

INNOVATION IN WASTE MANAGEMENT AND ALTERNATIVES IN THE CIRCULAR ECONOMY: THE CASE OF THE RIO DE JANEIRO CITY GOVERNMENT WITH THE GREEN FACTORY

A INOVAÇÃO EM GESTÃO DE RESÍDUOS E ALTERNATIVAS EM ECONOMIA CIRCULAR: O CASO DA PREFEITURA CARIOCA COM A FÁBRICA VERDE

INNOVACIÓN EN LA GESTIÓN DE RESIDUOS Y ALTERNATIVAS EN LA ECONOMÍA CIRCULAR: EL CASO DE LA ALCALDÍA DE RÍO DE JANEIRO CON LA FÁBRICA VERDE



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ABSTRACT

Solid waste management gains a role of relevant importance in response to climate emergencies, the Circular Economy (CE) moves in this direction by presenting the selective collection of recyclable materials as an operational mechanism to reduce waste disposal in the environment. The Sustainability agenda involves the combination of technologies where CE, Solidarity Economy, Social Economy are addressed in this article in compliance with the National Solid Waste Policy and the municipality's Sustainable Urban Development Master Plan. This study raises the question: How can cities respond to demands for sustainable waste management? As a research objective: to present alternatives in circular economy for city management. At the end of the article, the case study of Fábrica Verde in the city of Rio de Janeiro is presented, which, in addition to being a school of sustainability and environmental preservation, provides training to collectors of recyclable materials and transforms them into environmental agents when acting. in reducing waste disposal in the environment.

Keywords: Circular Economy. Green Factory. Recycling. Solid Waste. Sustainability.

RESUMO

A gestão de resíduos sólidos ganha papel de relevante importância em resposta a emergências climáticas, a Economia Circular (EC) vêm nesta direção ao apresentar a coleta seletiva de materiais recicláveis como mecanismo operacional na redução do descarte de resíduos no meio ambiente. A agenda da Sustentabilidade envolve a combinação de tecnologias onde são abordados neste artigo a EC, Economia Solidária, Economia Social em atendimento a Política Nacional de Resíduos Sólidos e o Plano Diretor de Desenvolvimento Urbano Sustentável do município. Este estudo traz o questionamento: Como as cidades podem responder às demandas por gestão sustentável de resíduos? Já

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como objetivo de pesquisa: apresentar alternativas em economia circular para a gestão de cidades. Ao final do artigo é apresentado o estudo de caso da Fábrica Verde na cidade do Rio de Janeiro que além de ser uma escola de sustentabilidade e preservação do meio ambiente, traz a capacitação do catador de materiais recicláveis e o transforma em um agente ambiental ao atuar na redução do descarte de resíduos no meio ambiente.

Palavra-chave: Economia Circular. Fábrica Verde. Reciclagem. Resíduos Sólidos. Sustentabilidade.

RESUMEN

La gestión de residuos sólidos está adquiriendo una importancia significativa en respuesta a las emergencias climáticas. La Economía Circular (EC) avanza en esta dirección al presentar la recolección selectiva de materiales reciclables como un mecanismo operativo para reducir la disposición de residuos en el medio ambiente. La agenda de sostenibilidad implica la combinación de tecnologías, y este artículo aborda la EC, la Economía Solidaria y la Economía Social, de acuerdo con la Política Nacional de Residuos Sólidos y el Plan Director de Desarrollo Urbano Sostenible del municipio. Este estudio plantea la pregunta: ¿Cómo pueden las ciudades responder a las demandas de una gestión sostenible de residuos? El objetivo de la investigación es presentar alternativas de economía circular para la gestión urbana. Al final del artículo, se presenta el caso de estudio de la Fábrica Verde de Río de Janeiro, que, además de ser una escuela de sostenibilidad y preservación ambiental, capacita a recolectores de materiales reciclables y los transforma en agentes ambientales al trabajar para reducir la disposición de residuos en el medio ambiente.

Palabras clave: Economía Circular. Fábrica Verde. Reciclaje. Residuos Sólidos. Sostenibilidad.

1 INTRODUCTION

The pillars for sustainable development are built with economic development practices that involve society, the preservation of the environment and the intelligent and sustainable use of natural resources with a view to preserving future generations. Sustainable development develops in order to find economic, social and environmental viability (Peron, *et al.* (2022), p. 178).

In order to better respond to the challenges related to the preservation of natural resources, the recycling of materials signals social and economic benefits and preservation of the environment. Environmental preservation actions are necessary mechanisms to promote sustainable development.

The effective work developed by public managers in cities and municipalities with the selective collection of materials and the reuse of raw materials, prevents materials with high potential for reuse from being thrown into landfills (Peron, *et al.* (2022), p. 179).

1.1 RESEARCH PROBLEM

How can cities respond to demands for sustainable waste management?

1.2 OBJECTIVES

General:

Present alternatives in circular economy for city management

Specific:

- a) Describe the alternatives in Solid Waste Management
- b) Inform the proposal of Circular Economy in Waste Management
- c) Providing sustainable alternatives with the Solidarity Economy
- d) Justify the need for the participation of the Government in the existence of sustainable recycling initiatives.

