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Study of the state of the art of the circular economy in Europe

Abstract

The Circular Economy, an approach to combating environmental challenges and promoting sustainable development, is currently a popular notion within policy and business advocacy groups. The EC notion and definitions are based on a fragmented collection of ideas which are derived from a variety of scientific disciplines and semi-scientific concepts. For this reason, it is the target of much criticism in academic and professional circles. The global economy is getting worse year by year, in 2018, the global circularity was 9.1%, in 2020 8.6% and in 2023, it dropped to 7.2. This means that more than 90% of materials are wasted, lost or remain unavailable for reuse for years, leaving a huge circularity gap: the globe depends almost exclusively on new natural resources. The objective of this article is to identify the state of the art of the circular economy, in addition to discussing the various definitions provided by the literature review.

Keywords: circular economy, linear economy, circularity, waste management, SDGs

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Introduction

The Circular Economy (CE) is a concept that emerges from the debate about sustainability and the finite nature of natural resources. This debate has its roots in concerns raised by Thomas Malthus in 1798.[1] In Europe, the former Dutch scientist and politician Ad Lansink proposed a waste hierarchy to the Dutch Parliament in 1979. Later, "A Community Strategy for Waste Management" (EC, 1989)[2] stated that prevention is "the first guideline", to waste that cannot be avoided must be recycled or reused, and the remainder discarded, effectively suggesting a three-tier waste hierarchy.[3]

The Circular Economy as an approach to combating environmental challenges and promoting sustainable has recently received increasing attention in discussions of industrial development.[4] The notion of EC is based on a fragmented collection of ideas derived from a variety of scientific disciplines and semi-scientific concepts.[4] In addition to being subject to much criticism in academic and professional circles, there is clearly a need for conceptual coherence over definitions, plans, implementations and evaluation modes. On the other hand, the circular economy is an emerging economic concept that provides new business models and strategies to reuse materials and resources to their full potential. At the heart of the circular economy is the principle of moving away from linear economy practices, directly challenging the "extraction, transformation, use, disposal" mentality, with the aim of achieving social well-being while operating within the bounders of our planet. In a circular economy, material loops are closed following the lead of an ecosystem and within a strategic approach that integrates climate change and biodiversity loss, while meeting societal needs. In this system, therefore, it is not only important that materials are properly recycled, but also that products, components and raw materials remain of high quality in these cycles,[5] preserving natural resources. Many companies are now exploring the use of recycled materials in their products, and some are even designing products with a focus on circularity from the outset.

The purpose of this paper is to identify the state of art of the circular economy, in addition to discuss the various definitions provided by literature review.

Circular economy

The EC notion and definitions are based on a fragmented collection of ideas derived from a variety of scientific disciplines and semi-scientific concepts.[4] Being the target of much criticism in academic and professional circles, the need for conceptual coherence in definitions, plans, implementations and evaluation methods becomes evident. Korhonen[5] reviewed the literature and found that, in general, the definition of Circular Economy, adopted by most authors, has a reference to the Elle MacArthur Foundation. In Table 1 below presents, some of the definitions of circular economy in the literature researched.[5]

Table 1 Circular Economy literature[5]

Definition	References
A. Base on EMAF definitions	
The CE has Been defined as an industrial system that is restorative or regenerative by intention and design, It replaces the end-of-life conception with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for elimination of waste through the superior design of materials, products, systems and business models.	Hobson, 2016
CE is an economic strategy that suggests innovative ways to transform the current predominantly linear system of consumption into a circular one, while achieving economic sustainability with much need material savings.	Singh and Ordonez, 2016
A circular economy is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times. The concept […] is a continuous positive development cycle that preserves and enhances natural capital, optimizes resource yield, and minimizes system risks by managing finite stocks and renewable flows.	Moreau et. 2017
The conception of circular economy conceives of a production and consumption system with minimal losses of materials and energy through extensive reuse, recycling and recovery.	Haupt et ll.2017
The circular economy, defined as a restoratives or regenerative industrial system by intention and design.	Niero et. 2017

Table 1 Continued....

