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Article

The Circular Economy: Recent debates and research trends

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Abstract: The Circular Economy is one of the most prominent cross-disciplinary and cross-sectoral concepts to emerge in recent decades. It has permeated academia, policymaking, business, NGOs, and the general public, leading to numerous applications of the concept, some of which only partially overlap. In this article, we review recent debates and research trends in the Circular Economy, outlining the ten most common groups of its conceptualizations using the PRISMA (Preferred Items for Systematic Reviews and Meta-Analysis) method. We then propose a post disciplinary and transnational research program on the Circular Economy that would not only combine hard and soft sciences in unprecedented ways but also have important practical applications, such as developing tools to embed the Circular Economy in natural, technical, economic, and socio-cultural settings.

Keywords: Circular Economy; global sustainability; circularity concepts; research trends; sustainable business models; European Union; United States of America; China

1. Introduction

The Circular Economy (CE) is one of the most prominent concepts to come to the fore in the past decade in business, academia, and policymaking. This does not come as a surprise and is not without its costs. Businesses have adopted it since it opens new business opportunities, gives rise to new business models, and develops new markets, domestically and internationally (Rizos et al., 2016), a result of both business motivations (Geissdoerfer et al., 2018) and the changing preferences of consumers (Rovanto and Finne, 2023). The spread of sustainable or "green" products and services, driven by enterprises implementing CE principles, attests to the CE concept's growing popularity. Furthermore, its increasing prominence in transdisciplinary research, where it is being explored and contrasted with traditional concepts, such as "environmental sciences" and "sustainable development," underscores its emerging importance in solving today's complex environmental challenges (Sauvé et al., 2016). The increases in academic literature, research funding, conferences, training programs focusing on CE, and the increased emphasis on CE in international policy agendas and corporate sustainability reports all show that it is becoming a more relevant and influential (Sauvé et al., 2016). Additionally, it has permeated policymaking in two of the three largest global markets, the European Union and China.

The European Union accepted CE as a key part of its previous grand strategy, Europe 2020 (Mazur-Wierzbicka, 2021), which set the goal to move in the direction of smart, inclusive, and sustainable development (Rodríguez-Antón et al., 2022) and is an integral part of Agenda 2030, a United Nations strategic document that was,

together with its Sustainable Development Goals, accepted as the current EU grand strategy, with strong implications on other European, national, regional, and local documents, strategies, and policies (Friant et al., 2021). In 2020, the European Commission (EC) approved the European Green Deal (EGD) with the Circular Economy Action Plan (CE Action Plan) as one of its main building blocks, thus cementing it as a strategic priority (European Commission, 2019a, 2020a). According to the Ellen MacArthur Foundation (2017), CE represents the EU's way of dealing with the pressures of growing economies and consumption of limited resources and environmental capacity as one of its most thoroughly developed concepts.

China has also recognized and seems committed to CE due to the tremendous environmental costs caused by its rapid economic development and resource scarcity (Ghisellini et al., 2016; Su et al., 2013). In view of this, China accepted CE in its national strategy as early as 2002 and included it in its 12th five-year plan for economic and social development (Su et al., 2013), as well as in its 13th (2016–2020) and 14th five-year plans (2021–2025) and Vision 2035.

The United States is the only one of the three largest markets that do not have CE as a part of its official grand strategy. Nevertheless, several decentralized CE initiatives exist in the U.S. (Wang et al., 2014). Other parts of the world still need overarching policy coordination in CE, although some initiatives exist. One example is the young but ambitious African Circular Economy Alliance (ACEA), which brings together a growing number of member countries and institutions to accelerate Africa's transition to the CE (Ellen MacArthur Foundation, 2023).

However, there are differences in approaches. While China has adopted the top-down principle in implementing CE (Merli et al., 2018), because of its centralized political system, the European Union is promoting bottom-up initiatives due to the principle of subsidiarity. The CE Action Plan explicitly emphasizes the engagement of all target groups: industry, policymakers, businesses (especially SMEs), HEIs, NGOs, and individual citizens as stakeholders in civil society.

The EC (2019b, 2019c) notes that CE is now an irreversible, global, and contemporary megatrend; nevertheless, much is still needed to scale up action at the EU level and globally to close the loop fully and provide the competitive advantage it brings to the EU economy. CE, therefore, opens new business opportunities, gives rise to new business models, and develops new markets domestically and outside the EU.

Using only technological and commercial ways to adopt CE to apply material circulation and sustainable growth on the basis of our current linear economic system will yield a different result. It will not be enduring and will intensify the challenges we are currently experiencing (Kara et al., 2022). Increased efforts will be needed in this field to implement the revised waste legislation and develop markets for secondary raw materials. Furthermore, the work started at the EU level needs to be accelerated at some point if the EU wants to reap all the benefits of transitioning from a linear economy to a CE. The linear economic system is a classic economic model in which natural resources are harvested, converted into products, consumed, and ultimately discarded as trash. This method presupposes that resources are limitless and may be used indefinitely. However, as the world's population rises and our consumption habits become increasingly unsustainable, it is evident that this paradigm will only be feasible in the short run. Hence, the almost universally accepted goal, also evidenced

in the UN Agenda 2030 and its Sustainable Development Goals, is to create a more sustainable and resilient economy that works for everyone while protecting the planet's natural resources and systems. In comparison to the linear production model, CE is a regenerative economic model that strives to keep resources in use for as long as feasible. Products are intended to be reused, restored, and recycled rather than dumped as garbage. Water, materials, and energy are to be included in circular flows. This strategy necessitates a fundamental transformation in how we design, manufacture, and consume goods and services and a shift in how we think about waste. The CE is founded on the concepts of reducing, reusing, repairing, refurbishing, and recycling, and it is intended to create a closed-loop system that decreases waste while increasing resource efficiency. However, the change from a linear production economy to a CE involves a paradigm shift in how we view economic activity.