2 MATERIALS AND METHODS

In the development of this study, bibliographic research was developed in important journals in the area of Sustainability and also the present study, has a qualitative bias by presenting the case study of the Green Factory in the city of Rio de Janeiro as a proposal for Circular Economy (CE) in the second largest metropolis in Brazil.

The EC proposal meets the determinations of the National Solid Waste Policy and meets the objectives of the Master Plan for Sustainable Urban Development of the municipality of Rio de Janeiro. And with the mission of collaborating with the improvement of

the selective collection management activity in the municipality, Fábrica Verde is created with this noble mission.

3 THEORETICAL FRAMEWORK

3.1 SOLID WASTE MANAGEMENT

Solid waste management in a city or municipality involves changing the behavior of society so that everyone is committed and involved with the separation of materials in their homes, schools, churches and also companies where it is possible to achieve economic, social and environmental development.

In a scenario of scarce resources and in the face of growing demand, there is a challenge for organizations, society and governments a new reality that is pointed out in the *triple bottom line report*. Also called the Tripod of sustainability, aiming at being economically, socially and environmentally viable (Menezes, *et al.* (2022), p. 3).

The solution comes from selective collection, according to Santiago, *et al.* (2021), p. 155, the feasibility of solid waste management represents selective collection. In order to avoid waste, it promotes social inclusion through the work of recyclable material collectors. Having a strong appeal in times of climate change and extreme weather events.

The return of raw materials involves reverse flows of packaging, repairs, recycling, cost reduction, and the contribution of new flows in the processes of acquisition, maintenance, disposal, and reuse of materials (Oliveira, *et al.* (2020), p. 5).

For Leite (2017), he highlights that the return of materials to the production cycle, being known as Reverse Logistics, brings economic revaluation, improvement in the provision of service to the customer, brings advantages to the construction and maintenance of a good corporate image, not to mention the benefits related to the environment.

Reverse Logistics is composed of logistics flows distributed by the reverse flows of materials, components, spare parts in order to reinsert materials in the consumer market (Oliveira, *et al.* (2020), p. 5).

The Reverse Logistics Flow considers the shared responsibility for the life cycle of the items. It includes information, post-sales, post-consumption and the return of the good through the distribution channels of Reverse Logistics (Leite, 2017).

The meaning of the National Solid Waste Policy – PNRS is directly related to Reverse Logistics and brings the need for environmental education policies, reuse of materials, correct disposal of items, helps the reverse flow of materials and contributes to sustainability being present in cities (Menezes, *et al.* (2022), p. 3).

The Solid Waste Law through the PNRS (Law 12.305/2010) defines economic and social development instruments by promoting the collection and return of solid waste to the business sector in ecopoints, disposal points, or collection points. Each organization uses a nomenclature that, in the end, represents the opportunity to dispose of the product or item in the right place at the end of its useful life. The organization then gives the correct destination (Santos, *et al.* (2023), p. 4).

An additional incentive to the PNRS, establishes the basic operational practice of Reverse Logistics in post-consumption actions (Oliveira, *et al.* (2020), p. 5).

Waste generation and population growth according to Santiago, *et al.* (2021), p.155. They bring significant volumes of solid waste, which in recent years has intensified. And the inefficient action of the public power, contribute to the effects of extreme climate actions.

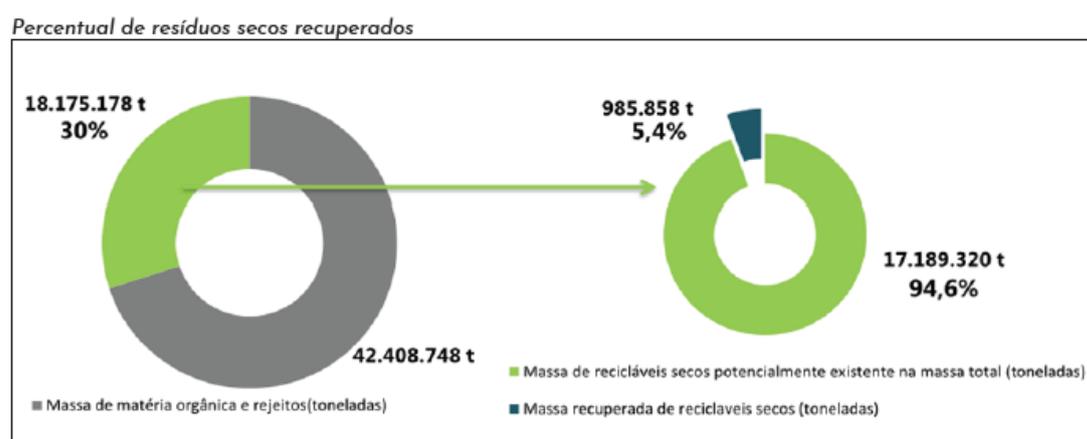
The Solid Waste Policy in its article 3, item XVII informs the shared responsibility for the life cycle of products and the due attributions to the manufacturer (Oliveira, *et al.* (2020), p. 5).