Definition	References
A. Base on EMAF definitions	
B. Based on own or other researchers definition	
The circular economy is a simple, but convincing strategic which aims at reducing both input of virgin materials and output of wastes by closing economic and ecological loops of resource flows.	Haas et al 2015
CE aims to achieve optimum production by minimizing natural resource utilization and pollution emission simultaneously and minimum wastage by reusing the wastes from productions and minimum pollution by recycling and restoring the technically useless wastes.	Wu et al.2014
A circular economy is a mode of economic development that aims to protect the environment and prevent pollution thereby facilitating sustainable economic development.	Ma et all 2014
CE is specifically based on both resource efficiency and eco-efficiency, and its purpose is to acquire a set of key measures to move towards a more circular, green, and sustainable economy.	Ma et all 2015
The term "circular economy" as mentioned in these measures is a generic term for the reducing reusing and recycling activities conducted in the process of production, circulation and consumption.	Naustdalslid, 2017
Circular economy is a general term covering all activities that reduce, reuse and recycle materials in production, distribution and consumption processes.	Blomsma and Brennan, 2017

Circular economy and linear economy

The circular system and the linear system differ from each other in the way in which value is created or maintained. A linear economy traditionally follows the "take-make-dispose" step-by-step plan. This means that raw materials are collected, and then transformed into products that are used until they are finally discarded as waste.[6]

In a circular economy, close the cycles of all these raw materials. Closing these cycles requires much more than just recycling. It changes the way in which value is created and preserved, how production is made more sustainable and which business models are used. Producers can take back their products after use and repair them for a new useful life.[7] The difference between a linear and a circular economy is on the Table 2 follow.

Table 2 Difference between linear and circular economy[4]

	Linear	Circular
Step plan system boundaries	Take-make-dispose	Reduce-reuse-recycle
	Eco-Efficiency	Eco-effective
	Short term, from purchase to sales	Long term, multiple life cycles
Reuse business model	Down cycling	Upcycling, cascading and high grade recycling
	Focuses on products	Focuses on services

There are nine planetary boundaries for the health of the planet currently, five of them are overshooting,[8] which measure environmental health on land, sea and air, have been broken, largely due to the impacts of the linear economy of "take-make-dispose". Figure 1 shows the overshoot of planetary boundaries.

Within the second, the focus is the eco-effectiveness of the system, which creates a positive impact, strengthens the ecological, economical and societal systems by using them, and focuses on services.

Circular economy and the sustainable development goals

The EC will enable the achievement of the goals of the sustainable development goals (SDGs), as well as establishing a synergy with the management policies of solid urban waste. Mainly related to the 3R - reduction, reuse and recycling, which may considerably reduce the need to use natural resources, processing virgin materials and manufacturing products, as well as reducing associated environmental impacts.

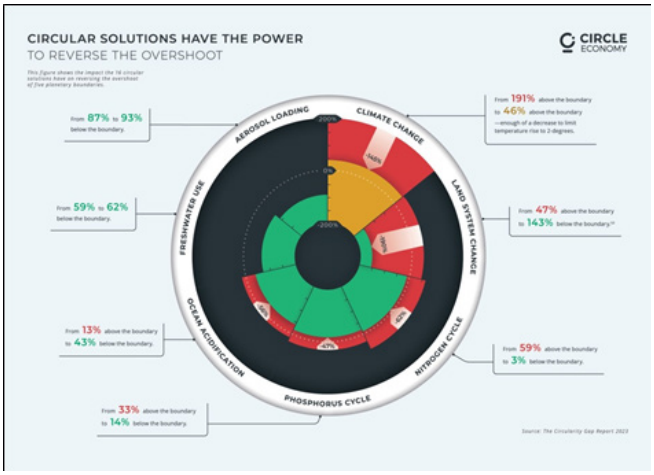

Figure 1 Overshoot of the planetary boundaries.[8]

The circular economy is directly linked to the implementation of the Sustainable Development Goals (SDGs) that constitute the universal 2030 agenda, with 17SDGs with 169 goals that are cumulative to all countries and reflect the economic, social, environmental and institutional dimension, in an integrated way. Contributes strongly to SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 12 (sustainable consumption and production**),** SDG 13 (combating climate change) SDG 14 (Conservation and sustainable use of oceans) and SDG 15 (protection and conservation of terrestrial ecosystems **t**errestrial). Aspects of the circular economy such as recycling household waste, e-waste and wastewater provide a 'toolbox' for meeting the SDGs.[9]

Challenges to implementing the circular economy

There are several challenges and difficulties in the implementation of the circular economy. In fact, we can highlight the following aspects: deficit of environmental education and general awareness, as well as a lack of investment in circular infrastructure[10] due to a lack of collection, sorting and processing infrastructure.[11] Regulatory frameworks need to be updated to incentivize circular business models

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and to remove barriers to the use of recycled materials and products[12] and value chains fragmented, with different stakeholders working in bubble and pursuing different objectives.

The global circularity

The global economy is now 7,2% and the situation is getting worse every year.[4] This has shrunk global circularity from 9.1% in 2018, to 8.6% 2020, and now 7.2% in 2023. This means more than 90% of materials are either wasted, lost or remain unavailable for reuse for years as they are locked into long-lasting buildings and machinery.