As a result, the CE idea has become increasingly prevalent in policy frameworks at the regional (e.g., in the Brussels regional CE plan), national (e.g., in the Italian National Recovery and Resilience Plan), and supranational (e.g., in the European Green Deal) levels (Mansuy et al., 2022). However, translating the goals outlined in those frameworks into actual activities may take time and effort. Focusing on the concepts, this article also provides different visions of CE. It addresses a persistent issue: CE has shown to be a strong, motivating, and mobilizing concept, but it is difficult to implement. However, many descriptions and concepts are already available. This fuels debates about what should be the real, the desirable, and the proper understanding of circularity. While CE has been readily accepted, we must be aware of the difficulties of providing clear definitions, which have significant consequences in business decisions, policy making, and academic debates across the disciplines. We are still at the stage at which a plethora of partially overlapping definitions and research approaches are employed, making it more difficult to develop a more unified research program.

As a result of its proliferation and (over)utilization, the "genotype" concept of CE has evolved into a number of "phenotype" applications, making it at times difficult to understand what a specific article or document is referring to. In this, CE is following the fate of other trendy concepts, for example the concept the social capital (see Adam et al., 2003). However, we believe that this will remain a very relevant concept in research, policymaking and business. Hence, the debates will benefit from bringing some order to the "chaos" of the recent debates and research trends and point to relevant future directions in which research programme could evolve.

For that purpose we provide an overview of recent debates and research trends. We start by presenting key research approaches addressing CE. We continue by outlining the most useful groups of concepts of CE that have emerged in the last decade. We use PRISMA approach to group them and develop a taxonomy. We then propose a research program in the field of CE that would not only combine the hard and soft sciences in unprecedented ways but also have important practical applications: the development of tools for embedding CE in natural, technical, economic, and socio-cultural settings. In this article we do not develop new approaches or definitions. Rather, we aim to bring some clarity to the debates.

2. Methodology

This article provides an overview of recent debates and research trends on CE concepts and research. It, therefore, relies heavily on an extensive systematic literature review using the PRISMA (Preferred Items for Systematic Reviews and Meta-Analysis) approach. The authors have followed the PRISMA 2020 flow diagram (Page et al., 2020) for new systematic reviews, which included searches of databases, registers and other sources (**Figure 1**). This approach enables us to provide a clear and reproducible process of analysis and reporting of previously conducted research on CE concepts (Denyer and Tranfield, 2009).

The exploration in the article is divided into two main segments. First, data were extracted and collected from multidisciplinary databases, namely Web of Science (WoS), Scopus, Core Collection, ScienceDirect, and other secondary resources from the authors' own databases, and previously collected resources, which record scientific articles, reviews, books, and other documents (including meetings notes, generating useful information for authors evaluating scientific activity from 2014 to 2023. Second, numerous articles have been examined, considering the basic aspect of the "conceptualisation, methodology and its research," which have been recovered from sustainability issues, for which the distinction of the research approaches to review structural dimensions and analytical concepts is crucial. Document analysis has been taken into account with the results of qualitative content analysis. Analysing qualitative data, characteristics of CE, and scientific research enriches and enhances a better understanding of current CE research issues and their concepts.