An ally to Reverse Logistics are the collectors, having a fundamental role in the reuse of items, facing a difficult relationship in the business relationship in the Reverse Logistics chain. Where the organization in cooperatives brings some representativeness to this professional (Oliveira, *et al.* (2020), p. 6).

Information plays a fundamental role in involving, raising awareness and encouraging the implementation of Reverse Logistics. And to contribute to the formation of selective collection in homes where it comes up against another obstacle, which are municipalities that do not have the offer of selective collection services (Santos, *et al.* (2023), p. 3).

In the consumer's view, their action of separating items and giving them the correct destination may seem tiny, but it is precisely this consumer who can change the reality in relation to the quantities that are recycled.

According to SINIS (National Sanitation Information System), in 2019 only 5% of solid waste is used in Brazil (Peron, *et al.* (2022), p. 182), see:

Figure 1*Dry waste recovered in Brazil*

Source: SINIS (2019).

Figure 01 highlights that of the waste produced in Brazil, 30% is solid waste and the remaining 70% is composed of organic matter and tailings and solid waste that would be able to be recycled, only 5.4% is reused and in this universe are included: plastic, glass, aluminum, cardboard, metals. Note that the need for actions is immediate, as 94.6% fail to receive the correct destination and are accumulated in landfills (Peron, *et al.* (2022), p. 183).

There is a crisis of civilization and environmental education represents the most promising proposal in modifying behaviors, bringing awareness and changes in habits in relation to the disposal of materials (Oliveira, *et al.* (2020), p. 3)

Added to habits that need to change, the partner and ally in the solid waste management process faces problems in sorting materials because they arrive in many cases, wrapped in food, dirty, where the materials could arrive separated and would greatly facilitate this process. The activities that make up the work process in the cooperatives are negotiation of recyclables, collection, weighing, sorting, shredding, pressing the material to facilitate transport to the industry, storing and transporting it to the next stage of the reverse channel that will transform the collected material (Oliveira, *et al.* (2020), p. 6).

3.2 CIRCULAR ECONOMY

The consumer society, very much inspired by the society of consumption of products and services, reflects social behavior where consumption is the maxim and what we actually buy is not always necessary for the development of life.

The growing production due to the consumerist society accelerates the production of waste, disposal, waste and also packaging. Such a model of production and consumption

reduces the production cycle time of waste, which results in volumes of natural resource spoils due to the exploitation of primary raw material (Santos, *et al.* (2023), p. 1).

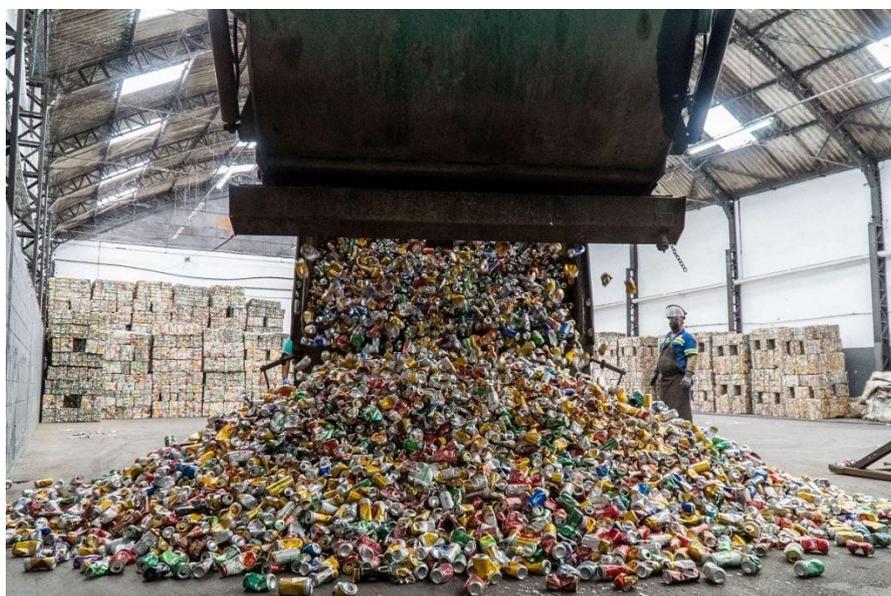
In view of the volume of waste produced by the current consumerist model of society, the exploitation of these wastes opens the way for the exploitation of secondary raw material (reuse). Which exists from the reuse of materials originated from selective collection. What is a problem for society (waste) can be a solution for the secondary material market.

The scraps of a clothing company are raw material for the manufacture of bedspreads, bags, cases, cases. The collection of batteries already used, the material that is part of its composition is dye for the ceramic industry, aluminum cans can become new packaging again.

The soda cans and aluminum pans that are no longer used can be melted and again be raw material for some type of aluminum material. This draws the circularity of this material and announces the Circular Economy (CE) market. It is worth mentioning that the recycling rates of cans in Brazil reach 99%,³ being the world record holder in the reverse logistics of aluminum cans.

