

ZERO WASTE FOR CIRCULAR ECONOMY: THE IMPORTANCE OF MUNICIPALITIES AND THEIR PUBLIC POLICIES FOR CIRCULAR ECONOMY

RESÍDUO ZERO PARA A ECONOMIA CIRCULAR: A IMPORTÂNCIA DOS MUNICÍPIOS E DE SUAS POLÍTICAS PÚBLICAS DE ECONOMIA CIRCULAR

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Abstract

The continuous increase in waste production in Brazilian society due to urbanization, new technologies and industrialization has led to pressure on natural resources, thus requiring the need to think of new ways of saving nature and polluting fewer areas by building spaces to dispose of this waste. In this way, the circular economy emerges as a way to resolve this situation. This study seeks to understand whether there is the possibility of establishing a circular economy in Brazil by analyzing the

Resumo

O crescente aumento da produção de resíduos na sociedade brasileira, devido à urbanização, às novas tecnologias e à industrialização, tem gerado pressão sobre os recursos naturais, tornando necessário pensar em novas formas de poupar a natureza e poluir menos áreas, por meio da construção de espaços para o descarte desses resíduos. Assim, a economia circular surge como uma maneira de resolver a situação. Este estudo busca compreender se existe a possibilidade de estabelecer uma economia circular no Brasil,



national solid waste policy and the roles of federated entities in its implementation, especially at the municipal level, the closest to society. This is a qualitative, descriptive research, with a deductive method, and bibliographic technique was used as a methodology. The theoretical framework is Valdemir Pires' theory on municipalism, which defends the increase of the role of the municipality in the exercise of public policies as being more efficient for economic development and the environment. In the end, it is concluded that it is necessary not only to give powers to municipalities, but mainly to offer funds so that they can implement and encourage other actors to achieve the circular economy.

Keywords: circular economy; linear economy; counties; PNRS; public policy.

analisando a Política Nacional de Resíduos Sólidos e os papéis dos entes federados em sua implementação, especialmente o município, ente mais próximo da sociedade. A metodologia utilizada foi a pesquisa qualitativa, descritiva, com método dedutivo e técnica bibliográfica. O marco teórico é a teoria do municipalismo de Valdemir Pires, que defende o aumento do papel do município no exercício das políticas públicas como o mais eficiente para o desenvolvimento econômico e para o meio ambiente. No final, conclui-se que é necessário não apenas dar competências aos municípios, mas, principalmente, fornecer fundos para que se possa implementar e incentivar outros atores a alcançar a economia circular.

Palavras-chave: economia circular; economia linear; municípios; PNRS; políticas públicas.

Introduction

The capitalist logic of production and consumption, driven by the technological knowledge increase, especially after the World War II, gave the system of production of goods and services an escalating pace, giving rise to a consumer society with an accelerated intensity never seen before.

One of the most striking characteristics of this consumer society is the post-consumption product disposal, the result of a linear economy, when natural resources and waste disposal areas are considered infinite.

Such linearity shows the environmental degradation due to extractive activities, pollution from the processing industry, planned obsolescence, and the consequent short life of products, resulting in an increasingly abundant waste disposal, with degradation of soil, water, and air.

In addition to the waste produced by mining, industry, and agriculture, waste produced in cities—where a large part of the world's population lives—is of particular importance. In cities, waste is mainly produced by homes, businesses, services, and public cleaning, which is generally called urban solid waste (USW).

The implementation of circular economy public policies is a fundamental process to promote the transition from a linear economic model to a more sustainable and efficient one, which seeks to minimize waste and maximize the use

of resources, encouraging reuse, recycling, and recovery of materials, in addition to waste reduction.

In this context, the question that arises is whether—considering cultural issues of consumption and production—public policies to encourage the circular economy should be adopted initially by municipalities, in order to cause a national impact that is in accordance with the principles of linear economy, making the change from local to global.

Thus, this article uses the deductive method, with a research technique based on bibliographical review and analysis of official documents, taking as a theoretical framework Valdemir Pires' theory of municipalism, which argues that municipalism must renew its theory to recognize the municipality as a true federative entity that coordinates its functions with other federative entities, besides having greater fiscal relevance.

The objectives of this research include identifying the main characteristics of the circular economy, investigating the challenges faced in its implementation in Brazil and how the 2010 *Política Nacional de Resíduos Sólidos* (PNRS – National Solid Waste Policy) has helped with these challenges, in addition to point out that the municipality, by means of public policies, is the major responsible for encouraging and developing strategies for the adoption of circular practices, contributing therefore to the advancement of environmental and economic sustainability, as well as to local development.

