

**IMPLEMENTATION AND ASSOCIATION OF
THE CIRCULAR ECONOMY IN THE
MANAGEMENT OF SOLID WASTES IN
RESENDE: STUDY OF MUNICIPAL PRACTICES
SEEKING INTEGRATION BETWEEN
PROCESSES OF SELECTIVE COLLECTION
AND CIRCULARITY**

**IMPLEMENTAÇÃO E ASSOCIAÇÃO DA
ECONOMIA CIRCULAR NA GESTÃO DE
RESÍDUOS SÓLIDOS EM RESENDE: ESTUDO
DE PRÁTICAS DO MUNÍCIPIO BUSCANDO A
INTEGRAÇÃO ENTRE PROCESSOS DE
COLETA SELETIVA E CIRCULARIDADE**

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Abstract The unregulated extraction, too much linear production and excess waste disposed of in the environment cause various damages both in the present and in the future of the population and directly affects its quality of life. This article aims to define and expose circular ideas, its thesis, applications, defend its importance, in addition to aligning these points with a possible implementation of the theme in the municipality of Resende/RJ - a city with about 132.3 thousand inhabitants, potential productive capacity and generates numerous wastes, requiring a proper management of these. The solutions available through the circular economy brings options for reuse and reintegration of this wastes and seeks ways to assist the process, either in the promotion of circular actions or mass awareness of the population on a subject of extreme importance and necessary to the environment.

Keywords Circularity; Environment; Waste; Reuse; Sustainability.

Resumo A extração desregulada, produção linear demasiada e excesso de resíduos dispensados no meio ambiente causam diversos danos tanto no presente quanto no futuro da população e afeta diretamente em sua qualidade de vida. O presente artigo visa definir e expor ideias circulares, suas teses, aplicações, defender sua importância, além de alinhar estes pontos à uma possível implementação do tema no município de Resende/RJ - cidade que conta com cerca de 132,3 mil habitantes, potencial capacidade produtiva e gera inúmeros resíduos, sendo necessária uma correta gestão destes. As soluções disponíveis através da economia circular traz opções de reutilização e reintegração desses resíduos e busca formas de auxiliar o processo, seja na promoção de ações circulares ou conscientização em massa da população sobre um tema de extrema importância e necessário ao meio.

Palavras-chave Circularidade; Meio Ambiente; Resíduos; Reutilização; Sustentabilidade



1 INTRODUCTION

The concept of waste does not exist in nature and the unregulated extraction of resources in which nature cannot regenerate in the same proportion plus the accelerated disposal of waste causes various consequences to the environment we live in such as: pollution, climate change, loss of biodiversity, concentration of wealth and hunger and a situation of resource depletion, and what is most worrying is that the current society is still heading towards this future.

The current society is governed by a model of production, consumption and disposal called by experts as linear economy: form of economic organization that consists of extraction of raw materials, transformation of this, minimal use and disposal of waste as waste. The linear economy influences the business model and affects the way people produce, think and is what shapes people as a society, generating major impacts on the environment.

The circular economy is a model that runs counter to the current one and seeks to act according to nature, doing what it does, using it as a master in the process and not as something to be dominated. Thus, this paper's overall objective is to study ways to implement changes in the recycling systems of the city of Resende - which has a high rate of waste generation and disposal - in search of an integration between production processes and sustainability, identifying challenges and opportunities through practices based on the Circular Economy.

Among the specific objectives that will be addressed in this article are the identification of waste management systems in the city of Resende; the encouragement of sustainable socio-economic development; analysis of the biggest challenges in the implementation of a production model based on circularity and identification of factors that facilitate and collaborate in the implementation of production systems using the Circular Economy as a basis and objectives whose focus is on sustainable development.

Thus, this paper seeks to define and list the major challenges and difficulties for the effective implementation of circular economy practices in the municipality of Resende. This is done by surveying and collecting specific data such as what are the city's recycling habits, what is the degree of support from public bodies, in addition to mapping practices, projects and areas of knowledge on the topic in the city in question aiming at an integration between production and sustainability.

The environment urgently needs effective methods and applications that help in its regeneration before the resources are exhausted once and for all. Nature is a medium common to all and the growing unregulated extraction and incorrect disposal makes it move towards a scarce

future. It is forgotten that resources are finite, besides the logic of linear economy only degrades the environment in which we live, interfering in various factors that cause external damage.