The European scene

The concept of circular economy gained prominence in Europe in 2013 with the first report of the Ellen MacArthur Foundation. The chronology of different activities that contributed to the development of the circular economy policy for the countries member to the European Union is described in Table 3.

Table 3 Chronology off different activities to EC in Europe[1]

Years	Regulation and communications
2014	Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Towards a circular economy: A zero waste programme for Europe (No. COM (2014) 398).
2015	Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Closing the loop – An EU action plan for the Circular Economy EN (No. COM (2015) 614) amending Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment on electrical and electronic waste, landfill waste, packaging and waste amending Directive 1999/31/EC on the landfill of waste amending Directive 94/62/EC on packaging and packaging waste amending Directive 2008/98/EC on waste legislative proposal to extend legal guarantees on goods sold online to 2 years.
2016	Proposal for a Regulation of the European Parliament and of the Council laying down rules on the making available on the market of CE marked fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 Launch of the "Innovation deals for a circular economy", which was open between 26 May and 15 September 2016, to identify perceived regulatory barriers to innovation Adoption on 30 November 2016 of the Ecodesign Working Plan 2016–2019 as part of the Clean Energy for All Europeans package Launch of the stakeholder's platform on food waste prevention, development of an EU methodology to measure food waste, and preparation of EU guidelines to facilitate food donations and use of former foodstuff as feed
2017	Proposal for a Directive of the European Parliament and of the Council amending Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment Communication on waste-to-energy processes and their role in the circular economy, (European Commission, 2017b) Launch of the platform to support the financing of circular economy.
2018	Monitoring Framework

State of the art in Portugal

Portugal has made some efforts towards the implementation of a circular economy. In effect, in 2018, Portugal approved its Action Plan for Circular Economy (PAEC), which aims to promote a more efficient use of resources and reduce waste generation. The plan includes 131 measures that cover areas such as waste management, eco-design, sustainable production and consumption, and innovation. The PAEC assumes commitments in line with the Action Plan for the Circular Economy of the European Union (EU), with the Paris Agreement, with the EU Industrial Policy Strategy, and with the Goals of the Sustainable Development Agenda 2030 of the United Nations.[13] Other steps towards the implementation of a circular economy are the following: Circular Economy Network: Portugal has launched a Circular Economy Network, which brings together companies, municipalities, and other stakeholders to exchange knowledge and experiences in this field. The network aims to foster collaboration and promote the development of circular economy initiatives. More information can be found on the website of the Portuguese Environment Agency (APA).[14] Circular economy incubator program: Portugal has established a circular economy incubator program, which supports the development of circular economy business models and provides funding and mentorship to start-ups in this field. The program is managed by the Portuguese Development Agency (AICEP) and provides support to Portuguese and foreign companies.

More information can be found on the website of AICEP[15]: Challenges and opportunities for the circular economy in Portugal: A study published in the Journal of Cleaner Production[16] analyses the challenges and opportunities for the circular economy in Portugal. The study identifies barriers such as the lack of infrastructure and investment, as well as opportunities such as the potential for job creation and the reduction of environmental impacts. The study suggests that a systemic approach is needed to fully realize the potential of the circular economy in Portugal.

Discussion and conclusion

The circular economy goes beyond the scope and focus of waste management and recycling actions aiming at a broader scope that ranges from the redesign of processes, products and business models, to the optimization of the use of resources. There are criticisms of CE either because of its various definitions or because of the different local, national and international strategies for its implementation. However, it is certain that moving from a linear economy to a circular one will bring benefits to the environment. The transformation process is still slow and it is noticeable, little progress in global circularity, this due to the different approach and level of development of nations. In fact, a great challenge is the development of new technologies and systems that support the circular economy, namely new recycling technologies, such as chemical recycling, which can convert plastics back into their original building blocks for reuse, and friendly digital platforms that can enable the sharing of resources and materials. Another challenge is the lack of infrastructure and investment in recycling and reuse systems, particularly in developing countries, while in EU countries have legal targets to meet recycling objectives, which facilitate the implementation of EC in their countries and, on the other hand, they have the financial capacity to implement them.

The circular economy goes beyond the scope and focus of waste management and recycling actions, aiming at a broader scope that ranges from the redesign of processes, products and business models,

to the optimization of the use of resources The transition from a circular economy to a linear economy depends on factors such as: circular innovations, consumer interest in adopting waste management through a 3R approach, the high initial capital costs, and the pollution caused by recycling, the durability of recycled products, high-energy consumption during recycling.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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