Figure 2

Recycling aluminum cans



Source: Recicla Latas / CICLOVIVO, 2024

The Circular Economy gives life to the material that would otherwise be discarded and the Linear Economy (EL) is the traditional model that we already know when there is no selective collection and reuse of this resource (secondary matter). And the disposal is direct

³ <https://www.gov.br/pt-br/noticias/meio-ambiente-e-clima/2022/04/indice-de-reciclagem-de-latas-de-aluminio-chega-a-99-e-brasil-se-destaca-como-recordista-mundial>

in landfills, reducing natural resources every time the industry accesses the raw material from nature (primary material).

There is energy use in CE compared to Linear Economy. It is possible to understand that in addition to the motivation in Sustainability, there are reasons that can increase the organization's contribution margin as its business production cycle is replaced by cleaner production.

The value of garbage lies in observing the advantages to the environment in the selective collection of items being observed, reduction in the use of virgin raw material or also called primary, energy savings in the reprocessing of collected materials and the valorization of secondary raw material and other factors resulting from this process that are in the reduction and disposal of garbage in landfills and the recurrent damage of its activity (Oliveira, *et al.* (2020), p. 2)

For Santos, *et al.* (2023), p. 1, environmental laws, consumer awareness and climate change, competitive market, respond with the charge to comply with Environmental Legislation. This forces companies to develop and use greater environmental control and preservation, as non-compliance with this directly affects their image with the consuming public. Such a requirement also brings focus to its entire chain and suppliers so that it is not co-responsible.

The reduction of the depletion of natural resources has in EC a fundamental strategy in the protection of the environment and reduction of pollution. In a direct way, it proposes to separate economic development and deplete natural resources. Reducing pollution and preserving natural resources are the objectives of EC for future generations (Teixeira, *et al.* (2023), p. 3).

The keynote of comprehensive CE occurs when there is no waste in the production process of a good or that it is simply reduced. And in the consumption of this, recycling occurs. There is a reuse in both production and consumption.

The dynamics of the EC designs its production cycle from the reuse of tailings and at the end of the useful life of the good, a collection point, ecopoint or simply the general recycling absorbed by the industry is also defined, the production starting with secondary raw material. This circularity means that energy expenditure is lower and the preservation of natural resources is no longer just a story told, welcome to EC.

According to Oliveira, *et al.* (2020), p. 2. Environmental degradation is everyone's issue because it affects people's quality of life. Environmental degradation is a subject that interests everyone and not just environmentalists, because it affects everyone and how we relate to the common home. This is the new market.

The new market brings the environmental theme in products and services and such a theme is even a differential in how the market relates to its audience by informing sustainable products, the requirement is to go beyond sustainability reports to investors. Which opens up a new competitive market inspired by EC.

Recyclable materials represent an available market, they represent a resource that does not make natural extraction being a secondary raw material. Which requires the transformation of this material and is available at low cost (Oliveira, *et al.* (2020), p. 2).

The potential of business models aimed at CE brings great opportunity in reducing energy consumption, generating value, creating new production cycles in a more economical way, reusing materials. New indicators, product design (*Eco Design*) and creation of new services (*Eco Innovation* and *Open Innovation*). Where just thinking about it leads us to question why we don't dive into this new market once and for all? The start was given to entrepreneurship with a focus on CE (Teixeira, *et al.* (2023), p. 2).

The 3 Rs are the pillars of the EC that are Reduce, Reuse and Recycle in this way the new productive market operates (Teixeira, *et al.* (2023), p. 4). Observe the following table:

Table 1

Pillars of the Circular Economy

REDUCE
It reduces the consumption of primary energy and raw materials, curbs waste and brings increased production efficiency, making production processes optimized.
REUSE
It is the reuse of products or components of the same, even if recovered and that are not waste and can be used in their initial purpose efficiently.
RECYCLE
It is the process of recovering waste and materials after consumption, bringing limits to waste that was previously wasted in nature.

Source: adapted from Teixeira, *et al.* (2023)

Added to the EC comes to thicken the "broth" of the new market, the Creative Economy, which according to SEBRAE (2004), ⁴means all kinds of knowledge, creativity, intellectual capital, expertise, applied in the generation of employment and income in areas of the traditional economy in its applications in industry, agriculture and commerce where the greatest emphasis is on the creative potential of people, groups or associations in the production of creative goods and services.

According to Silva, *et al.* (2024), p. 5. In the application of EC, we can bring examples such as oil burned from restaurants and waste accumulated in homes, once collected and

⁴https://sebrae.com.br/sites/PortalSebrae/artigos/o-que-e-economia-criativa_3fbb5edae79e6410VgnVCM2000003c74010aRCRD#:~:text=Economia%20Criativa%20C3%A9%20Um%20termo,gera%C3%A7%C3%A3o%20de%20trabalho%20e%20renda.

processed, can be transformed into neutral soap. The banana peel waste that can be used in the production of cake. The use of natural cosmetics in the production of soap, therapies, use of herbs and roots for the production of teas, for various treatments. This highlights the concern with the preservation of areas covered by forests and preservation of the balance of fauna and flora.