Based on a theoretical review of the circular economy and its impacts, one sought to base the analysis of the bibliographic data collected. The delimitation of the study focuses on the implementation of public policies at the municipal level, considering the importance of municipalities as key actors in this transition process in Brazil.

In the end, the objective is to demonstrate that public policies are the main instrument for initiating practical changes towards the circular economy and that, considering cultural issues of production and consumption, they have to occur at the municipal level. To achieve this objective, the municipality have to have more effective and increasing public financing to guarantee the effectiveness of the process towards zero waste.

1 Linear economy

The linear economy emerges in a society disconnected from natural cycles, bringing with it a preponderance of anthropocentrism, which objectifies nature

and separates human beings from it. This is due to the fact that humankind is considered the image and likeness of God, who gave this nature as a gift to be used by human beings and, therefore, they can do so infinitely, as it will never end. The paradigm of anthropocentrism arises when human beings see themselves as superior to nature, taking away its soul, and it is the result of the Newton-Descartes mentality of objectifying nature.

This mentality dominated humanity until the middle of the 20th century, when the Meadows Report, produced by the Massachusetts Institute of Technology at the request of the Club of Rome, demonstrated that this is not true and that the natural elements that provide resources for industry and human life are finite and difficult to regenerate. The publication of the Meadows Report stimulated social movements to protect nature, which eventually led to the creation of the 1972 Stockholm Convention, which brought the notion of the environment to the surface. Over time, the need to think about economic development that considered environmental protection as an important element arose, giving rise to the concept of sustainable development in the 1987 Brundtland Report. The indiscriminate and unconscious use of these natural resources can lead to the point of no return, that is, the moment when nature is no longer capable of regenerating itself and, as a result, resources become scarce or impossible to use.

Global industrialization, since its beginning, has been based on this logic of infinite resources, which prevents reflection on their exploitation and appropriate use, since one deduces, as a basic thought, that the elements of nature or natural resources are infinite. And, even if they were used and discarded, as they come from nature, they would be reintegrated into it, and this thought was the basis of the linear economy. If they are infinite, there is no concern about how or how much they are exploited, as long as this is done at the lowest possible economic cost, ignoring other costs. Thus, prices only reflect the costs associated with extraction, ignoring the value of natural resources and even the labor and its conditions involved in production (Miyashiro *et al.*, 2023).

Production must be low-cost, so that the consumption of new products are increasingly stimulated and consumers are encouraged to get rid of old products—even if they are still useful. It is necessary to remember, however, that this “throwing out” is just the removal of the item from the individual’s field of vision, as there is no “out” on the Planet. This waste will take up space and pollute if it is not disposed of properly or if it is not reused. Another important point about waste is that the people do not understand its synergistic impact, that is, they do not see the sum of the waste of all individuals. As highlighted by Silva and Godoy Júnior (2023, p. 12, free translation):

Each agent in the production and consumption cycle has its isolated action and, sometimes, little relationship with each other. The mass production model dematerializes and depersonifies the perception of production and its impacts on the part of those who consume and discard. People don't know where goods, materials, food (and so on) they consume come from to where they go. It is common for people to only have vision of their microsphere.

Thus, after the Industrial Revolution, with the concern to produce solely for economic profit, only consumption stands out and is visible, with the entire production chain being ignored, and the same happens with the product after it becomes waste, garbage. The linear economy emerged from this scenario and is based on the triad of extracting, producing, and discarding. In other words, nature raw materials are transformed into industrialized products, consumed, and then discarded. Although this economic model was successful for a certain period, as it provided products at affordable prices, there was a population increase and, as resources are finite, the scarcity of certain materials begins to be noticed due to the exacerbated and inefficient use of nature.

The harmful effects are also beginning to assume large proportions, such as pollution, loss of biodiversity and, most visible currently, climate change on a global scale, thus demonstrating that the linear economy can no longer be maintained, pointing out the urgent need to create a more sustainable economic system that takes care of future generations, especially as there is population growth that generates a constant increase in demand for energy and products and, ultimately, will lead to an increase in waste production, which causes a loss of energy in the natural system. This is because, once a resource is discarded, all the energy of that element is lost, unlike what would happen if it were used in a reuse or recycling process, maintaining Lavoisier's Law: "Nothing is lost, nothing is created, everything is transformed". According to Freitas (2023), more than R\$8 billion is lost every year in materials sent to illegal landfills. This demonstrates the urgent need to end this type of economy. Another important issue, according to the Brazilian National Confederation of Industry (CNI) (2018, p. 17), is that "this model has proven ineffective in facing the main challenges of contemporary society, including: reduction of poverty and social inequalities, climate change, water scarcity, loss of biodiversity and depletion of natural resources".