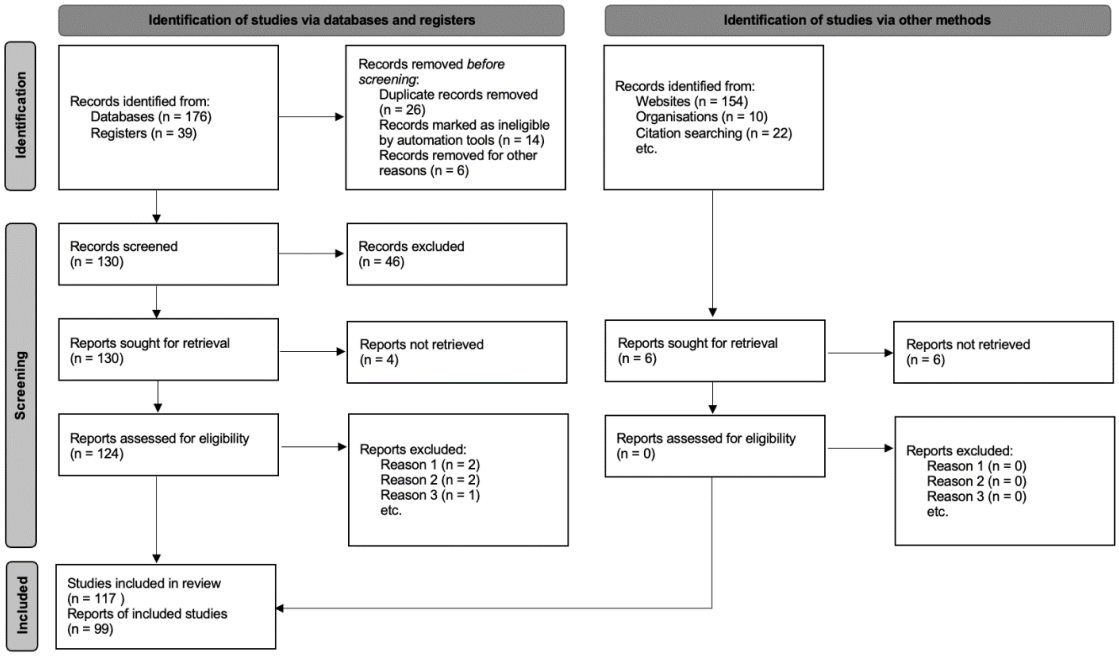

Figure 1. PRISMA 2020 flow diagram for new systematic reviews (databases, registers and other methods).

PRISMA 2020 flow diagram shows the flow of information through the different stages of the systematic review and provides the number of records identified, included and excluded, and the reasons for exclusion. The literature and other sources include

117 sources/items (e.g., articles, chapters, case studies, and interviews), which fall into the types as mentioned above according to the typology of works and have therefore been included and reviewed. The 117 sources/units included in the review met the three inclusion criteria—they deal with 'concepts', 'methodology' and 'researching concepts and methodology of CE'. The excluded records have not addressed these criteria.

3. Concepts regarding CE

CE, whether observed as an empirical outcome or as a theoretical, normative concept, is not only based on technological and economic factors but is also shaped by social forces (institutions, social networks, cognitive frames) as defining structural principles, as argued by Džajić Uršič (2020). A closer look at the various CE concepts aids in understanding the theoretical background. Observing and understanding various concepts and definitions enables perceiving how CE is applied in different contexts and sectors.

The authors acknowledge the complexity of the CE field, which is characterised by a proliferation of concepts that are often scattered and overlapping. This recognition aligns with the observations made by Gregson et al. (2015), who describe CE as "a notion and an ideal." Unlike previous studies that may have tackled CE from a single academic standpoint, this article draws on a wide range of disciplines, including ecology, economics, law, ethics, system dynamics, and organizational studies. The authors also reiterate Hoffmann's (2003) argument for the significance of incorporating social ideas into IE to achieve sustainable development.

To further strengthen the article's justification for the inclusion of 10 "sub-sections" as follows, the authors have structured the selection of concepts by considering existing literature based solely on CE concepts, which is a key differentiator from some previous researchers who have followed a variety of different approaches (Audet, 2016; Dryzek, 2022; Homrich et al., 2018; etc.).

Once the relevant literature has been identified, the authors systematically group the appropriate studies based on their nature and characteristics. Each group of CE concepts included a certain range of CE topics that have common themes or characteristics. This contributed to an organized overview of the CE ideas by offering a more systematic and complete classification of CE ideas. This method provides a coherent and hierarchical presentation of CE principles, which might be useful for readers looking for a thorough overview. We arranged the CE ideas in the following sets: (1) the concepts of CE origin and its evolution/development; (2) a new sustainable paradigm (EU?); (3) challenge: a new paradigm or merely a new designation and/or renaming? (4) analysis of 114 definitions; (5) industrial and economic model for a sustainable society; (6) concepts and practices; (7) transformation of business models and their integration into practice; (8) positive and negative impacts on the economy; (9) effects on the economy; (10) restrictions. These concepts are briefly presented below.

(1) The genesis of the concept of circularity might be traced back to the advent of environmental consciousness. When we say "environmental and "ecological consciousness," we imply reflections and concerns about the influence of people's

actions on the biosphere. These problems are linked to capitalism and industrial development: they arose when economic processes advanced, significantly influencing the increased impact of economic processes and industrial development on our natural environment. This was due to the methods through which resources were exploited and the effects on landscapes. The concept of CE cannot be traced back to one single date or author but to diverse schools of thought. It is commonly believed that the concept was introduced by the environmental economists Pearce and Turner (1989), who built their theoretical framework on previous studies of the ecological economist Kenneth Boulding (Andersen, 2007; Boulding and Jarret, 1996; Ghisellini et al., 2016; etc.). Nevertheless, Pearce and Turner (1989) are not considered the initiators of the CE concept but did conduct a comprehensive evaluation of the literature and specified that the origins of CE are mostly in the context of or implemented in Industrial Ecology (IE) and ecological and environmental economics (Ghisellini et al., 2016). The Ellen MacArthur Foundation (2013) has promoted recent theories, such as Biomimicry and the Blue Economy, the Performance Economy, and Cradle to Cradle, adding comprehensibility to the CE concept. Pearce and Turner (1989) explain the alteration from the out-of-date linear or open economic system to the CE system. They also describe a CE model based on the following hypothesis: "There is an extensive interdependence between the economy and the environment. They explain four economic functions of the environment that can be identified and affect the development of a CE: amenity values (e.g., the beauty of landscapes), provision of resources, sink for waste and emissions, and life-support system (Turner et al., 1993).