2 THE LINEAR ECONOMY AND THE TRANSITION TO THE CIRCULAR ECONOMY

Linearity is more comprehensive than production itself, defining itself as an ideology, since it is an economic and mental model that conditions several daily practices in society. Since the beginning of industrialisation, according to the demand and the increase in population at an increasingly intense pace, a fast model was chosen, which intensifies extraction, and makes us need more resources than the planet would be able to offer, support and regenerate.

One of the major consequences of the linear economy model, as far as mental thinking is concerned, is the fact that planet Earth is seen as an infinite stock of resources and that what is extracted does not return to the chain as something of value but as waste in the form of rubbish that is not reused.

Sustainable production and consumption highlight the importance of efficient natural resource management to redefine the development process towards sustainability. From this perspective, the circular economy is allied with other green economies, such as the low carbon and bioeconomy, to face the challenges imposed on humanity by the various environmental crises. Many developed and developing countries have already been promoting concrete actions around the circular economy, such as the G7 and G20 groups of countries, the European Union, organisations such as the Organisation for Economic Cooperation and Development, the World Bank, and the Inter-American Development Bank, among others.

Regarding the impact of economic activities on the environment, a paradigm shift is required in the production and consumption mode, and for this to occur, a separation is required between economic growth and consumption of natural resources associated with the environmental impacts generated. An efficient management of natural resources guided by this separation demonstrates how new production and consumption behaviours aligned to an aligned economy strategy determines the strategic nature of the circular economy or circularity in the new viability paths towards an inclusive and sustainable development.

The circular economy acts through innovation and design. It replaces the end-of-life concept with the concept of restoration, exchanges fossil energy for renewable energy, eliminates the use of toxic chemicals that hinder material reuse, and aims to eliminate waste through a new design of materials, products, and systems and, from this perspective, builds new business models. Such models seek to keep natural resources in the economy for as long as possible, maintaining their

economic value and technical properties (NCM, 2015) (DUBEUX and CAMPOS, 2020).

Given the new relationship between man and nature and the growing concern of some consumers with the environment, the current modes of production and consumption guided by linearity in Brazil must be rethought in light of the challenges imposed by the various environmental problems faced. We must know how to face the challenges based on conservation and not destruction, restore damaged ecosystems and use resources in an increasingly lean and conscientious manner.

These aspects are important, revolutionary, and can generate great business opportunities for Brazil if combined with a good economic management that manages to plan beyond the generation of money, but also from where what is being sold is being extracted and the observation of the process from its beginning. One of the challenges for the effective implementation of the circular economy lies in making this connection between conscious production and value generation for the products in the chain, thinking about their value and usefulness even before they start being produced.

3 THE CIRCULAR ECONOMY IN PRODUCTION MANAGEMENT ALIGNED TO THE SUSTAINABILITY ENGINEERING ÁREA

Brazil is a country that produces on a large scale, and therefore the extraction and generation of waste that is disposed of in the environment - often incorrectly - is also high. According to data from the National Radio Agency for the year 2021, in Brazil 80 million tons of waste are produced every year and this number is growing according to the increase in population and production demands.

Some authors show how much the combination of circularity and proper production management emerges in order to obtain satisfactory results. It is noteworthy that initiatives to minimize impacts through the introduction of socio-environmental criteria have emerged in view of the insufficiency of the linear mode of production in mitigating negative externalities, which are configured as harmful impacts to the environment (Berardi and Dias, 2018).

The structuring and implementation of a circular production system are directly linked to production engineering, given the scope of the areas pertinent to this field of knowledge, such as supply chain and reverse logistics, suggesting a closed production cycle, project preparation, product development, among others (ABEPRO, 2016).

Thus, an integration between production engineering and circular economy is required in order to enable production optimisation aligned with sustainability. Also according to ABEPRO

(Brazilian Production Engineering Association), production engineering is divided into 10 major areas, and one of these is sustainability engineering - which has a strong relationship with the circular economy. The fusion between the areas is a broad field that enables researches, possible applications and initiatives when producing.

Changing production practices means analyzing all the steps that make up the production process, from the extraction of resources to their final disposal, taking into account the management of the life cycle of each product (SWAR et. al., 2011). Thus, it is possible to highlight that the combination of production engineering knowledge and its application with circular thinking enables the vision of the cycle as a whole, considering not only the final product, but also all the steps to get to it.

The approach of circular economy to Production Engineering knowledge also enables a better use of resources and correct planning of their use. Besides being possible to integrate the circular economy theme to sustainability engineering, it is also possible its integration with product development (design, sales, use) and operations and production processes, being able to obtain results that facilitate an effective implementation of the circular economy facing the society and production model currently experienced. Lembre de explicar com a riqueza do detalhe.