The linear economy moves away from the planet's natural cycle—process known as Cradle to Cradle. In this cycle there is no waste because the residue from one process is the raw material for another, which is the principle of the circular economy, bringing a new way of thinking about economic cycles in current industrial processes, based on the cycle of nature.

According to Fangueiro and Guimarães (2023), the circular economy theory was created by economists Pearce and Turner in 1989, based on 1966 studies by ecological economist Boulding, as an alternative to the current economy. The objective is to reduce the use and demand for extracting materials from the planet's finite environmental resources, as well as minimizing the amount of discarded products, that is, waste, establishing a renewable energy cycle.

Brazil is a large producer and exporter of raw materials, that is, natural resources, but the creation of public economic and social policies based on the circular economy will guarantee Brazilian industry an even larger market. Therefore, it would be at the global forefront, complying with national and international legislation to move to a more sustainable system, and complying with the precepts of treaties such as the Paris Agreement and the UN 2030 Agenda, in addition to several other international agreements, as well as environmental treaties and policies of input-importing countries, such as the European Union, in addition to ensuring its place among the most influential international economies, guaranteeing the supply of environmental resources for raw materials for longer and at a better price. According to Tavares *et al.* (2020 *apud* Silva; Ganga; Godinho Filho, 2023, p. 2, free translation),

[...] the linear economy model has proven to be unsustainable, as it is based on the theory that resources are inexhaustible, disregarding the degradation of nature and the growing accumulation of waste, which makes the change to a circular economy essential for a smart, sustainable, and inclusive economy.

The shift to the circular economy requires rethinking current ideas and knowledge, as well as creating new processes, new public social and development policies that encourage less use of natural resources and promote reduced use, recycling and total reuse of materials, in addition to the need to create educational policies to encourage consumers to adopt new consumption and disposal practices. This change in thinking requires time and investment, and it is impossible to achieve it in the same way and at the same time in all countries and regions worldwide, as changing the meaning of consumption takes time, producing new practices and knowledge. Furthermore, it is important to remember that there are several variables that distinguish consumer populations in the world and that the consumer is a key player in changing and leaving the linear economy behind. Even for companies, there is a need for organizational changes and supplier training. Therefore, changing from the linear economy to the circular economy is not simple and depends on three main economic actors: the industry, the consumer, and the State. One needs to provide a solution to today's most important

economic problem. How to grow infinitely and have unlimited demands with finite and limited natural resources? It is possible, but it depends on a change in the relationship between human beings and nature, as this issue is worsened by the increase in the world population, which puts increased pressure on this demand for the production and generation of unused waste, especially in large urban centers, which, according to Aguiar *et al.* (2023), are home to the majority of the world and Brazilian population.

2 Generation of urban solid waste and environmental impacts

USW, popularly known as garbage, is the waste that people produce in their homes (domestic) and that from urban cleaning, which is waste from sweeping streets and squares, unblocking and cleaning drains, landfills, stream banks, in short, of all public places. In addition to USW, there is waste coming from commerce and services, and from the following sectors: construction, health, industrial, mining, agroforestry, transport, and sanitation (sludge from sewage treatment plants and wastewater treatment).

The growing production of solid waste, especially USW, has transformed its management into one of the most important environmental problems today, mainly due to its inadequate disposal.

An example is the case of Brazil, where, despite high collection service rates—98% of the urban population and 92% of the total population (urban and rural)—around 40% of USW is still discarded in landfills at open sky, causing significant environmental impacts (SNIS, 2021).

According to research carried out by the *Associação Brasileira de Empresas de Limpeza Pública* (Abrelpe – Brazilian Association of Public Cleaning Companies), when analyzing data on the USW production in the country in the last decade, there was a considerable increase from 67 million tons in 2010 to 79 million tons in 2019. In this research, when considering the population at the beginning (2010) and at the end of the decade (2019), there was also an increase in per capita production, from 348 kg/year to 379 kg/year (Abrelpe, 2021).