(2) The underlying uniqueness of CE concepts also involves decoupling resource reduction and development under the idea that ever-growing economic development and profitability can happen without ever-growing pressure on the environment (Frosch and Gallopoulos, 1989). The new sustainable industrial paradigm, as stated by Frosch and Gallopoulos, "would change the linear model into a more united industrial ecosystem" (Frosch and Gallopoulos, 1989, p. 144). They endorse the embedded integral circularity and suggested overflows of industrial processes that should operate as raw materials for other processes, "the industrial ecosystem would function as an analogue of biological ecosystems" (Frosch and Gallopoulos, 1989, p. 144). This principle re-emerged years later in more defined forms known as "biomimicry" (Benyus, 1997) and "biomimetics." CE has not yet been fully accepted as the new paradigm, but the hope remains that it will become one in the near future. Thus, this article also attempts to contribute to this process by discussing the scientific and research aspects of some concepts of CE that need to be further endorsed.

As Ehrenfeld (2000) argues later, CE is a societal paradigm that contains a set of structures on top of which social action is created, and CE may be argued to have the potential to become a paradigm in which industrial production and consumption will change fundamentally. This paradigm is our underlying worldview; it is the vocabulary with which we understand and interpret the world and our place in it. It is the basic philosophy of culture and societal development in the global society. However, in the European Union (EU) and elsewhere, CE is frequently pushed as a new sustainable paradigm. The EU has established a CE Action Plan (European Commission, 2020b) to accelerate the transition to a circular economy and increase the EU's

competitiveness while lowering its environmental effect. Some EU members have already enacted CE legislation, policies, and initiatives, such as extended producer responsibility programs, waste reduction objectives, and eco-design requirements. The EU's CE Action Plan includes measures to encourage sustainable consumption and production, such as a proposal for a "right to repair" and a ban on single-use plastics (European Commission, 2020b).

(3) Is CE really a new sustainable paradigm? Or is it just a redefinition of something under our noses the whole time? CE began appearing regularly in technical journals under the review field of environmental economics (EE). In 2018, the World Economic Forum officially endorsed the concept in association with some governments and non-governmental organizations (NGOs), such as the Ellen MacArthur Foundation and the World Resources Institute (WRI). The Platform for Accelerating the CE (PACE) document was published to encourage developments in adopting CE principles. Some multinational corporations also participate in implementing PACE. This idea of development is now included in the European Union Horizon 2020 program, while implementation documents have been prepared by EU standards agencies (Sikdar, 2019).

The implementation of user recycling arrangements aims at a higher level of source splitting and encompasses a connected set of changes regarding new organizations, appropriate product design, and new disposal behaviors (Baxter and Childs, 2017). The other way of reuse is concerned with business models, which involve changing the relationships inside value chains and assuaging doubts related to financial risk. The last is associated with future consumer requests and high capital requirements (Linder and Williander, 2017). Given the role of social embeddedness in all its varied forms as structural, political, cognitive, spatial, chronological, and cultural embeddedness (Boons and Howard-Grenville, 2009), it is crucial to implement the CE or the discussion concerning waste is "a social process of valuation and the industrial, political and economic means of its realization" (O'Brien, 2008, p. 5). The CE concept, therefore, suggests that further integration of social theories into IE is necessary to achieve sustainable development. Views from other disciplines, especially sociology, economy and economics, law, ethics, system dynamics, and organizational studies, must be included in IE beyond merely superficial linking (Hoffman, 2003).

As explained by Cottafava et al. (2019), it is apparent that several study streams emerge from various epistemic domains, especially ecology, economics, and bioeconomy. As a result, the growing importance of CE in achieving the overarching goal of "sustainable development" prompted researchers to devise novel approaches to understanding it through various "field-specific" interpretations. The depth of CE's epistemological subtleties prompts sceptics to question its potential, claiming it needs more conceptual clarity. CE has been defined by Gregson et al. (2015), as "a notion and an ideal", while Brennan et al. (2015, p. 610) emphasize that "theoretical or paradigmatic clarity about the concept of CE has yet to fully emerge".

(4) We discovered that there is no single, globally accepted definition of CE, but rather a spectrum of definitions reflecting various interpretations and implementations of the idea. The study of the 114 definitions did, however, reveal some similar themes and features. There is an interesting study about the CE definitions, as discussed by