4 INNOVATION IN DESIGN IN THE QUEST TO REUSE PRODUCTS

Among the circular economy principles are the creation of business models that add value to the manufactured product and the creation of products with multiple uses, and it is in this pillar that product design innovation is applied, aiming to meet these principles and extend the product's useful life, thinking of packaging designs with a more attractive appearance that can be easily reused and repurposed.

The industries that produce consumer goods tend to worry more about the momentary design of the product and not think about the future, being this design only for that moment and becoming obsolete in a short term. When one buys certain consumer goods, in 03 months a different model is launched with a more modern design than the previous one, tending these actions to stimulate consumerism and consequently a greater production, extraction and generation of waste disposed of incorrectly. According to the designer and researcher of the Ideia Circular website, Mônica Moura, "design means having and developing a plan, a project, it means designating.

Still, for some authors, design can effectively contribute to the change of cultural, industrial production and consumption profiles, leading to the resolution of real problems and effective changes towards greater sustainability of production systems (MANZINI; VEZZOLI, 2016).

Consequently, by investing in a circular design, it is possible for products to have their lifespan extended and to last longer in the eyes of consumers. When thinking about design, we should not only talk about aesthetic issues, but also about functionalities and unique features of a

product that will make it stay longer in circulation and avoid consumerism and unbridled discarding.

5 INTEGRATION BETWEEN PRODUCTION PROCESSES AND SUSTAINABILITY

The ecological position is mostly considered unfeasible, given that the prevailing logic in the global economy encourages consumption and the intensive use of natural resources, and the conventional is inconsistent with the major global environmental issues (VEIGA, 2010). The constant unregulated extraction of resources for production, in quantities greater than nature is capable of replenishing, has caused great wear and tear on natural means and resources, with the current economy being concerned only with monetary factors and not taking into consideration the process as a whole.

With the current and growing extraction of resources, the integration between productive processes and sustainability becomes essential, since this integration is able to allow a cleaner production and ensures that the productive processes do not interfere too much in nature and in the replacement time necessary for its regeneration.

For Drucker (2001) the challenge, in terms of management for the 21st century, is related to how organisations deal with changes. According to the author, it is not possible to manage change, but to be ahead of it. Thus, one might state that a given organisation or entity needs to lead a change and this must be treated as an opportunity for the company, with the application and transition to the circular economy being a change that brings opportunities and benefits.

It is of great importance that there is integration between the way in which one produces and sustainability, enabling a synchrony between these two aspects in order to bring benefits to both parties. Such integration is so necessary both because the environment is constantly damaged by the means of production, but also because of the countless benefits that can be generated for companies in terms of resources and use of raw materials.

In other words, this article seeks to identify and study data concerning circular economy implementation challenges at Resende by means of the integration of productive means and sustainability, conducting a thorough analysis of data collected in conjunction with other tools such as field research, graphs and comparative analyses. Using research techniques, this paper will list the main challenges and investigate what actions have already been taken in the municipality in question in relation to waste reuse and sustainable practices.

6 THE MUNICIPALITY OF RESENDE AND SOLID WASTE MANAGEMENT

Considered a sub-regional capital of high influence in the region, the city of Resende is the pole of

the region of Resende, Rio de Janeiro with about 1099 km² and approximately 132,300 inhabitants. The city's GDP is about R\$ 8.6 billion, where the added value comes from services, followed by industry, public administration and agriculture, and within its area of influence, the city attracts most visitors for transport logistics. (CARAVELA, 2022)

Still, of the total number of workers, the three activities that most employ in Resende are: public administration in general (5912), manufacture of automobiles and 13 vans (1448) and inter-municipal cargo transport (1240). Among the city's characteristic sectors, the manufacture of trucks and buses stands out (CARAVELA, 2022). Below is the table with the industries of the municipality in 2018 according to the data provided by the municipality in the Comprehensive Solid Waste Management Plan.

As a region modernises and expands in terms of industrial and population growth and does not seek alternative means of maintaining sustainable practices, there is the likelihood of increased waste generation that can threaten its biodiversity, biosecurity and quality of life, since these threats are considerable when the focus is on practices based on a linear economy.

Integrated solid waste management can be considered a challenge to be overcome by municipalities from the very beginning. Thus, it is necessary to create public policies that consider environmental education, investment in changing habits and attitudes, and also assist in the reduction and prevention when generating waste. To this end, it is necessary that municipalities have a concentrated strategy that facilitates the achievement of goals and to obtain the desired planning, ensuring paths towards sustainability.