Thus, each Brazilian, on average, produced 379 kg of waste in 2019, that is, 1,038 kg per day, around 10% more than the 0.95 kg/day in 2010, reflecting the increase in consumption in production of solid waste over time.

When analyzing consumerism and the production of USW in Brazil, researchers Godecke, Figueiredo and Naime (2012, p. 1704, free translation) comment:

The difficulty for people in changing their consumption patterns, among other factors, is causing irreversible environmental impacts. Suffice it to say that in the last 40 years the estimate is that the planet has lost 30% of its biodiversity, with the greatest impact in tropical countries, where the loss reached 60% of the original fauna and flora (WWF, 2010). In relation to USW, the extent of the impacts can be inferred from the production volumes, associated with the level of effectiveness of its management and the harm it can cause.

The USW composition varies according to habits, customs, income, climate, etc., but in different regions of developing countries USW is composed, for the most part, of organic origin. This organic fraction is formed from food preparation residues and leftovers, as well as vegetation pruning.

The organic fraction, being the most significant and unstable part, as it decomposes quickly, is the one that requires priority attention. The careless disposal of this material in vacant lots, on the banks of rivers and streams, and in open landfills has many negative impacts, as, in addition to causing soil and water contamination, constitutes foci for the proliferation of vectors that spread diseases such as leptospirosis, typhoid fever, bubonic plague, giardiasis, and filariasis, among others.

In Brazil, the organic fraction represents around 50% of the weight of USW collected. The average USW composition in Brazil is 45.3% of organic matter; 16.8% of plastic; 10.4% of paper and cardboard; 5.6% of textiles, leather, and rubber; 2.7% of glass; 2.3% of metals, and 14.1% of waste that is material, generally inert, with no known alternative for reuse, recycling, composting, or even energy use, such as dust, soil, ash, in addition to 1.4% of other unidentified waste (MMA, 2022). This has an impact on the environment, but also on human health.

The final USW disposal in landfill areas causes serious negative impacts, being an inadequate form of final disposal of solid waste, without any technical criteria, characterized by the discharge of waste directly onto the ground, without any prior treatment, putting the environment and public health at risk (Mendonça; Zang; Zang, 2017, p. 488, free translation).

At the end of its natural life cycle, organic matter, since it is living matter of plant or animal origin, goes through the putrefaction process, and through the action of bacteria and biochemical reactions decomposes until the mineralized matter stabilizes, releasing chemical substances as gases and liquids. These gases and liquids have significant polluting potential.

Many of the gases contribute to global warming, the main cause of climate change, with catastrophic effects, such as rising sea levels due to the melting of glaciers at the poles, and intensifying natural phenomena, as torrential rains that

cause floods and droughts that destroy crops, among other damages. Furthermore, they cause bad smell, which are carried by the winds, causing disturbances in neighborhoods.

The liquid formed during decomposition, called percolate or leachate, has a high polluting potential due to its ability to consume oxygen from surface waters, causing the death of fish and aquatic biota in general, as well as unpleasant odors.

The presence of packages, plastic, paper, cardboard, metals and glass, batteries, light bulbs, electronic devices, and other elements containing toxic substances in USW, in addition to increasing the volume and hindering the decomposition of the waste mass, makes the percolate more dangerous and can contaminate soil, water, vegetation, and fish. Besides, it contaminates other animals and humans through the food chain.

This shows that the linear economy is a problem that must be fought by the three main actors, as already mentioned, industry, consumer society, and the State. The State has an essential role in this matter, as it is the only holder of police power, that is, the power to impose changes through public policies and laws that oblige other actors and itself to adopt more appropriate environmental attitudes with regard to the current times.

Brazil is a federation, and the issue of solid waste is a concurrent and common competence, as established in arts. 23 and 24 of the 1988 Constitution (Brasil, 1988). It is up to all federated entities to monitor and contribute to waste reduction, reuse, and recycling, and enable the real insertion of the circular economy as a Brazilian public economic policy, essential to achieving the desired sustainable development and guaranteeing the intergenerational right to the environment.

3 The circular economy as a solution to waste

As its name suggests, the circular economy is a concept that occurs when a production process seeks greater circulation of materials and substances through the reuse or recycling of waste, resulting in economic development with less dependence on the use of natural resources. New product manufacturing depends less on virgin raw materials, and the priority is the material reuse and recycling. In this sense, it is clear that, to move forward, it is also necessary to redesign circular economy processes to optimize these materials. “Circular economy” (CE) is described as “moving away from our current linear economy (make-use-dispose) towards one where our products, and the materials they contain, are valued differently; creating a more robust economy in the process” (House of Commons, 2014).