Dahlsrud (2006). First, relevant stakeholders are interviewed to determine if they understand the concept; it has been found that these stakeholders often refuse to provide thoughtful ad hoc responses (Johnston and Beatson, 2005; O'Dwyer, 2003). Second, a collection and analysis of written contents and definitions were obtained. However, some common themes and elements emerged from the analysis of the review of 114 definitions conducted by Kirchherr et al. (2017); the authors Kirchherr et al. (2017) used three approaches to develop a representative sample of CE definitions. First, they retrieved definitions from the CE literature sample set by Ghisellini et al. (2016), which is said to be representative of writings on CE (European Commission, 2019a). The sample includes 155 articles, but only 74 of them mention the term "CE," and of those, 54 define it, according to our analysis. Second, they searched Elsevier's Scopus for the term "CE." Next, they skimmed the results of these searches specifically for conceptual literature on the assumption that this literature would contain definitions. They also skimmed the bibliographies of identified conceptual articles. Thirdly, they included all definitions outlined in a recent special issue on the CE in the Journal of Industrial Ecology. A total of 114 CE definitions were collected. This research is interesting and demonstrates the opposite of what we thought: the understanding of the CE is much wider than its present meaning (Kirchherr et al., 2017). Interestingly, Kirchherr's opinion from 2022 is particularly critical of the current state of sustainability and transition literature. The author argues that a significant portion of the research in this area can be categorized as "scholarly bullshit." This work contributes little to advancing knowledge but is produced mainly to meet the current academic system's demand for high citation counts and to gain tenure or secure promotion and funding. Kirchherr (2023) uses his work on CE as an example of this "scholarly bullshit." It is a critique of 114 definitions of CE that culminates in proposing the 115th definition of the term. This resonates with our research, which also emphasizes the difficulty of providing clear definitions of CE and acknowledges the prevalence of partially overlapping definitions and research approaches.

(5) The dependence of the CE on rule systems becomes even more evident when examining the initial three key value concepts and their condition for realization: the three Rs (Reduce, Reuse, and Recycle) as the most relevant principles of CE. The three Rs embody the operative ideas or values of the industrial and economic model for a sustainable society. Their realization, however, is not causally founded in any natural propensity of society but dependent on rules and habits that emerge and become ingrained in people's minds due to external pressures. We can imagine such pressures to be of a top-down enforced nature or as self-imposed individual responsiveness to deteriorating environmental conditions. Given the circumstances, the realization of such values requires time and repeated practice and is thus bound to happen along a learning-by-doing trajectory. Any know-how, such as how to put in place the 3 Rs since values that are not memorized in the mental maps of society will disappear over the generations. Institutions normally function as a remedy against such knowledge loss and can also instruct individuals in society on how to handle emerging (socio-economic) challenges. In this regard, any materialization of CE is based upon a complex combination and sequencing of rule-based structures. Most of the time, "CE" refers to a model of production and consumption that is fundamentally different from

the “linear economy” model that has dominated society.

CE is also described as an approach through a systems design outlook, and understanding it through practical case studies is the most common approach. It can help to describe and develop the CE paradigm; one possible difficulty is the unclear situation of the objectives of a CE. A difference can exist between individual and system-wide ideal approaches, while CE aims at planning better systems (Velte et al., 2018). Hence, the literature is full of best-practice examples of CE in industrial countries. Practices are centred on optimizing the use of energy required for the product’s manufacturing and sale, employing sustainable design or eco-design techniques, and employing innovative materials that are less polluting and more sustainable for society (Velte et al., 2018). The majority of practices are suitable models to recycle and reuse materials for the same or new products, reducing energy use and drastically reducing waste. The United Kingdom, Germany, Netherlands, France, China, Norway, Finland, Denmark, and Sweden are countries that have advanced best practices of the CE. The long-lasting goods sector (electronic, electrical, carpets, furniture, etc.) and the cloth sector have advanced some interesting practices in the CE (Valavanidis, 2018). A literature review bears numerous publications that conclude there is interest in providing industries with models, methodologies, and tools that facilitate the adoption of efficient environmental management and production practices for a sustainable society (Velte et al., 2018). Several publications, for example, focus on creating circular economy models, which strive to establish closed-loop processes and reduce waste. These models provide the industry with a framework for building more sustainable goods and processes and chances to recover and reuse resources (Geissdoerfer, Savaget, et al., 2017). Additional articles are concerned with developing sustainability assessment tools and procedures that may assist industries in measuring their environmental, geographical and social impacts and identifying opportunities for improvement to enable innovations (Jagtap et al., 2021). These technologies can also assist industries in identifying best practices and standards for long-term production and management (Kourtit et al., 2021; Lieder and Rashid, 2016; Tuenge et al., 2013).

(6) Different authors have detailed definitions of the concept of CE; Geng and Dobestein (2008) argue that CE is understood to mean the realization of a closed loop of materials flow in the whole economic system, implying a closed loop of materials, energy, and waste flows. Yuan et al. (2006) say that the concept of CE was promoted in China as a new development strategy to alleviate the shortage of resource supply by improving resource productivity and the eco-efficiency of production and consumption, which will accelerate the economic transformation from economic growth to economic development. The difference between the two modes is that economic growth relies on a continuing increase of resource inputs while economic development relies on the improvement of efficiency (resource productivity and eco-efficiency. Park et al. (2015) claim that the CE policy seeks to integrate economic growth with environmental sustainability, with one element relying on new practices and technological developments, similar to the application of emergency medical technicians (EMTs). Ma et al. (2019) argue that CE is a model of economic development that aims to protect the environment and prevent pollution, thereby facilitating sustainable economic development. Wang et al. (2014) state that CE is an

important way to protect the environment and resources and to achieve sustainable development; it can transform a traditional linear growing economy, which depends on resource consumption, into an economy that relies on the development of ecological resource circulation; while Haas et al. (2015) say, "the CE is a simple, but convincing, strategy, which aims at reducing both, the input of virgin materials and output of wastes by closing economic and ecological loops of resource flows." Haas et al. (2015) added also that in CE, material flows are either made up of biological nutrients designed to re-enter the biosphere, or materials designed to circulate within the economy (reuse and recycling). Prieto-Sandoval et al. (2016) propose the following definition: CE is a social, environmental, and economic paradigm, whose purpose is to prevent the diminution of resources and revitalize environmental resources through the closed loops of materials and to decrease the loss of energy in the process.

