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Circular Economy and Its Conceptual Hurdles

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Introduction

The concept of circular economy (CE) has become one of the most important pillars of climate change mitigation efforts as its implementation seeks to decouple economic growth from resource use. Despite this key role in decarbonisation, research on CE is still fragmented across various disciplines.

This paper, first in a series of publications on circular economy[1], reviews the growing literature on CE with the aim of improving the understanding of the concept based on an overview of its various definitions and meanings. There is a pressing need to develop a more holistic and comprehensive understanding of the concept and the principles that fundament CE as legislation, national strategies and public policies are being formulated and will be later implemented based on this apprehension.

Definitions, Concepts and Principles

Despite gaining significant attention from scholars and practitioners, the concept of CE is rather an "underspecified notion, difficult to describe, and comprising elements from diverse areas" (Kirchherr et al., 2017). There is a plethora of points of view about CE in the related literature, some of which formulated by scholars, professionals, governmental bodies and international institutions into various definitions, each echoing their particular aspirations (Sillanpaa and Ncibi, 2019). **The absence of a common understanding on the meaning of CE opens space for misinterpretations and creates the premises for a wrong application of the notion.**

Numerous definitions and interpretations were put forward by various legislative entities such as the European Commission (EC), international organizations

[1] Once the conceptual framework is specified, a second publication will offer a mapping of the major CE policies and regulations existing at the EU level to better understand the conditions as well as the structure of the institutional set-up that define the play-level field for CE. Lastly, a case study report on Romania will explore the state of the art in the built environment from a CE perspective in order to identify which practices are currently being implemented and which need further development. Subsequently, a set of policy recommendations will be proposed to advance the circular transition within the built environment in Romania.

(OECD, UNDP, WEC, WEF, Club of Rome etc.), NGOs and consulting firms (Kalmykova, 2018). For instance, one of the most popular and used definitions of CE is the one advanced by the Ellen MacArthur Foundation (EMF): "an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts toward the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems and business models" (EMF, 2015).[2] This definition builds on three key pillars that together lay the foundations for advancing CE transition, namely: (i) creating a closed system, where materials are continually kept at their highest value with negligible environmental damage, (ii) preserving natural capital and increasing resource efficiency, and (iii) adopting effectiveness as a standard. In another description offered for the concept, EMF stresses the significant contribution CE brings to decouple economic growth from resource use (EMF, 2015).[3]

Similarly, the United Nations Environment Programme (UNEP) advanced its own definition of the CE, perceiving it as an economic model that generates "low consumption of energy, decreased emission of pollutants, and high efficiency, using CE as a generic term for industrial economy, which is, by design or intention, restorative" (Skene, 2017).

The concept has also gained prominence in the EU energy and climate policy architecture through the adoption of the Action Plan for the Circular Economy (EC, 2015). However, since it represents a far-reaching legislative package encompassing various policy proposals on matters such as sustainable product design and waste management, no explicit definition of CE was provided in the plan. In other official EU documents, CE was described as "a production and consumption model which involves reusing, repairing, refurbishing and recycling existing materials and products to keep materials within the economy wherever possible […] waste will itself become a resource, consequently minimizing the actual amount of waste".[4]

[2] Subsequently, this definition has been adopted by academia, governments, and various international organizations, including World Economic Forum (WEF) (Sillanpää and Ncibi, 2019).

[3] On the other hand, assuming economic growth is still desirable, CE should provide compelling reductions in terms of environmental impacts in order to consider the economic development it ensures as preferable to that originating in the prevailing economic model. In other words, "while the focus is still on making business operations profitable, in a CE model, this is achieved by embracing a number of regenerative and closed-loop strategies" (Cristoni and Tonelli, 2018), such as switching to bio-based materials and green energy sources, designing for a prolonged use, refurbishment, remanufacturing and components recovery.

[4] EU parliamentary research service. Circular economy. Available online at: http://www.europarl.europa.eu/thinktank/infographics/circulareconomy/public/index.html

The academic world has also generated several proposals to define this new emerging notion of CE. For instance, Sillanpää and Ncibi (2019) defined CE as: "an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow. […] CE limits the throughput flow to a level that nature tolerates and utilizes ecosystem cycles in economic cycles by respecting their natural reproduction rates". Geissdoerf et al. (2017) similarly define CE as "a regenerative system in which resource input and waste, emissions, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops".

Based on the already existing definitions of CE, de Jesus and Mendonca depict the concept as "a multi-dimensional, dynamic, integrative approach, promoting a reformed socio-technical template for carrying out economic development, in an environmentally sustainable way, by-re-matching, re-balancing and re-wiring industrial processes and consumption habits into a new usage-production closed-loop systems" (de Jesus and Mendonça, 2018).