According to 2019 PMR data, selective collection in the municipality of Resende covers about 40% of the total number of households, this being carried out by the Recicla Resende Collectors Association (ACRR) in partnership with the Municipal Government, where the waste collected goes through stages such as: sorting, separation and baling and storage in the yard until they have sufficient volume for them to be marketed.

Resende Municipality also has an integrated solid waste management plan that defines and demonstrates practices that aim to treat waste and prevent its incorrect disposal into the environment. Based on research and data presented in this article, it is possible to conclude that the city of Resende has actions and planning when it comes to waste, and this interest is a differential compared to other cities in the region.

7 CONSIDERATIONS AND CONCLUSION

It is indisputable that the increase in waste generated by society is of concern to all, whether due to the space the waste occupies, its inadequate disposal, diseases caused by exposure to the waste and/or the pollution of river sources. In search of improved management in this area, since 2010, with the approval of the National Solid Waste Policy (PNRS), Brazil determines that several productive sectors implement reverse logistics and selective collection programs (BRASIL, 2010b).

With the territorial extension, population and growing number of industries, the municipality of

Resende is a major generator of waste, whether domestic or industrial. Making an analysis and projection, it is estimated that the population of the municipality will grow around 50% more from 2013 to 2032, having also been observed the increase in the number of new industries, these facts being directly related to the amount of waste that are generated and require treatment.

In Brazil there is law number 12305 establishing the National Solid Waste Policy (PNRS), which sets out the practices that should be adopted with a view to implementing selective collection practices, carrying out the correct waste management, acting in areas such as urban cleaning services and aiming to put an end to open air dumps. Resende is a reference city in the region in terms of development and economic and industrial growth, being a municipality of great relevance in the region, which stands out for being the stage of major industries and the high potential for consumption and job generation. The economic performance and the number of new business opportunities are the points that draw the attention of those who choose to become a resident of the city.

With this and having great productive potential, whether in industry or commerce in general and as there is no way to talk about production without remembering raw materials and waste generation - solid or otherwise - it is paramount that CE practices are implemented and associated in the sustainable management of the city as soon as possible in order to integrate production and sustainability, promoting quality of life and assisting in a healthy growth.

Based on the aforementioned scenario and approaches to the circular economy, it is possible to associate these practices with the municipality's intentions, working with a process of improvement based on what is already done. Observing available data and performing a thorough analysis, it is possible to conclude that the municipality is already in an initial implementation phase based on the recycling practices it already has, and this process should only be managed based on circular ideas and undergo improvements regarding the return of this waste, allocating it in a way that generates value in its production chain. As an example, we have the recycling cycle of a very common waste in everyday life: paper.

Circular Economy practices define that losses are avoided right at the beginning of the process, and this aspect is already thought of at the time of production planning of a given product. Thus, it is possible to think of waste reduction causing it to return as raw material for the process, whereby biological and/or non-toxic materials may return to the environment through composting or anaerobic digestion by nature; and materials such as glass, polymers and other solid waste may be reused in the production chain or have their useful life extended by design.

With the purpose of mapping and studying the main challenges for an effective implementation of the circular economy in the city of Resende, bibliographical and bibliometric researches were conducted enabling a better mapping of the city's data that can be used for a better conclusion and analysis of the scenario as a whole, analysing sustainable practices and the city's production flow.

According to the study on waste management in the municipality of Resende, satisfactory results were obtained, since PMR has detailed reports related to the management of solid waste, has a planning application in addition to acting with the selective collection in homes enabling sustainable practices and

helping the population also create this habit with the constant passage of collectors in the homes and neighborhoods of the municipality.

Easy vehicle access and the number of industries in the city facilitate the use and intensification of selective collection conducted in trucks in the city. Furthermore, one might also mention Resende's representation for its extensive commerce, which influences in the growing number of thrift stores that are in operation in the city that aid in sustainable and conscious fashion, also contributing to the advancement of sustainable practices and circular economy, given that the manufacturing of clothing items is still something that generates a lot of waste and largely affects the environment.

Sustainability is something necessary to companies and what they have been worrying about nowadays with the growing number of consumers concerned about acquiring products from conscious companies that avoid means of aggression to the environment. Thus, the municipality in question, acting with circular practices and in accordance with adjacent and beneficial processes to nature can attract a large number of entrepreneurs and investors willing to contribute to a healthy and sustainable economic growth.

After studying the implementation of circular practices in waste management in Resende, we are thinking of discussing project partnerships with the city hall for the effective application of circular practices. Therefore, it would be interesting to present the project and demonstrate how the circular economy can reintegrate processes, act in the sound economy and have means of integration. All this together with a necessary and primordial good for all beings: the environment.

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