As explained by Brennan et al. (2015) in the study of Geissdoerfer et al. (2017), the concept of the CE, which is no longer new, has gained much importance on the agendas of policymakers (Brennan et al., 2015). This becomes evident, for instance, in the comprehensive European Circular Economy package and new CE Action Plan (European Commission, 2020a) but also Chinese Circular Economy Promotion Law (Lieder and Rashid, 2016).

(7) The transformation towards the CE concept guides firms to change their structures, competencies, and policies/approaches. In this review, the literature on the transformation of business models and their integration into the practice of CE primarily emphasizes the transformation of embedded linear prevailing business models (Bocken et al., 2017; Lewandowski, 2016; Winans et al., 2017). Some recent researchers analyzed the role of business models in allowing the transition to the CE (Centobelli et al., 2020; Chen et al., 2020; Hoffman, 2003; etc.). The drastic change in firms' existing business models is in line with the dynamic competence of firms to adapt to new changes in the system (Teece et al., 1997). The study by Khan et al. (2020) revealed the dynamic capability of appointees to identify the business opportunities enabled by CE principles. Nevertheless, the risk of changing a necessary business model may create inconsistent conflicts in CE decisions. The principles of CE affect the way firms create, deliver, and capture value in their business model (Bocken et al., 2017; Stål and Corvellec, 2018). This new business model entails employees and managers being engaged in the process of changing the organizational culture and inspiring the firm to take advantage of the opportunities offered by the CE (Rizos et al., 2016; Stål and Corvellec, 2018; Ünal et al., 2018). As stated by Elkington and Smith (2016, p. 27), "McKinsey estimates that shifting towards circularity could add $1 trillion to the global economy by 2025, creating 100,000 new jobs within five years." This presents a tremendous opportunity for organizations that are able to extract value from reducing waste in the system. Besides the obvious ecosystem benefits, CE initiatives can be significant catalysts for economic growth. Achieving these benefits requires businesses to actively transition from a linear model to a circular one. This transition includes self-reflection and an authentic assessment of current business models, so firm leaders need to ask themselves if their business model is at risk of becoming too expensive, too unproductive, or inappropriate in regard to growing sustainability market challenges and demands (Singer, 2017).

(8) Transitions of the economic model from manufacture-consumption-waste to a manufacture-consumption-reuse economy requires the participation and duty of several stakeholders, especially producers, users, and policymakers (Laurenti et al., 2018). Value co-creation among these stakeholders is a critical part of the feasibility of the CE economic model, with positive impacts on the economy's sufficiency, society, and the natural environment. For example, the positive/negative impacts on the economy of the CE approach have been guided by the study "Growth Within" (Ellen MacArthur Foundation and Environment, 2015), based on a large meta-analysis of existing literature on the employment effects of material and resource efficiency. The "Growth Within" report from the Ellen MacArthur Foundation argues that the direct redistribution effects between the waste and recycling sectors (positive) and materials sectors (negative) are equal. The nature of the employment effects thus depends on the indirect and induced effects of the CE, which are described to be a net negative for manufacturing sectors (the manufacturing sector faces significant public concern due to issues like toxic waste, environmental disasters, pollution, biodiversity loss, and climate change. While sustainable development aims to find a compromise, the irreconcilable differences between "anthropocentric and ecocentric paradigms" (Trollman et al., 2021, p. 1053) hinder a harmonious solution (Purser et al., 1995), but strongly positive overall due to the rebound effect of increased consumption due to overall lower prices across all sectors and some additional "eco-innovation" jobs (Ellen MacArthur Foundation and Environment, 2015). In addition, CE relies on further digitalization and automation. Stegeman (2015) argues an essential problem in the macroeconomy where the macroeconomic cycle is the focus. Not the materials cycle or the effect on inventories of natural resources or waste. The flows of goods/services, incomes, and production are counted towards Gross Domestic Product (GDP), so the gap that analysis must carefully bridge is the gap between the macroeconomic conceptual framework and the effects of change because of the CE. To summarize positively, CE leads to cost savings for businesses and reduces their environmental impact in industries related, to job creation and economic growth, improving public health, reducing costs associated with environmental damage, and increasing public support. However, CE practices often require significant investment in new technology, infrastructure, coordination, and investment from multiple stakeholders. The most negative aspect is job losses because of insufficient technical skills and abilities that are not yet present in the workforce in some sectors (Džajić Uršič, 2020; Fric et.al., 2023) with issues like lack of skills being detected in other sectors as well (Besednjak Valič et. al., 2023).