One of the common principles that can be extracted from these different approaches is that of **maximizing the value of resources**, i.e., eco-efficiency, which is considered synonymous with CE by some (Kalmykova, 2018). Eco-efficiency[5] is regarded as "one of the several consequences of CE, along with economic value and job creation, reduction in emissions and waste, improved resource security and decreased price volatility" (Kalmykova, 2018). Waste management is also a common feature associated with CE.[6] According to various perspectives, the primary aim of CE is to design out waste and thus maximize the utilization of materials and products that would otherwise be quickly discarded or considered obsolete. To overcome these issues, the "main environmental strategies (the Rs): reduce, reuse, recycle and recover" (Kalmykova, 2018) should be implemented.

[5] To offer some clarity to the debate, Kalmykova (2018) makes the following distinction between eco-efficiency and eco-effectiveness: the former is an approach based on "minimizing the volume, velocity, and toxicity of the material flow system" while eco-effectiveness requires "the transformation of products and their associated material flows such that they form a supportive relationship with ecological systems and future economic growth".

[6] CE has most often been considered just an approach to more responsible waste management (Ghisellini et al., 2016). Such a narrow approach could induce CE to be unsuccessful regarding the transition and not take full advantage of the opportunities that the model implies. Instead, it requires a broader and more comprehensive perspective. CE bears the possibility to "understand and implement radically new patterns and help society reach increased sustainability and well-being at low or no material, energy, and environmental costs" (Hofmann, 2019).

Reconceptualization of CE

Many of the existing definitions of CE are too equivocal and inaccurate, while their advocates usually do not manage to correlate them or stress enough the importance of their conceptualizations.[7] This is why CE is frequently depicted as an 'umbrella concept' essentially rooted in concerns around resource and waste management. As confusion on the meaning of CE and divergence regarding its terminology in use still exist (De Angelis, 2018), establishing an unanimously accepted interpretation of CE is a laborious endeavour. Therefore, the concept may be operationalised through a set of characteristics, rather than a universally applicable definition. Prieto-Sandoval et al. (2018) suggested four key aspects: "the recirculation of resources and energy, the minimization of resource demand, and the recovery of value from waste, a multi-level approach, its importance as a path to achieve sustainable development, and its close relationship with the way society innovates". Each aspect demands further unpacking.

Firstly, the CE is at its core a model where resources, materials and energy constantly re-entering the production cycle therefore reducing the impact of one's operations on the environment. This simple explanation can be further broken down into four more practical principles: (i) it seizes green technologies and focuses on a more sustainable use of natural resources by reducing to a minimum the need for raw materials, (ii) it maximizes the utilization rate of assets, keeping the value of products at its highest during every stage of the life cycle (iii) it emphasizes capabilities to set up circular flows of materials and products and (iv) it minimizes and gradually phases out negative externalities (water and air pollution, soil degradation, release of chemicals etc.).

Secondly, CE aims to circulate materials and products at their highest value for as long as possible. One way circularity can be endorsed is through practices of product life extension (Rizos et al., 2017) such as cycles of maintenance, repair, refurbishment, and remanufacturing. Furthermore, improving the way products are designed could provide more durable goods and support recovery practices. For instance, one potential approach would be to regulate these aspects through establishing precise mandatory requirements on product lifespan, repairability and recyclability of the product.

Thirdly, the concept is characterised as a system that is 'restorative and regenerative by design' (EMF, 2015). In the specific context of CE, this implies a

[7] CE approaches may differ depending on the industry it applies. Those lead to a number of industry-oriented conceptual frameworks and models that are robust and applicable to specific areas, but not necessarily to others. As a result, practitioners and researchers have a comprehensive set of artifacts available for use, but, on the other hand, the lack of a common ground among them may hinder standardization and assessment.

continuous positive development cycle that preserves and enhances natural capital, optimise resource yields, and minimise system risks by managing finite stocks and renewable flows. A CE system replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, and aims for the obsolescence of waste (Rizos et al., 2017).

Finally, the CE model brings an innovative way of consumption and production that aims to offer a more sustainable vision, moving beyond mere economic growth as an indicator of well-being. New conceptualisations of CE have incorporated the social dimension while modern notions and practices such as collaborative consumption, sharing and performance economy now enhance the CE lexicon. In order to advance its conceptual development and, eventually, reach a consensus on the definitional aspects, CE should not be limited to engineering processes but include within its framework social concerns, public acceptability issues and behavioural transformation.

To conclude, CE represents an all-encompassing concept, an aspect that makes its conceptualization as well as its operationalisation a very laborious endeavour. Rather than aiming for an unanimously and far-reaching CE definition, **a set of univocal features might prove more effective in establishing a functional conceptual framework for CE.** Therefore, when designing CE related public policies, strategies or vision documents, policymakers should ensure that the following elements are taken into account:

1. Shifting to a closed-loop production model, which entitles the elimination of waste and emissions as well as the continuous channelling of outputs.

2. Prolonging the lifespan of resources and products by implementing new and more efficient designs, technologies and production practices.

3. Limiting the throughout flow to a level that nature tolerates and utilises ecosystem cycles by respecting their natural reproduction rates.

4. Creating simultaneously economic, social and environmental value.

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