The breadth of the Creative Economy translates activities in which its processes, products and services are inspired by local culture, everyday knowledge, skills taught by generations that impact the economy, cultural preservation, affect society by mobilizing territories. That preserve the local culture and interrupt the economic model of linear production for a sustainable model by reducing environmental risk and valuing the well-being of local society (Silva, *et al.* (2024), p. 5).

The Creative Economy represents an alternative for developing countries and in this case Brazil can be a leader in Latin America by combining the growth of the international market, job and income generation in a difficult scenario. Creativity, technical knowledge, scientific research, economic and cultural development weave the fabric of sustainability (Silva, *et al.* (2024), p. 2).

The EC represents business models and production system focused on sustainability that makes use of resources in a more intelligent and efficient way and with controlled impacts on the environment in response to the unsustainable model of the consumer society (Teixeira, *et al.* (2023), p. 4).

The transition from EL to CE as an essential factor in the promotion of the new market, goes through the transition from the traditional model of consumption and production where it requires the scientific community to stimulate and encourage innovation and sustainable attitudes through the Creative Economy.

The construction of a new market requires deepening organizational values in a sustainable way, even if this requires the consumer to stop comparing brand A, B or C due to the choice of brands that deliver sustainable goods. There is a factor of awareness and technical adaptation to make this transition feasible (Barboza, *et al.* (2022), p. 1).

For Barboza, *et al.* (2022), p. 2. The construction of the new consumer market brings the concept of economic development based on greater efficiency in the use and management of recyclable resources without forgetting the environmental impact, inclusion and well-being of society.

Setting Sustainability goals are necessary to transition to the Sustainable market and as a competitive strategy, organizations must adapt their business model and operational plan to CE concepts. Sustainable entrepreneurship can help managers of organizations

achieve sustainable values and practices in their business production cycle (Teixeira, *et al.* (2023), p. 3).

The change in the organization's values can influence its Strategic Planning. With this, they create the ideal environment that is conducive to the construction of operational objectives in the implementation of goals aimed at sustainable practice. You can see that it is a whole process of convincing and clarifying.

3.3 SOLIDARITY ECONOMY

The professional activity performed by the individual has an important and highly relevant role because it is his source of survival, allows his participation and insertion in his society and enables the achievement of his goals. In this context, the activity developed for survival finds in Social Entrepreneurship (SS) strength, expression and existence.

HE and survival are responses to the difficulty of most Brazilians in reaching the formal labor market, where in search of ensuring survival, many work informally. In view of this reality, HE proves to be an alternative to confront poverty, social inequality, and the emancipation of people (Pereira & Cosenza (2023), p. 2).

The development of Public Policies occurs in a fundamental way to insert informal workers in a system of organization and education where the excluded population, organized in cooperatives, can experience a new relationship with society (Pereira & Cosenza (2023), p. 4).

According to data from SEBRAE (2004),⁵ the Solidarity Economy is supported by principles that escape the logic of consumption and concentration of wealth in the hands of a few people to operate in a logic that benefits the common interest of the people, group or society that makes up the community. See the table below:

Table 2

Principles of Solidarity Economy

Aspects:	Features
Collegiate	Decisions are made jointly
Cooperation	Joining forces to achieve the common good
Solidarity	Union of interests and purposes
Focus on the human being	Interest in the human being and the common good
Diversity	Cultural, religious, ethnic, gender and others.
Local look and learning	Value of knowledge acquired from generations.
Protection	Balance of the parts
Preservation	Environmental preservation and recovery

Source: adapted from SEBRAE, 2024.

⁵ <https://sebrae.com.br/sites/PortalSebrae/artigos/conheca-a-economia-solidaria-que-incentiva-producao-socialmente-justa,2a47bc9ee5826810VgnVCM100001b00320aRCRD>

In the Solidarity Economy system, areas of situation such as recycling cooperatives, communities that integrate family farming, cooperatives with small and medium-sized organic producers, fishermen's cooperatives in a region, and credit cooperatives are exemplified. Examples of this activity are (SEBRAE, 2024).

The logic of CE and the Solidarity Economy establish a direct relationship with the principles of sustainable development and directly meet the proposal of the Sustainable Development Goals (SDGs), established by the United Nations – UN (Barboza, *et al.* (2022), p. 2).

The Circular Economy and the Solidarity Economy weave the fabric that forms the fabric of the Economy of Good. Where the long-term vision creates sustainable values that encompass types of business based on the common good of the people in their territory.

The social vulnerability of recyclable material collectors, they experience social exclusion, hunger, unhealthy housing, experience social hostility, are mistaken for beggars. They constitute a group that, even organized by cooperatives, experience difficulties and once the Government extends a hand, they can bring value to their activity (Oliveira, *et al.* (2020), p. 6).

Actions of the Government in collectors' cooperatives, contribute to the Circular Economy by structuring, training, presenting facilitated credit for the acquisition of equipment, legalization and incentives for the development of their activity, contribute to Sustainability because their end activity is the Circular Economy. The circular economy is an alternative to the linear production model (Teixeira, *et al.* (2023), p. 3).

