



Circular economy and its impact on environmental sustainability

La economía circular y su impacto en la sostenibilidad ambiental

Angel Maldonado Castro

Quevedo State Technical University, Faculty of Social Sciences, Economics and Finance,
amaldonado@uteq.edu.ec, <https://orcid.org/0000-0001-6478-7365>

Jenny Maldonado Castro

Universidad Técnica Estatal de Quevedo - Ecuador, School of Business Sciences,
jmaldonado@uteq.edu.ec, <https://orcid.org/0000-0003-1531-7695>

Roger Yela Burgos

Quevedo State Technical University, Faculty of Social Sciences, Economics and Finance,
ryela@uteq.edu.ec, <https://orcid.org/0000-0003-0643-163X>

Edgar Moreno Suquilanda

Quevedo State Technical University, Faculty of Social Sciences, Economics and Finance,
emoreno@uteq.edu.ec, <https://orcid.org/0000-0002-7801-4520>

ABSTRACT

This article establishes a reflection on the circular economy and its impact on environmental sustainability, which is based on the optimization of resources avoiding pollution, as well as environmental degradation through reduction, recycling, and reuse, that is, the circular economy aims to improve the efficiency and effectiveness of use of resources. In this sense, the circular economy is an alternative to the linear economy whose approach is to take, manufacture and dispose of, which is unsustainable for economic growth due to scarce resources. Therefore, this research aims to identify the components of the circular economy that affect environmental sustainability. In this document, it analyzes the concept, principles, as well as the components of the circularity economy, describes the difference between circularity and

sustainability, in turn, tries to correlate the circular economy with environmental sustainability.

RESUMEN

El presente artículo establece una reflexión sobre la economía circular y su impacto en la sostenibilidad ambiental, la cual se basa en la optimización de recursos evitando la contaminación, así como, la degradación ambiental mediante la reducción, el reciclaje y la reutilización, es decir, la economía circular tiene como fin mejorar la eficiencia y la eficacia del uso de los recursos. En este sentido, la economía circular es una alternativa a la economía lineal que tiene como enfoque tomar, fabricar y desechar que es insostenible para el crecimiento económico debido a los recursos que son escasos. Por lo tanto, esta investigación tiene como finalidad identificar los componentes de la economía circular que inciden en la sostenibilidad ambiental. En este documento, se analiza el concepto, los principios, así como los componentes de la economía circular, describe la diferencia entre circularidad y sostenibilidad, a su vez, trata de correlacionar la economía circular con la sostenibilidad ambiental.

Keywords / Palabras clave

Circular economy, recycling, environmental, sustainability

Economía circular, reciclaje, medioambiente, sostenibilidad.

Introduction

Companies generally conduct their operations according to the principle of the "Take, make and dispose" model, in which by obtaining the raw material they would transform it into a finished product which they would sell in the market to the final consumer (Ghisellini et al., 2018). In this linear approach, organizations or companies do not have to worry about what happens to the final product once it is discarded because the assumption of linear economics holds that there are infinite resources available to manufacture the product and there is no concern about resource depletion. (Goyal et al., 2018).

Circular economy aims to reduce the consumption of raw virgin resources for the optimization of the use of by-products, or the

recycling of discarded products as the main source of resource materials in addition to decreasing the pollution generated at every step (Pinjing et al., 2013)The circular economy aims to solve the resource, waste and emissions challenges facing society by creating a total supply chain from production to consumption that is restorative, regenerative and environmentally benign. (Baratsas et al., 2021). It has been approached on the basis of a study in which the Earth is represented as a closed, circular system with scarce resources in which the economy and the environment must coexist. (Ma et al., 2019).

- 3 In this sense, the objective of this research is that through a systematic review of the literature to identify the main components of the circular economy that have an impact on environmental sustainability. The circular economy is a viable alternative to the linear economy, whereby, by maximizing the value of resources throughout the life cycles of the products that contain them, resources can be used in a more effective and efficient way, in addition to the fact that the negative environmental, economic and social impacts associated with the life cycle of products can be minimized (Brandão et al., 2020).

This document is composed of four parts: the first section corresponds to the introduction to the topic of circular economy, the second section concerns the literature review where the background of the research was based, as well as the concepts related to the research topic were defined, in the third section the methodology was established, which announced the type of research that was developed, as well as the process that was carried out, the fourth section reported the results that were presented during the research process.