Ribeiro and Kruglianskas (2014), when analyzing the possible benefits of the circular economy, point out the following benefits for the economy, companies, and consumers:

- **Benefits to the economy:** (i) reduction in raw material costs; (ii) reduction of market and material supply volatility risks; (iii) creation of new business opportunities and growth in the primary, secondary, and tertiary sectors; (iv) reduction of externalities, and (v) establishment of more resilient economic systems.
- **Benefits to consumers:** (i) improvement of product quality; (ii) reduction of planned obsolescence; (iii) greater choice, and (iv) secondary benefits, as new product features.
- **Benefit to companies:** (i) profit potential in new businesses, as reverse cycle activities; (ii) new forms of relationship with customers; (iii) opportunities in new business models, for example, re-manufacturing, reconditioning, etc.; (iv) new financing opportunities; (v) creation of resilience and competitive advantage; (vi) reduction of raw material costs and risks; (vii) direct gains from the recovery/recycling of previously discarded materials; (viii) reduced product complexity and more manageable life cycles, and (ix) encouraging innovation and eco-design.

It is worth noting that, according to the authors, the biggest beneficiary of a circular economy would be the business sector.

For Li (2012), the circular economy is a more sustainable economic growth model, based on the highest possible efficiency of reusing or recycling waste, which helps save natural resources, reduce pollution and the final waste disposal.

Thus, it is clear that, to migrate from a linear economy—whose product life cycle is analyzed in a conventional “cradle to grave” view—to a circular economy, it is necessary to consider the waste potential for reuse or recycling as raw material, replacing virgin raw materials, among others. It means moving to a more sustainable model called “cradle to cradle”, in which the materials and substances contained in waste begin to feed the beginning of a production process instead of being discarded.

Practicing Zero Waste means not to dispose of waste in landfills, but separate it for selective collection or reverse logistics, thus contributing to the circular economy.

Zero Waste is an ethical, economical, efficient, and visionary goal, aimed at guiding people in changing their sustainable lifestyles and practices to emulate natural cycles, where all discarded materials are designed to become resources for others to

use. Zero Waste means designing and managing products and processes to avoid and eliminate systematically the volume and toxicity of waste and materials, in addition to conserving and recovering all resources, and not to burn or bury them (Duarte, 2011, free translation).

Brazil's PNRS defines selective collection as the differentiated collection of solid waste previously selected from producing sources, to be sent for recycling, composting, reuse, treatment, and other alternative destinations, such as landfills, co-processing, and incineration (Brazil, 2010).

According to the Ministry of the Environment (MMA, 2022), in 2018, selective collection was already present in 1,322 Brazilian municipalities. However, these collections are still incipient, as they have only reached 3% of the existing potential for recyclable materials.

As for the organic fraction, it has to be composted to produce soil compost, and the packages have to be sent for selective collection or reverse logistics. Hazardous waste for treatment and landfills.

In Brazil, co-processing in cement kilns and incineration are still used for industrial waste and healthcare services, but they are still strongly discouraged for municipal solid waste.

The most recent Brazilian legislation already provides that by 2033 the USW collection will be mandatory in three fractions: recyclable, organic, and waste.

4 Solid waste in Brazil, the PNRS and the municipalities' role in the circular economy

In Brazil, solid waste policy remained under debate in the National Congress for around 20 years, due to the interests of different sectors of society. More than 80 bills, addressing different types of waste over time, ended up subsidizing a replacement that, when approved, resulted in Law no. 12.305, of August 2, 2010, known as the National Solid Waste Policy Law (PNRS).

Prevention and precaution, sustainable development, and the polluter-payer and protector-receiver principles are among the PRNS principles, important to achieve its objectives of protecting public health and environmental quality, with the service provision universalization. To this end, it established the Agenda 21's hierarchy of solid waste non-production, reduction, reuse, recycling, and treatment, as well as the environmentally appropriate final waste disposal.

It is also worth noting the objective, established in Art. 7, item XII, of the "integration of collectors of reusable and recyclable materials in actions that involve shared responsibility for the life cycle of products" (Brasil, 2010, free

translation), given the need to integrate the almost one million collectors in the country, originating a new circular economy.