The organization of cities and municipalities can reinvent themselves for the implementation of the Circular Economy by creating conditions for the practice of Sustainable Management, such as influencing equipment that works with the Sustainable logic, how to encourage the opening of Recycling Cooperatives, train social entrepreneurs, sustainability managers, selective collection in the neighborhood, through the Master Plan for Sustainable Urban Development and the service to National Solid Waste Policy.

The implementation of innovation in CE in the businesses present in a territory requires a transformation process that must include awareness, training, organizational redesign, technologies, culture, and willingness to do. It is perceived that for the development of businesses inserted in Solidarity Economy, CE, Sustainable society, managers must radically reinvent their business conception, processes and mentality, coming to internalize concepts and business models based on circularity and sustainability (Barboza, *et al.* (2022), p.2).

The recognition of the variety of strategies and possibilities in Social Entrepreneurship brings a great diversity of enterprises allied to the Solidarity Economy in the fight against poverty and social inequalities (Pereira & Cosenza (2023), p. 7).

3.4 PARTICIPATION OF THE PUBLIC AUTHORITIES

Social Entrepreneurship brings an alternative to generate work and income, benefiting populations in situations of exclusion and exposure to vulnerability (Pereira and Cosenza (2023), p. 7).

For a better understanding of the possibilities and power of action of the Government with a view to Social Entrepreneurship in the performance in territories, the authors of this study propose the strategy of approximation, analysis and action with the Diagnosis, Development and Management (DDG) method presented in the following table:

Table 3

DDG Strategy

Step 1 - Diagnosis and evaluation of possibilities
Identify areas in the territory with potential for the formation of recycling cooperatives and groups interested in participating in the cooperative.
Step 2 - People and process development
Training, development of people and guidance in the handling of equipment and in the design of processes.
Step 3 - Incubation management
Entrepreneurial training in management, operations and development of indicators and communication, dialogue and negotiation with stakeholders.

Source: authors, 2024

Stage 1 is where the Diagnosis and evaluation of possibilities takes place, bringing to the public manager the look at the city and identifying places and groups interested in participating in the incubation of a recycling cooperative. Such a look allows us to perceive the potential of the region in the implementation of Circular Economy and Solidarity Economy actions.

In the second stage, it is where there is the Development of people and processes, with the group selected and with the equipment assembled (Recycling Center) it is time to develop a training process and development of the skills necessary for the operation of the Recycling Center.

And in the last stage, the incubation management begins, they are trained in the processes necessary for Collective Management, where skills are developed in the identification of partners, financial management, study of materials and recycling potential, development of financing projects for entrepreneurs.

In step 3, skills for managing a Recycling Cooperative are trained. Skills are developed for the analysis of economic viability and business potential in Circular Economy in a language that is accessible to the cooperative, remembering that these are people who mostly did not have the opportunity to advance in elementary school.

The formation of partnerships is fundamental for Sustainability projects at EC. Therefore, identifying condominiums, churches, industries, institutions with the potential to supply materials for selective collection, allows for greater volume and productivity of the recycling cooperative, which results in a reduction in the disposal of materials in nature and foreign exchange for the cooperatives (Teixeira, *et al.* (2023), p. 10 and 11).

According to Santiago, *et al.* (2021), p. 159, describes the initiative in the São Carlos region of São Paulo to articulate the network of supporters of selective collection that culminated in the creation of the Community Garbage Forum that evolved years later in the creation of the Community Forum on Solid Waste of São Carlos that operates to date. Being a place for debate, ideas and innovation in the operationalization of sustainable practices in Circular Economy, Social Economy and Solidarity Economy.

An example of a benchmark for city halls and state governments for the implementation of cooperatives represents the case of the city of São Carlos with the support network that resulted in the Community Forum on Solid Waste of São Carlos, developed in 4 stages, as follows: (Santiago, *et al.* (2021), p. 159 - 168:

Table 4

Synergy of the Community Forum on Solid Waste of São Carlos - SP

Scenario 1 – Creation and Implementation of the Community Garbage Forum
Under the leadership of the Municipal Executive, civil society actors discuss actions in defense of solid waste management, propose solutions from a social and technical point of view. The forum's agenda was solid waste management aimed at reducing waste generation and recycling of materials.
Scenario 2 – Unification of Cooperatives of Waste Pickers
Promotion of the unification of cooperatives where it enabled the expansion of selective collection, improvement in the remuneration of cooperatives, feasibility in the acquisition of equipment and resources for the modernization of the cooperative. Expansion of selective collection in the municipality.
Scenario 3 – Formation of a support group for COOPERVIDA
Expansion of the cooperative's governance structure and supporters, by bringing better operability and guarantee of resources and operation.
Scenario 4 – Creation of the São Carlos Solid Waste Community Forum
Consolidation of the long-term project for solid waste management that came to guarantee and modernize the cooperative in favor of the National Solid Waste Policy.