Since the second half of the 1970s, a new economic system of change in business model innovation and consumer behavior has been conceptualized in which both producers and consumers focus on reprocessing refurbishing, renewing and recycling previously used materials and products (Hysa et al., 2020). The concept of circular economy has become very popular since it was introduced by policy makers in China and the European Union as a solution that will enable countries, companies and consumers to reduce damage to the environment and close the product life cycle. (Deselnicu et al., 2018)..

The ambition of the model is to create circular material flows that break with the current linear economic logic of take, make, and

dispose, creating commercial value for its participants (Esposito et al., 2018). From its beginnings, the circular economy manifested itself as an alternative model to the neoclassical economy both from a theoretical point of view, recognizing the fundamental role of the environment, as well as its functions and the interaction between the environment and the environment, addressing issues such as the challenge of global resource scarcity and the challenge of environmental pollution. (Ghisellini et al., 2016)..

- Whereby the thoughts and practices of circular economy are important for both business and sustainable development of all industries. (Patwa et al., 2021), this type of economic system is an alternative to the existing linear economy that is based on the take-make-dispose principle, which is unsustainable for economic growth due to the limited resources in the world (Dinda, 2020). In this context the circular economy has the potential to lead to sustainable development, while decoupling economic growth from the negative consequences of resource depletion and environmental degradation. (Babbitt et al., 2018).

In this way, a set of tools can be used for sustainable purposes. (Sauvé et al., 2016)Therefore, companies should radically change their business models under the paradigms of the circular economy, in addition, society as a whole will have to change their styles due to meet the challenges posed by population growth, environmental degradation, climate change and unexpected events. (Wiedmann et al., 2020).

In open systems, waste is converted back into materials and objects through recycling, thus, a linear economy is transformed into a circular economy (Trica et al., 2019)In open systems, fees for closed-loop recycling and open-loop recycling are often not published individually, but are communicated as a rate, which is problematic because open-loop recycling usually has secondary material recovered in product systems with lower quality requirements, therefore, improving recycling efficiency for a more circular economy includes a transaction from open-loop to closed-loop recycling. (Graedel et al., 2011)..

The environmental benefits of recycling depend on the difference in impacts resulting from supplying equivalent products either from primary or secondary material (Geyer et al., 2016)The circular economy is perceived as a crucial economic model that differs from

the industrial economy. (Rashid et al., 2013)The circular economy is perceived as a crucial economic model that differs from the industrial economy, as well as being the solution to harmonize the ambitions of economic growth and environmental protection. (Lieder & Rashid, 2016). It is therefore an alternative of a cyclical nature, i.e. it uses resources and reuses them once their use is complete. (M. Oliveira et al., 2021).

A circular business model is a business model in which the conceptual logic for value creation is based on using the economic value retained in products after their use in the production of new offerings (Linder & Williander, 2017). Therefore, in order to transform linear production systems into closed-loop systems, resources and by-products must undergo multiple production and consumption cycles and end-of-life treatments under the 3R philosophy of reduce, reuse and recycle. (Genovese et al., 2017).

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There are internal and external factors that impact the adaptation of a business model to circular economy principles, internal factors refer to organizational capacity, while external factors involve technological, political, socio-cultural and economic issues (Roos, 2014)The fundamental constructs and constituent elements of circular business models can be derived from the fundamental principles of the circular economy. (Lewandowski, 2016).

In this sense, these are characterized by the closure of raw material chains, a transition from ownership to service provision and a more intensive utilization of product functionality. Thus these business models are focused on the recognized five building blocks: creating loops, creating value, choosing an appropriate strategy, designing an entity that fits with the organization between parties, and developing circular profit models (Rogge & Reichardt, 2016).

Circularity and sustainability.

A sustainable circular economy should not only take an environmental perspective, i.e., it should also take into consideration economic and social performance (Melanie Haupt & Hellweg, 2019). In this way, it is an economic model aimed at the efficient use of resources through the decrease of waste, which has as its main objective of a circular economy is economic prosperity, followed by environmental quality; its impact on social equity and future generations is hardly mentioned (Murray et al., 2017).

This system seeks to move from an economic behavior of production-consumption-waste to one of production-consumption-reuse. (Prieto-Sandoval et al., 2018) In this sense, environmental goods have a public character and have no price because they are not exchangeable in the market, however, not having a price does not necessarily imply that they are worthless; the economic appreciation of ecosystems is given by the perceived utility they provide to stakeholders. (Gómez-Baggethun et al., 2010).