The national, state, and municipal solid waste plans stand out. As instruments, which must cover all types of waste. Taking into account that there are 5,570 municipalities in the country and that the majority of them are small, the law encourages the development of intermunicipal, regional, and metropolitan plans, integrating the public service provision through consortia.

The PNRS uses a federal system of organization to implement its objectives. However, in its articles 10 and 18, the PNRS gives the municipality a greater responsibility for waste collection and disposal, as it is closest to society. But this perspective does not eliminate the states' and the Union's responsibility.

Despite Art. 6, Item VIII; Art. 7, Items II, III, and IV; and Art. 8, Items VIII and IX, dealing with points that address the circular economy, they do not oblige municipalities—or even other federated entities or social actors—to implement it, but rather to execute plans linked to waste collection and disposal. Therefore, it is the waste disposal perspective that has been used, rather than the actual implementation of a circular economy leading to zero or near-zero waste.

Another important point of the PNRS is the shared responsibility that appears in section II of the Law, establishing the precepts for the social actors' participation, especially companies and public authorities. The consumer society appears more like a spectator that has to only receive adequate environmental education, but without carrying out real democratic participation in waste reduction policies or even in circular economy policies, which, despite not being mentioned in the Law, are implicit in its Art. 3, Item VI, and Articles 7, 11, and 13.

The national plan contains general guidelines, objectives, and targets that must be detailed in state plans for their respective regions, and so on, down to the local level. Nevertheless, the responsibility for USW management lies with the municipal government. Management is defined as the solid waste collection, transportation, and final disposal. For other types of waste, the responsible party is the producer.

Citizens should dispose of their USW in the specified locations, on the specified days and at the specified times, in accordance with the municipal urban cleaning agency's regulations. From then on, the responsibility for the USW collection, transportation, and final disposal lies with the municipal public authority, which can carry it out directly or indirectly. Directly, through municipal bodies, such as companies, local authorities, secretariats, departments, etc., or, indirectly, through contracts, concessions, public-private partnerships, and so on.

For other types of waste, the responsible party is always the producer, and the municipal service, in the case of commerce and services, can assume this responsibility if the volumes and characteristics are similar to those of domestic waste, charging for the service. Thus, solid waste from small stores, grocery stores, offices, schools, etc., with the same characteristics as domestic waste, could be collected by the public cleaning service.

Therefore, the municipality is not obliged to take over the collection from companies and services that produce waste in large volumes, such as supermarkets and shopping centers, or hazardous waste, such as paint stores, construction materials stores, gas stations, and hospitals and medical clinics, among others. Even waste from municipal public health services have to have its own collection, transportation, and final disposal system.

However, it is always good to remember that monitoring compliance with legislation by public and private producers is the responsibility of public authorities at the three levels of federative entities in Brazil: municipalities, states, and the Union.

In Brazil, as mentioned previously, according to the National Sanitation Information System (SNIS), around 98% of the urban population and 92% of the total population (urban and rural) are provided with USW collection services (MMA, 2022). Therefore, the problem is not in collection coverage, but in final disposal. Furthermore, municipal public services are frequently collecting waste that is not within their competence, even worsening inappropriate disposal, subjecting themselves to administrative, civil, and criminal sanctions.

According to the Planares (the national solid waste plan), in 2018, three thousand municipalities (54%) still disposed of their USW in an environmentally inappropriate way, and the majority of which was in the Northeast Region (MMA, 2022).

Another instrument that deserves to be highlighted is reverse logistics, inspired by the extended producer responsibility provided for in Directive 2008/98/EC of the European Community on waste, amended by Directive 2018/851 of the European Parliament, of May 30, 2018.

Reverse logistics, introduced in Law no. 12.305/2010, according to its Art. 3, Item XII, is a

[...] instrument of economic and social development characterized by a set of actions, procedures and means designed to enable the collection and return of solid waste to the business sector, for reuse, in its cycle or in other production cycles, or other final destination environmentally appropriate (Brasil, 2010, free translation).

And it provides for the shared responsibility of manufacturers, importers, distributors, retailers, and consumers for the environmentally appropriate solid waste disposal. This first study presents one of the elements of the circular economy in Brazil, which is being created by PL 1874 of 2022, still being voted on in the Brazilian National Congress. The first is the obligation to implement a reverse logistics system (RLS) containing disposal points where consumers should dispose of their post-consumption waste. Furthermore, the RLS must provide for the collection and transportation of waste discarded at these points for environmentally correct disposal, preferably for reuse or recycling.