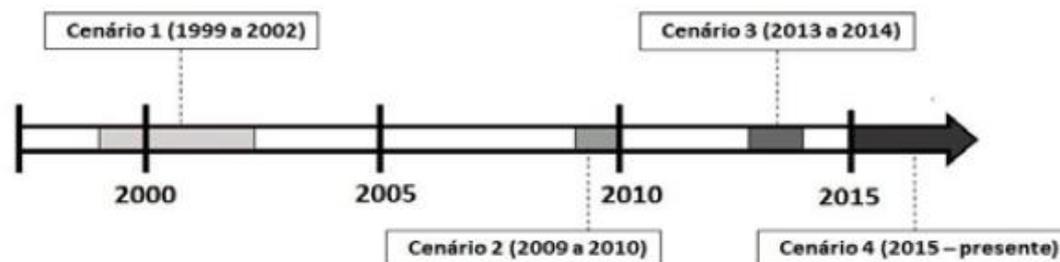
Source: adapted from Santiago, *et al.* (2021).

Throughout each stage presented in the previous table, it is clear that a Public Policy with results involves the participation of society in an organized way, solutions are built that modernize and improve Circular Economy operating equipment.

In the following timeline, the evolution of the scenarios presented in table 04 will be presented. Where it is verified that the sustainability of environmental preservation and social welfare projects are matured and improved over time. See:

Figure 3

Formation of scenarios - Community Forum on Solid Waste



Source: adapted from Santiago, et al. (2021), p. 166.

The consolidation of CE, Social Economy and Solidarity Economy strategies requires the involvement of society, universities, and the business environment where each one collaborates for the preservation of the common home. Conscious consumption, selective collection, environmental education, waste reduction, composting done in homes for home gardens and the generation of work and income are the result of the process of awareness about Sustainability (Oliveira, *et al.* (2020), p. 2).

The formation of networks indicates the possibility of enhancing actions and works as an instrument for understanding the relations of the Government with the occupied territory. An example of this was previously presented with the Community Forum on Solid Waste of São Carlos - SP (Santiago, *et al.* (2021), p. 156).

According to Santiago, *et al.* (2021), p. 156 and 157 the contribution to the formation of networks in the context of solid waste, CE, Social Economy and Solidarity Economy in the field of Social Sciences are conditioned by cultural, political, social factors, values, orality, learning passed from generation to generation that have considerable importance and relevance to be understood and respected.

3.5 THE CASE STUDY: GREEN FACTORY

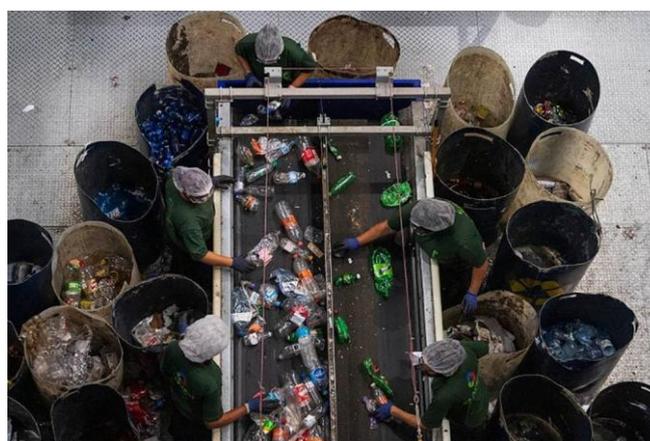
Inaugurated in April (04/03/2024) the Green Factory in the Cordovil neighborhood in the North Zone of Rio de Janeiro on the banks of Avenida Brasil, an important route for the flow of production in the city.

The space will be used to sort recyclable materials and from these, it will produce tiles, soap, secondary raw material and training is offered at the factory for selective collection.

Figure 4*Green Factory – Cordovil – Avenida Brasil*

Source: CICLOVIVO, 2024

The Cooperatives occupy an intermediate position in the recycling production chain and operate in the purchase and sale of recyclables in general, develop activities of collection, weighing, sorting, shredding, pressing and transportation. Since screening is the most delicate point of the process (Oliveira, *et al.* (2020), p. 6). And in these stages at the Green Factory, the recyclable collectors will be trained.

Figure 5*Workers in the sorting of recyclables*

Source: eureciclo and Flacipel / CicloVivo (2024).

Fábrica Verde fulfills the mission of increasing the volume of waste recycling in the city of Rio de Janeiro and promoting the social and economic inclusion of waste pickers through EC.

Each collector who works in the project will receive a scholarship and also a commission for the recycled material at the Factory, which will have an incentive to allocate

material, in addition to logistical support and the sale of these materials that will be sold on the sales platform: Compre.Rio of the city of Rio de Janeiro. See below:

Figure 6

Compre.Rio Platform



Source: CICLOVIVO, 2024

The operating logic of Fábrica Verde is to be a training and training center in CE, Social Economy, Creative Economy and Solidarity Economy with the aim of transforming the municipality into a reference in Sustainability and care for the environment. Transform the collector of recycling items into an environmental agent by reducing the disposal of waste in the environment, which brings a new look to this activity by resignifying and valuing the activity of this worker.