The emergence of a new paradigm demands the design and development of new indicators and new metrics. Materials, non-renewable resources and fossil fuels as well as monetary flows are indispensable for economic growth. (Brown & Ulgiati, 2015) However, the limited availability of resources and the struggle for unlimited economic growth generates socio-environmental chaos and events that are extremely damaging to society and ecosystems. (Marques, 2020).

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Companies, governments and academics have developed different proposals to measure the circularity of services and products. These metrics should provide an indication of how well the circular economy principle is applied, however, more generally circularity metrics have been criticized for not representing the systematic and multidimensional nature of the circular economy, i.e., the performance of environmental, economic and social (Saidani et al., 2017).

In this sense, the circular economy is perceived as a sustainable economic system where economic growth is decoupled from resource use, through the reduction and recirculation of natural resources. These metrics can be classified into two groups, the first makes involves circularity measurement indices, which are intended to provide a value expressing how circular a system is, the second group involves circularity assessment tools, which are intended to analyze the contribution of circular strategies to circular economy principles, focus on environmental or economic impacts (Corona et al., 2019).

The transition to a sustainable circular economy requires assessment methods that can be applied at all levels: from individual products to larger systems and entire economies (Melanie Haupt & Hellweg, 2019). Thus, the circular economy has generated widespread awareness and a willingness to act by governments and industries because it supports the implementation of the Sustainable Development Goals, among the relationships that stand out are clean

water and sanitation, affordable and clean energy, decent work and economic growth, responsible consumption and production, and life on land. (Schroeder et al., 2019).

In this way, it is indispensable to have relevant indicators that not only evaluate circularity but also environmental performance because circularity is not necessarily equivalent to environmental sustainability (M. Haupt et al., 2018). At its core, the circular economy is a radical concept, as it is historically embedded in a critique of established systems relationships that have produced unsustainability that characterizes the linear forms of global capitalism (Hobson, 2021).

- 7 The approach taken by the circular economy is whole systems with the aim of redesigning economic and social relations not only to reduce the impact that humanity has on the environment, but to radically rebalance the relationship between man and nature, which seeks to explain that the purpose of this system is to improve the relationship between humans and the natural environment in turn in the economic and social spheres (Boehnert, 2015).

Environmental sustainability and the circular economy.

Environmental sustainability refers to social, economic and environmental balance. Sustainable development is a societal goal defined at the macro level and includes broad notions of ecological, economic and developmental or social sustainability, however, the circular economy approach is mainly defined at the micro level through a consumption and production model, i.e., if the implementation of circular initiatives brings better results towards sustainability, then the circular economy becomes a tool for sustainable development (Bartelmus, 2013).

The circular economy is a sustainable development strategy that aims to address urgent problems of environmental degradation and resource scarcity. The 3R principles of the circular economy are to reduce, reuse and recycle materials. (Heshmati, 2017). Although sustainable development establishes the triple bottom line system, in which the focus is on environmental, economic, and social benefits as a whole, the circular economy prioritizes the economic system where the main beneficiaries are the economy and the environment (Geissdoerfer et al., 2017).

One of the objectives to be fulfilled by the circular economy is sustainability (Lazarevic & Valve, 2017), which implies that this type of economic system that replaces the end-of-life concept with the reduction, reuse, recycling and recovery of materials in the processes of production, distribution and consumption, with the aim of achieving sustainable development, simultaneously creating environmental quality, economic prosperity and social equity, for the benefit of current and future generations (Kirchherr et al., 2017).

The ability of the circular economy to contribute positively to environmental growth, i.e., positive net growth of natural capital and ecosystems is often implied rather than demonstrated (Corvellec & Stål, 2019). Circular economy thinking equates to incremental rather than radical transformations, a weak rather than a strong form of sustainability (Hobson & Lynch, 2016). Economists as well as environmental and materials scientists must assess the ecological impacts and the costs and benefits of product (Stahel, 2016).

The circular economy is the manifestation of a paradigm shift, which will require changes in the way society legislates, produces and consumes innovations, while using nature as an inspiration to respond to social and environmental needs, thus (Hofstra & Huisingh, 2014)The cycle of extraction and transformation of resources and the distribution and recovery of goods and materials is emerging as a cycle of extraction and transformation of resources and the distribution and recovery of goods and materials. (Park et al., 2010). There is a positive impact of implementing the circular economy between environmental management, consumers and associated cost reductions. (Ormazabal et al., 2016).

