastics already exist today, they are only used in some cases, such as surgical materials or in agriculture.

The plastic materials collected by the Selective Collection are taken to the Sorting Center. There, the different types of plastics are separated and sent to recycling factories where they are melted again to manufacture new products.

Figure 9: Life Cycle of Plastic



Source: Adapted by the author

Paper

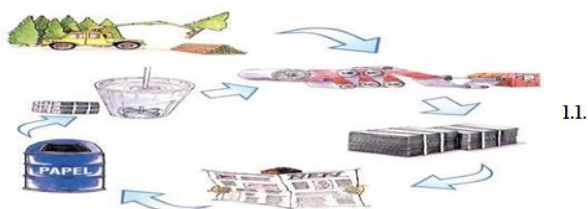
The paper is made from cellulose fibers found in tree woods such as eucalyptus and pine. To obtain cellulose pulp, the wood is peeled and cut into small pieces in a chipper. Then, the pieces of wood are mixed with water and caustic soda in large tanks and cooked to separate the cellulose pulp. Eucalyptus has shorter cellulose fibers and this provides a very smooth surface paper, used mainly for writing and for photocopying. Pine has longer cellulose fibers and is therefore used to make paper for boxes and packaging that need greater strength (Monteiro at al, 2016).

The trees used to make paper are planted by man and are therefore a renewable source of raw material. For the manufacture of recycled paper, the various types of used paper are called scraps. They are collected by the Selective Collection and taken to the Sorting Center. At the Sorting Center, the shavings are separated from the other packaging materials and tied in bales. The bales are sold to paper recycling plants.

Scraps are classified according to the type of paper and the amount of dirt they contain. The cleaner and more selected the shaving, the more valuable it is, and the better the paper obtained from its recycling. At the recycled paper mill, the shavings are mixed with water in a large blender called a hydropulper.

The mass obtained goes to the cleaning sector where materials such as metals, plastics and sand are removed. The resulting pulp goes to the paper making machine for water removal, pressing and drying, finally forming the recycled paper sheet.

Figure 10: Paper Life Cycle



Source: Adapted by the author

2.4. Packaging use and reuse

The greater the reuse of post-consumer materials, such as plastic packaging, paper, cardboard, Styrofoam, among others, the smaller the amount of waste sent to landfills. This minimizes the impacts on the environment and society, since each waste has its own decomposition time. The decomposition time of garbage is the time it takes for waste to decompose and disappear from the environment.

One way to solve this problem is to adopt the Principle of Sustainability R's: rethink, refuse, reduce, reuse, and recycle. These principles take into account the ideal of prevention and non-generation of waste, added to the adoption of sustainable consumption patterns, aiming to save natural resources and contain waste.

The use and use of packaging is part of the recycling construct, which has 5 main steps:

- Discard
- Collection
- Triage
- Destination
- Processing

It is important to note that this process is multidimensional, taking into account that it mainly involves: us, citizens and consumers, industries, recycling cooperatives, private

operators, independent collectors and, finally, recyclers (Evangelista, 2021).

2.5. Environmental Education and Citizenship

First, it is important to remember that the Environmental Management System is a process aimed at solving, mitigating and/or preventing environmental problems, with the objective of sustainable development (Monteiro at. Al, 2016).

Selective Collection for recycling is an important action to preserve the environment, but for it to give results, it is necessary that the whole society collaborates and participates in the construction of a change in mentality and consequently habits in relation to the problem of garbage. Such awareness will not happen overnight, but through a constant work of Environmental Education that guarantees the involvement and participation of all: the school, the family, the community and the State.

Environmental Education alone is not enough to solve environmental problems, but it is an indispensable condition for it. The importance of Environmental Education is to contribute to the formation of citizens aware of their role in preserving the environment, and able to make decisions on environmental issues necessary for the development of a sustainable society. The role of the public power is fundamental for such demands to materialize. In the case of waste treatment, laws, regulations and procedures are defined by the Union, States and municipalities.

Normally, the municipalities are responsible for the collection, transportation, treatment and disposal of garbage, while the State is responsible for environmental inspection and the Union is responsible for defining general rules. According to the United Nations Environment Programme (UNEP), a sustainable society must be in harmony with the following principles:

1. Respect and care for the community of living beings;
2. To improve the quality of human life;
3. To conserve the vitality and diversity of Planet Earth;
4. Minimize the depletion of non-renewable resources;
5. To remain within the limits of Planet Earth's carrying capacity;
6. Modify personal attitudes and practices;
7. Enable communities to take care of their own environment;
8. Generate a national framework for the integration of development and conservation;
9. To form a global alliance.

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