For reverse logistics (RL), the PNRS established, in art. 33, which post-consumption products would be subject to RL: pesticides and their packages; lubricating oils and their packages; tires; batteries; lamps, and waste from electrical and electronic equipment.

Paragraph 1 of art. 33 of the PNRS provided for the extension of the elements listed in the head provision through regulation,

Art. 33. Structuring and implementing reverse logistics systems, through the return of products after use by the consumer, independently of the public urban cleaning and solid waste management service, is the obligation of manufacturers, importers, distributors and traders of:

[...]

Paragraph 1 In accordance with the provisions of regulations or sectoral agreements and terms of commitment signed between the public authorities and the business sector, the systems provided for in the head provision will be extended to products sold in plastic, metallic or glass packages, and to other products and packages, considering, as a priority, the degree and extent of the impact on public health and the environment of the waste produced (Brasil, 2010, free translation).

This happened with the publication of Decree no. 7.404, of December 23, 2010, which regulated the PNRS and expanded the list, adding packages in general and medicines to the mandatory RL (Brasil, 2010).

According to art. 36, “Within the scope of shared responsibility for the product life cycle, it is the responsibility of the holder of public urban cleaning and solid waste management services, observing, if applicable, the municipal plan for integrated solid waste management: [...]” (Brasil, 2010).

It can be seen that the PNRS establishes shared responsibility with regard to the product life cycle, with the support from selective collection of recyclable materials and reverse logistics for post-consumption products, when all actors, manufacturers, distributors, retailers, and consumers have to contribute to a circular economy towards Zero Waste practices.

These precepts added to the PNRS seek to introduce into society a new way of thinking about the production and use of materials, which must take sustainability into account, since, as already mentioned, they are finite. Recycling and reuse are an important start to giving visibility to the circular economy, but it must move towards the other Rs already seen (reject, rethink, reduce, reuse, repair, renew, re-manufacture, recycle, and recover) so that production and consumption relations are changed to create a virtuous circle of use of environmental goods. Always remembering that, to make changes, it is necessary to forget what has already been learned and create new habits of consumption, use, and production of goods that are truly durable and, thus, see the economy from a new perspective. According to Abdalla and Sampaio (2018, p. 86, free translation), “the reuse of materials and better efficiency in recycling “garbage” [...] are even capable of moving the economy and generating less dependence on natural resources”, fulfilling, thus, the necessary and expected basis of sustainability today. However, without adequate public policies, it is difficult to implement the precepts of the circular economy, reason why the public authorities’ action is necessary, and, as the PNRS says, especially the municipality’s action.

The municipality is the federated entity that is closest to society and which, according to the law, has the obligation to manage waste and, although it is not clearly defined in the law, it should also be the main public authority to create circular economy policies, given that it makes no sense to adopt fair policies for proper disposal or even recycling and reuse alone. Circular economy public policies, as already seen, have to be applied from the conception of the product, through its production until the end of its useful life cycle. Therefore, it is necessary to think of a strategy that encompasses the entire process, while also being aligned with the local consumer culture, and this has to be part of a broader plan of action strategies to meet the circular economy principles.

The municipality should not assume this responsibility alone, but has to convene all interested parties, companies, consumers, and other state entities to create a strategy to establish the circular economy, thinking from the local to the global, although understanding that the global has an impact about the location. It is interesting to note that, according to CNI (2018), 76.4% of the country’s industries develop some element belonging to the circular economy, but 70% of companies have never heard of the topic, which shows the lack of dissemination of information about the topic and proves that there is a lack of policies that demonstrate and help develop circular economy strategies and provide opportunities for processes in this sense, demonstrating to companies that such strategies

can reduce costs, losses and waste. According to the CNI (2018), companies that comply with the circular economy principles have shown better economic performance, with profits of 36%, revenues 47% higher and profits 81% higher.

Furthermore, encouraging scientific research can innovate technologically commercial practices, leading to the much-desired circular economy, as material innovation is necessary to replace current materials and not to make the product more expensive, allowing for a more circular sector and, at the same time, advantageous for the actors, so that there is no resistance to change and better use of resources. This requires the participation, awareness, and commitment of central actors in the circular economy. According to Petrini, Domenico and Nascimento (2023, p. 5-6, free translation),

To obtain stakeholder involvement, there is a need to cover basic strategies, infrastructure, and incentive policies, so that interactions and exchanges can take place. These initiatives can support the involvement of people who practice the circular economy by offering participation opportunities, including for marginalized groups (Clube & Tennant, 2023), so that circularity would be rooted in solutions that are more capable of satisfying the individuals' needs.