Thus the circular economy requires innovative solutions to legislation, production and consumption, which must be in line with sustainable wealth creation (Scheel, 2016). Measures must be implemented to ensure reverse flows of post-consumer products and close loops when convenient, which implies that the circular economy is not different from sustainable development because both depend on the intervention of some authority. (Souza, 2013).

Assigning monetary values to resources or ecosystem functions may not necessarily solve the main challenges related to the transition to sustainable futures, since it may not improve environmental conditions, thus may not decrease inequalities related to access to resources, and is likely to suppress alternative valuation methods, so

monetary valuation approaches should be handled with caution because they facilitate methodological and discursive legitimization for the commodification of nature, which may worsen socio-environmental conditions. (Kallis et al., 2013).

To measure the transition to a sustainable circular economy and monitor change in economic systems, the vision must extend to the entire life cycle (Moraga et al., 2019). Sustainability is divided into environmental, economic, social, and technical areas of concern (Dewulf et al., 2015). Reuse, repair and recycling are becoming crucial activities in many sectors, thus the circular economy is a way to increase the sustainability of economic systems. (Elia et al., 2017).

Circular economy practices are, by definition, sustainable and do not consider impacts on social equity and intergenerational well-being.

- 9 Material circularity refers to the investigated life cycle stage of the product or service under study, however, sustainability performance is assessed using a life cycle perspective (Blum et al., 2020). Because the circular economy should also aim for a reduced environmental impact, the need for an impact-based indicator becomes obvious. (Melanie Haupt et al., 2017).

Over the years, many methods have been developed to assess the sustainability of the production and supply of raw materials, therefore, they have been developed with the aim of addressing specific sustainability issues, among these methods are, classical life cycle assessment, which is generally presented in an environmental context (Jeswani et al., 2010) While social life-cycle assessment methods focus primarily on social issues. (Sala et al., 2013).

Materials and Methods

This research establishes a bibliographic analysis to identify the main components of the circular economy that have an impact on environmental sustainability. It is important to note that the systematic review of the literature was carried out through the use of scientific articles, i.e. journal publications and websites. A set of keywords related to circular economy and sustainability were selected. The search was performed by combining these keywords. The search string applied was: "circular economy" "sustainability" "environment" "recycling".

The keyword combination was applied to "title, abstract and keywords" in the Google Scholar database which is noted for

containing an extensive amount of information. The search led to the identification of 137 publications, of which 117 were excluded after reviewing the information presented in each. The selection of eligible publications was based on the reading, as well as the relationship they presented with the established search criteria and the objectives of the study.

The articles reviewed were published in different journals such as: Resources, Conservation and Recycling; Environmental Development; Journal Cleaner Production; Energy Security and Development: Sustainability, International Journal of Green Economics. In this way, 20 publications were included that addressed issues of circular economy, sustainability and circularity, which served as the basis for the preparation of this document.

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Results

To complement the findings of the literature review, an analysis of the selected articles was carried out. The results are shown and discussed in this section, it should be noted that the circular economy, as well as sustainability are emerging topics, which are still being discussed today. This research presents the evolution of the topic, starting with the concepts of both circular economy and sustainability, describes the transition from a linear model to a circular one, the characteristics, as well as its main principles, and also tries to correlate the circular economy with sustainability, consequently, the impact it generates on the environment.

Sustainability requires a broad view of problems and impacts, as well as a practical understanding of what is done and how it is done. (Nidumolu et al., 2013) In this way, the concept of sustainability is attracting more attention as societies are aware of the environmental consequences of their actions, therefore, one of the most critical challenges facing humanity is the scarcity of resources, therefore several approaches have been established to reduce the impacts on society among which the circular economy stands out. (Morone & Yilan, 2020).

- Economic sustainability is developing positively if economic value is generated, including this dimension adheres to the neoclassical growth paradigm.

- Environmental sustainability is developing positively if less damage is done to the environment, i.e. if the impact on climate change is reduced, or if the natural habitat of animals is better protected.
- Social sustainability is developing positively if better social conditions are created for all human beings.

Because natural resources are limited, the circular economy tries to find how resources can be used in the most efficient way, thus proposing that closing loops and repeated use of resources has the potential to achieve maximum eco-efficiency. (Figge et al., 2018) However, this type of economic system is compatible with sustainable development, through its three associated pillars, not only targeting its benefits in the economic sphere but also environmental and indirectly social benefits. Therefore, it proposes new patterns of production, consumption and use, based on circular flows of resources. (Giurco et al., 2014).