(9) As the previous paragraph mentioned, CE has indubitably much more positive rather than negative effects on the economy; instead of today's take–make–dispose of a linear model of production, CE is restorative by design-using and reusing natural capital as efficiently as possible and finding value throughout the life cycles of finished products (Vishwakarma et al., 2022). Three major principles govern the CE and its effects on the economy: (1) preserve and enhance natural capital by controlling finite stocks and balancing the flow of renewable resources; (2) optimize resource yields by circulating products, components, and materials in use at the highest possible levels at all times; (3) make the system more effective by eliminating negative externalities" (Bouton et al., 2016). Significantly, CE's economic benefits reduce several strategic

issues that businesses confront today. For instance, material expenses are drastically cut by resale and component recovery, even without the benefits of yet-to-be-created circular materials and improved reverse technology. Also, "built to last" helps save warranty expenses and benefits beyond the price effect and extends to reduced costs of uselessness, increased choice, and secondary benefits (Džajić Uršič, 2020; Ellen MacArthur Foundation, 2013).

(10) The public and private sectors of CE initiatives are growing; however, there is a need for examination when concerning restrictions of various CE activities. Such restrictions are the constraints that arise when implementing CE principles. Despite the numerous advantages of CE models, significant problems and limitations that prevent their wider implementation exist. For example, landfill limits on specific materials and goods have generated motivation to pursue more sustainable waste usage in CE. This is especially seen in reducing food waste. As explained by Kumar et al. (2023), these obstacles include regulatory barriers (Mangla et al., 2018), a dearth of innovation in eco-friendly packaging materials for food waste reduction (Kumar et al., 2021), absence of circular design in food packaging, enforcement of environmental policies, limited market demand for recycled materials, insufficient digital infrastructure, issues related to refurbished products, and inadequate government support. These constraints, together with regulation and value considerations, require an immediate solution to the problem of composite material waste disposal. We must also mention the need for more awareness and understanding of the CE concept and infrastructure and technological limitations (e.g., standardization in CE practices can limit their implementation) (Ellen MacArthur Foundation, 2021).

The EC had intended to promote resource efficiency and waste reduction prior to the introduction of CE. The need is already outlined in the EU's Action Plan (European Commission, 2019c), where progress towards the restrictions of CE is clearly defined and measured. The CE Action Plan (2015) highlighted the need to implement new manufacturing practices influenced by circularity approaches rather than only in terms of effectiveness. The EC (European Parliament and Council, 2009) announced the establishment of resource efficiency objectives to aid in the development of more circular futures for products and services through a revised product policy, as well as the expansion of the Ecodesign Directive (Directive 2009/125/EC) to include resource efficiency standards (European Parliament and Council, 2009). Moreover, a set of regulations, including Directive 2019/904 (European Commission, 2019b), which limited the manufacture of single-use plastics, was released (Pinyol Alberich, 2020; Pinyol Alberich et al., 2023). The CE Action Plan (European Commission, 2019c) suggested economic incentives to encourage greater recyclable production and revising current EU legal instruments to align them with the CE. These commitments were made in 2018, when the EC announced a package of plans, including the options to address the interface between chemical, product, and waste regulation, the European strategy for plastics in a Circular Economy, and the monitoring framework for a Circular Economy. It seems that in the CE Action Plan (European Commission, 2020a, 2020b), the EU institutions took a more active role in promoting the CE transition by converting directives into rules, investing more funds in implementing CE practices and monitoring policy implementation. This move required greater government engagement without necessitating a high degree of innovation. Consequently, while

the EC's CE structure primarily fits into the category of circular modernity, some state-driven restrictions surrounding waste and product durability break this trend and offer member states a considerable role in market intervention.

4. New research program: Propositions

CE provides ample opportunities for a coherent transnational interdisciplinary or even post disciplinary research with substantial value added and in the following section we aim to outline its possible starting points. In fact, we see it as the outline of an entire international and interdisciplinary research program that would not only combine hard and soft sciences in unprecedented ways but would also have important practical applications, such as the development of tools for embedding CE in the natural, technical, economic, and socio-cultural settings. The proposed research program is an interdisciplinary research project dealing with dynamic complex networks, crossing boundaries, and being shaped by the technical, natural, computer, and social systems. This is possible because CE networks are such networks and such networks are noted as successful in different sectors (Besednjak Valič et al. 2022). Thus, research would contribute to studying sustainable economic ecosystems through interactions and exchanges between industrial flows and their surrounding environment, in which sustainability would not only be understood in ecological or environmental terms. We should emphasize that this field of research is steadily gaining ground, as the intentional development of novel CE networks in accordance with the systemic approaches of economy, ecology, and policy have significant potential to decrease the dissipation of energy and materials. This leads to the interest of researchers, policymakers, and businesses, which provides opportunities (Mohamed and Mativenga, 2019).

Any ambitious research program should be planned as a ground-breaking effort to provide interdisciplinary theoretical and methodological foundations for systematic research on dynamic CE networks. The aim should be to develop a theoretical model and adopt novel approaches and analytical techniques that will enable us and other researchers to gain new knowledge of the underlying foundations of CE and its observable facts.