In this way, more sustainable communities would be created, meeting human aspirations without reducing the product supply or impeding social, economic, and cultural access. Currently, in Brazil, there is a search for the implementation of sustainability and there is a lot of discussion about Environmental, Social, and Governance (ESG) criteria, but the effective practices of this policy that favors the circular economy are still timid. Vier *et al.* (2021) defend the need to change values and principles, but other authors analyzed by Santos (2023) believe that government intervention through more efficient public policies is important for the circular economy implementation. Silva (2021 *apud* Santos, 2023, p. 24) argues that

[...] the advancement of the Circular Economy in Brazil will be possible through the establishment of a set of public policies and the improvement of financing lines aimed at stimulating investments in innovation and new businesses, encouraging and promoting projects in areas such as basic sanitation and recycling.

According to the analysis by Santos (2023), in Brazil, there is a need for public participation in the form of drafting public policies as the main element for the circular economy implementation. As the municipality is the main actor proposed by the PNRS and the one closest to citizens, it must be the one that, when making local decisions, combats the linear economy and provides an instrument for achieving circular development. One should always have in mind that, currently,

the majority of the world and Brazilian population lives in urban centers, which, due to their own format and the growing urbanization trend, must be rethought of to implement the long-awaited sustainable development in urban development based on the precepts set out in the 2030 Agenda, but always taking local and culturally different priorities into account. Thus, among state actors, the municipality is currently the most likely to implement the circular economy as a public policy in Brazil. However, the municipalities find several problems in carrying out such an undertaking, and the first of them is the lack of financial resources, since they, despite receiving various obligations and responsibilities in the Brazilian federalist configuration, do not receive the necessary funds for the circular economy implementation. The distribution of resources must be rethought of, as it is impossible for the municipalities to implement education, innovation, and incentive policies without their own resources. One discusses whether the municipality should have a greater participation in the national budget and also control over federated entities and society to implement sustainability policies, especially the necessary adaptation to the circular economy.

Final considerations

Today's consumer society demands goods and services that increasingly encourage the exploitation of natural resources and the production of post-consumption waste, leading to environmental degradation throughout the product entire life cycle in a linear economy system.

In addition to awareness initiatives to change habits and attitudes towards consumption, in solidarity with current and future generations, the circular economy emerges as an important alternative for a more sustainable model of conscious consumption.

In the linear economy—which analyzes the life cycle according to the “cradle to grave” principle—extracted raw materials are transformed into products, consumed, and discarded as waste.

Zero waste is one the principles of the circular economy—which analyzes the life cycle according to the “from cradle to cradle” principle—and proposes reusing or recycling waste from consumer products as raw materials for the production of new products. Thus, it contributes to a more sustainable model by saving natural resources through reduction of the demand for virgin raw materials and by reducing environmental problems that arise from the waste disposal in landfills, most of the time still inappropriately.

In this sense, one emphasize the importance of selective collection and reverse logistics for the reuse and recycling of post-consumption products and the offer of collection in three stages (recyclables, organic fraction, and waste) for the composting of the organic fraction, resulting in strong incentives for the practice of zero waste for the circular economy.

Therefore, to strengthen the system, the suggestion is that the content and implementation of Brazilian legislation to stimulate the circular economy should be reinforced, establishing principles, objectives, and instruments to achieve the goals defines in Planares.

It is necessary to implement clearer public policies to stimulate the circular economy and raise awareness among the population of the importance of selective collection and reverse logistics for reusing and recycling post-consumption products and the anticipation of collection, in order to generate important incentives for the practice of zero waste for the circular economy, at the municipal level and other federation levels as well

In this context, the municipality is the most important state actor, as the text demonstrates, since it is in direct contact with society, which, as can be seen, has cultural habits of product consumption and production that impact the economy. Ignoring these facts ends up making practical changes unfeasible and, therefore, more general public policies would not have the necessary effect for the change towards the circular economy. The PNRS text demonstrates this fact by giving the municipality a prominent place in the solid waste reduction policy implementation.

The municipality is the entity closest to social reality and, therefore, have to be used as an effective instrument of change, but it makes no sense to grant legislative and executive powers and not to provide economic instruments of change, without which policies remain only on paper and cannot be implemented with the effectiveness expected by the international agreements and treaties signed by Brazil.

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