Circular economy can be defined as a concept in which the implementation of this model involves reducing the consumption of raw materials, designing products in such a way that they can easily be disassembled and reused after use (eco -design), prolonging the useful life of products, through maintenance and repair, the use of recyclable materials in products, and the recovery of raw materials from the waste stream (van Buren et al., 2016)..

Thus, the circular economy is an elegant concept that can contribute to a more sustainable society if its approach to the problem is carefully designed and prudently implemented, with foresight for unintended consequences such as durability of materials, access to information and pollution of water resources. It is therefore important to keep these issues in mind when devising a circular economy model. (Anastas, 2020).

Proponents of the concept state that the circular economy has to offer a novel path to sustainable development, with sustainable development defined through the triple bottom line concept as simultaneously achieving economic performance, social inclusion and environmental resilience for the benefit of current and future generations (Geissdoerfer et al., 2017) The circular economy is developed around the idea of whole-system change directly related to resource extraction, waste generation, product design, environmental

awareness, innovative business models and inclusive policies. (Bocken et al., 2017).

A circular economy is the transition from linear to circular material flows, where resources, once taken from nature, remain in the economy as long as possible, whereby, legal and semantic technical processes transform waste into resources to increase the useful life of the raw material, thus, waste does not exist in a circular economy, therefore, the circular economy can be understood, like landfills, as an ideological strategy (Hird et al., 2014).

The search for sustainability has pointed to the need to move from a linear to a circular model. However, the transition is not trivial; modifying production chains with a focus on reducing the consumption of virgin raw materials, reducing emissions and preventing waste generation involves implementing new processes and services, which can add considerable environmental impacts to the supply chain. (de Souza Junior et al., 2020)..

The circular economy, however, remains an emerging topic area and, while the potential of increased resource circularity to contribute to sustainable development has been widely recognized, the relationships between the concepts of circular economy and sustainability, the practical implementation and quantitative evidence of the beneficial effects of circular economic practices on the triple bottom line of the economic, environmental, and, in particular, social domains are under-explored. (D'Amato et al., 2017).

China is one of the countries that has implemented this economic model as a national policy for sustainable development, for which it has established laws, as well as national projects to facilitate the implementation of this system, in addition it has published indicators so that in this way progress can be reported, as well as the achievements obtained by using this type of economic model. (Geng et al., 2012) However, the simple change to circular systems does not necessarily result in favorable alternatives, as they can occur as trade-offs in relation to environmental, economic or social impacts. (C. T. de Oliveira et al., 2021)..

The transition from the current linear economic model to a circular economy is one of the most prominent topics in academic literature, public governance and the business domain, whereby stakeholders have implemented circular economy strategies to decrease resource use, as well as, the associated impacts, trying to boost economic

competitiveness while generating a positive social impact. (Roos Lindgreen et al., 2020)..

In the context of the shift from linear to circular model, decision makers are faced with how to effectively address and measure the outcomes of the transition, i.e., the impact this has on society (Jabbour et al., 2019). Recycling practices are now also intended to contribute to sustainable materials management by pursuing a higher degree of material cycle closures, enhanced recovery of strategically relevant materials and avoidance of environmental burdens associated with the extraction and refining of raw materials. (Nelen et al., 2014)..

13 The search for ways to promote sustainability through private business models led industries to abandon classical production methods and resort to new market demands such as the use of innovative technologies to achieve the goals of sustainable development (Fuso Nerini et al., 2019). In this way, the circular economy proposes an innovative path towards sustainable development by introducing a different way of perceiving value in the management and handling of natural resources. (Kirchherr & Piscicelli, 2019).

The transition from linear value chains of finite resources to circular value chains of infinite resources provides the material conditions for continued economic growth, while reducing the environmental impact of resource use (Gregson & Crang, 2015). Consequently, the idea of a circular economy is based on the assumption that a market economy can enter into an efficient and successful partnership with the environment while maintaining current power relations, policies and norms . (Hobson, 2013).

There are several points of convergence between circular economy, industry 4.0 and sustainable development goals, these convergences are mainly focused on the comprehensive promotion of environmental sustainability through the implementation of technologies for the benefit of circular practices that could lead to a path to achieve sustainability (Oláh et al., 2020)In this way, the optimization of processes, reduction of emissions and excessive use of resources could be promoted. (Dev et al., 2020).