To start such a program, one should divide the research enterprise into two main phases. The first should consist of a critical analysis of the literature and the development of contemporary analytical protocols. One should critically overview current state-of-the-art published research and analytical techniques and explore ways to significantly improve them for future research. Additionally, one should study the underlying structure of existing CE networks from both quantitative and qualitative points of view, using quantitative objects to theoretically model CE networks and design visualization and using qualitative research to fill gaps and explore new ideas.

In the second phase, if possible, one should test newly developed analytical techniques on reliable data from EU and non-EU countries. This would allow us to analyze the robustness of analytical techniques for the analysis of networks at different stages of development. Finally, several countries exist with no systematic efforts for CE and with only spontaneous small-scale networks. However, this could change in the future. Such countries can be especially interesting cases from the research

perspective on embedding CE networks in environmental, technical, and socio-cultural settings.

The crucial goal of such a project would be to use mathematical theory in connection with social disciplines to develop tools to research, analyze, design, optimize, and model (computational modeling) dynamic complex CE networks, including their structure, dynamics, and properties, and to determine how they are shaped by their interaction with technical, natural, computer and social systems. The research program would follow other more specific goals (Rončević and Fric, 2015):

1) Reviewing and consolidating state-of-the-art knowledge and research methods on the CE, including knowledge of CE practice, procedures, frameworks, and guidelines, as well as a review of scientifically verified technologies enabling these processes (decision support technology, ontology engineering, social networking, and user-centric technologies).
2) Developing sound system-theoretic and theoretical foundation and research methods for the analysis of complex CE networks by exploring the applicability of mathematical network analysis.
3) Developing knowledge models and knowledge methodologies capable of capturing and processing knowledge and information in CE networks. In this, it should especially focus on developing computer ontologies required to manage and facilitate CE implementation.
4) Investigating the mutually structuring communication CE networks with the technical, natural, computer, and social systems.

The comprehensive research program should especially emphasize the role of social systems on the dynamics of CE networks, specifically, how networks of relevant stakeholders (social networks), institutions (multi-level environmental and industrial policy and practice), and cognitive frames (public perception) influence their structuration. We intend to combine critical semiotic analysis with an evolutionary and institutional approach to political economy offers one interesting way to achieve this goal (Jessop and Oosterlynck, 2008) transformation from a linear to a circular economy in which an evolutionary and institutional approach to semiosis enables recognizing the semiotic dimensions of the political economy (Jessop and Oosterlynck, 2008).

5. Conclusion

CE has grown significantly in recent decades, which has led to the increased potential of the CE concept in everyday society and the widespread strategic national policy agendas of the EU Member States (Merli et al., 2018). This has resulted in greater recognition of the utility of CE concepts in everyday life and the inclusion of CE in the strategic national policy agendas of EU Member States. While waste streams, recuperation, and disposal continue to be important aspects of CE, the article emphasizes that circularity's significant contributions to climate change mitigation are viewed as a strategic national goal for the future, considering socioeconomic metabolisms. With this acknowledgement, researchers and practitioners can design tailored treatments and strategies to overcome barriers to CE adoption and optimize its beneficial impact by addressing these gaps.

The empirical research aims to differentiates the article with its organized taxonomy of CE, principles derived from a thorough literature analysis that includes many authors. Unlike earlier studies, it addresses conceptual obstacles in CE by giving a systematic framework that addresses overlap and dispersion concerns. Its multidisciplinary approach, which incorporates studies from ecology, economics, law, ethics, and other fields, provides a comprehensive view of CE. Including the EU's CE policies and activities in research proves its relevance in the world. It also adds an innovative and complete tool for comprehending CE, filling a critical gap in the literature and furthering CE studies.

First, we investigate CE with an organized approach providing a comprehensive analysis of the legislation and recent debates. Second, we grouped CE concepts and most related research approaches connected to the CE. The topic of CE is nowadays a known business approach. Still, in this case, we aimed to analyze it through a specific perspective, including various texts, publications, and articles (from several years through the authors' careers). The goal of this review follows its methodology, and the article presents the systematic state of the art of recently used concepts in the field of CE. Mostly it aims at a better understanding of trends and gaps in CE. The review of various research studies shows that a significant measure of academic work dealing with it was done. However, the outstanding concepts contribute a uniqueness for understanding CE and fill a crucial gap in the literature. While the article discusses trends and gaps in CE, it is important to note that adopting CE practices varies greatly among businesses and locations, demanding further detailed analyses.

Concluding, the awareness of CE's strategic role in addressing climate change and transforming socioeconomic breakdowns is one of the articles' key outcomes. Additionally, the systematic approach utilized in this empirical study permitted a thorough examination of CE recent discussions and trends, resulting in a deeper knowledge of contemporary CE practices and issues. Acknowledging its limitations, this research primarily focuses more on the European context, however such future research might investigate the worldwide landscape of CE adoption. Propositions for future research might focus more on specific obstacles that hinder the broad implementation of CE, such as infrastructure barriers and the necessity for established ideas. Multidisciplinary research initiatives should be more encouraged to investigate the interactions between CE and subjects such as sociology, economics, law, and ethics.

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