The dynamics of the process of social transformation through CE promotes new nuances in the social behavior of individuals in their municipality by fostering the practice of care for the "common home", I remember a situation of family dialogue that involved my mother, me and my nephew. And in this conversation the subject was the disposal of an old cell phone that my nephew Breno no longer used and was taking up space in the kitchen cabinet and the detail: the device already had a swollen battery. My mother asked him if it wasn't better to throw it in the trash and he agreed, that's when the seed of CE sprouted. I explained the importance of proper disposal in an "ecopoint" or deliver it to the store where he purchased the device, finally he took the cell phone to work, because there in the company, he has an electronic/technological waste disposal system that he did not even remember and the dialogue we had, awakened the memory of the recycling project in the company he works for.

Figure 7

Cooperatives and their impact on the environment



Source: PepsiCo/ CicloVivo (2024).

The factory occupies 6000 m², located on Avenida Brasil with BRT in front and easy connection with other important roads such as Linha Vermelha, Washington Luiz and Linha Vermelha.

In addition to recycling training at the factory, there will be training projects for 1500 people annually. The experience is already under observation by the Secretary General of the Presidency of the Republic so that the experience in case of success can be expanded in the rest of the country, according to a report by Minister Márcio Macedo.

Figure 8

Authorities inaugurate the Green Factory



Source: Beth Santos / Rio City Hall / Plurale website (2024).

The Fábrica Verde was inaugurated by the Mayor of Rio, Eduardo Paes (center), along with Minister Márcio Macêdo (in suit) and the Secretary of Environment and Climate

at the time, Tainá de Paula (on the right). This demonstrates the need to integrate powers into solutions for the environment.

Fábrica Verde was born with the proposal of being a factory/training school in Creative Economy where, from the waste processed in the factory, it is transformed into products with added value and functionalities in the utilities market. The proposal is to be an Innovation Factory with Sustainable Products (FIPS) based on recycling.

Figure 9

Long Life Packaging Plates



Source: CicloVivo (2024).

Among the applications of a FIPS, it allows the application of technologies in Clean Development Mechanisms – CDM, where it is a polluter in one segment and makes raw material for another, see the following table:

Table 5

Processing of processed waste

Product:	Residue:	Items developed:
Textile	Scraps	Clothes, Cases, Bags, Cases
Residential oil	burnt oil	soap, cosmetics, biodiesel

Source: author, 2024

In addition to being a solution for the reduction and disposal of waste in the environment, CDM applications promote sustainable products. This inaugurates a new consumer market that deserves to be highlighted by announcing the need for creativity and innovation in the area of Sustainability and Brazil can occupy a prominent position in this market, given the strength and strength of entrepreneurship in Brazil.

Figure 10*Long Life Packaging Plates*

Source: CicloVivo (2024).

The production capacity of the Green Factory in this first phase is prepared to process for operation in various products of the recycling production chain, as can be seen in the following table:

Table 6*Production Plan*

Product	Production	Jobs	Billing
Screening	≥ 300 t. recycled material/m	32	Not informed
Textile	9000 blankets and 4000 garments/m.	42	R\$ 204 thousand/m
Vegetable oil	≥ 2000 kg of soap and soaps/m. And thus avoid contaminating something close to 150 million liters of water.	12	R\$ 15 thousand/m
Long life packing	≥ 6000 eco-friendly tiles/m	12	R\$ 480,000/ m
Electronic	Refurbishment of 50 computers/m	20	R\$ 80,000/ m
Coconut	Processing of 80,000 kg/m, production of 50,000 kg/m of fiber and pallets for green fuel.	12	R\$ 80,000/ m

Source: adapted from Rio de Janeiro City Hall (2024).

4 CONCLUSION

Throughout this study, it was understood that solid waste management requires a work of awareness of the population regarding the separation and disposal of waste.

Everyone should be involved with the separation of materials in their homes, schools, churches and also companies where it is possible to achieve economic, social and environmental development. The government has the responsibility to create the foundations for the development of sustainable businesses and encourage the Circular Economy in the municipality.

Reverse Logistics, through the selective collection of materials, represents the essential mechanism to change the data of the National Sanitation Information System (SINIS), which points out that only 5.4% of solid waste is used in Brazil. Climate emergencies are a response to the existing consumption model in Brazil and the environment demonstrates the exhaustion of the current business production cycle.

The comprehensive Circular Economy (CE) occurs by reducing the amount of waste in the production process and introducing the reuse of materials throughout the consumption cycle of the good.

The Solid Waste Law through the PNRS (Law 12.305/2010) recommends that States and Municipalities should develop instruments that reduce the disposal of waste in nature and in the valorization of the Solidarity Economy by preserving local culture, values and traditions.

The Government must act in order to foster and encourage the creation and operation of businesses with the purpose inspired by the Circular Economy. Organizations, through process innovation, must rethink the way they operate and the life cycle of the products they manufacture and sell, as more and more laws and market pressure will require sustainable products and services.

The Green Factory was inaugurated in the North Zone of Rio de Janeiro and brings the proposal to train, qualify and develop cooperatives of recycled materials to operate in the Circular Economy. And thus, reduce the disposal in landfills of items with recyclable capacity.

Of the various materials that the factory will process, plastics, oil, technological waste, among others with high potential for added value, stand out. It is, therefore, the challenge to make the second largest capital in the country a reference city in Sustainability and care for the environment.

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