There is an increase in circularity indicators at both the product and macro level, many of these measure material or value recirculation, ostensibly as a proxy for environmental impact (Parchomenko et al., 2019), such metrics arguably run the risk of driving actions based on

increased circularity and not necessarily on improved environmental performance, leading to what we call "circularity for circularity's sake." (Tukker et al., 2013)..

The goal of the circular economy in transitioning from a linear pattern to a circular system in which the social value of products, materials and resources is maximized over time, however, it should be noted that circularity in itself does not ensure social, economic and environmental performance. The sustainability of the circular economy should be measured against its linear counterparts to identify and avoid strategies that increase circularity but lead to undesirable externalities. (Walzberg et al., 2021)..

14 Material efficiency is a key element of new thinking to address the challenges of reducing impacts on the environment and resource scarcity, while at the same time meeting service demands and material functionality, in this sense, the circular economy is directly related to material efficiency, which is based on the principle of optimizing the utility embodied in materials and products throughout the life cycle. Life cycle assessment is used to evaluate the environmental benefits of materials recovery and recycling. (Walker et al., 2018).

One of the core principles of the circular economy is a perceived reduction of environmental impacts, therefore, it is necessary to fully understand the implications of the circular economy, this includes the impacts of circular products and services, as well as possible macro effects (Saidani et al., 2019). In this context, the circular economy has been promoted as a promising alternative to unsustainable production systems. (Johansson & Henriksson, 2020).

By proposing a regenerative and restorative system of production and consumption, which closes the input and output cycles of the economy the circular economy is expected to solve the problems of resource scarcity, biochemical flow disruption and climate change, all while revitalizing local and regional economies (Batista et al., 2018). However, it should be noted that a poorly managed transition could lead to an increase in energy demand and greenhouse gas emissions. (Monsaingeon et al., 2020)..

There is a generally recognized planetary boundary that identifies the need to conserve at least 75% of the earth's natural ecosystems (Steffen et al., 2015), currently, only 62% of natural ecosystems remain, and the transition to a circular, carbon-free economy could worsen the situation, especially if the complex interactions between

energy, biodiversity and material resources are not adequately addressed (Heck et al., 2018).

In this context, biodiversity provides key solutions to global problems by reducing soil erosion, improving human health, contributing to climate change adaptation, mitigating climate change, improving water quality and quantity, improving soil health, reducing air pollution, improving wastewater treatment, and inspiring human creativity and innovation (Del Borghi et al., 2020). These nature-based solutions must be better integrated with regenerative and restorative circular economy practices. (Reynaud et al., 2019).

In addition, a circular economy can also lead to reduced demand for goods through longer usage rates, reuse, repair, recycling and refurbishment strategies, as well as single-life compartments, all of which should significantly reduce environmental pressures (Bengtsson et al., 2018). Thus comprehensively assessing the sustainability impacts of the circular economy is a major challenge. (Velis, 2018).

Because a large majority of production systems that are defined as circular generate a higher environmental impact than their linear counterparts such as biofuels and biopolymers. In addition a circular economy approach that focuses on eco-efficiency generates a rebound effect, i.e., where reducing the costs of a product or service leads to higher demand, while creating savings that incentivize consumption in other areas (Zink & Geyer, 2017). Thus, efficiency gains lead to higher levels of overall resource consumption in the economy. (Junnila et al., 2018).

Conclusions

The circular economy is an innovative alternative economic system that contributes to reducing environmental impact through sustainable practices involving reuse, recycling and reduction, which affect environmental sustainability because resources are used effectively and efficiently by maintaining the value of things, while seeking the elimination of waste to conserve biodiversity and reduce pollution and degradation in the natural environment.

Sustainable development and circular economy are related terms because the activities developed by the circular economy contribute to sustainability by maximizing environmental benefits, which means

that this innovative economic model can be considered as a strategy for sustainable development because its objectives and principles are interrelated, however, it should be noted that the circular economy not only generates environmental benefits but also involves both economic and social opportunities. Waste management, as well as the efficient use of resources by the circular economy contributes to reducing greenhouse gas emissions, which are the cause of climate change, which means that the circular economy does less damage to the environment, in this sense, a transition from the linear model to the circular model suggests a change in the productive matrix, diversifying the use of resources, increasing competitiveness and technological and industrial innovation, reducing environmental impact.

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