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Replaying the circular economy orchestra: The echoes of R and the symphony of I

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ABSTRACT

The Circular Economy (CE) is a pivotal pathway to achieving sustainability. This article critically reviews circularity strategies (Rs) and emphasizes the importance of not loosely categorizing any word starting with R as a new circularity strategy. It then discusses the rebound effect (another R) and the potential for overconsumption linked to CE. Furthermore, the article highlights the role of individuals, placing I at the heart of the narrative by emphasizing their pre-use and post-use roles and going beyond a consumer. It underscores that awareness does not necessarily lead to behavioural change or result in a fully circular society due to various factors such as urban/rural settings, social and cultural norms, financial status, beliefs and values, age, and gender. Finally, the concept of sufficiency and its relevance to CE are explored, highlighting the need to prioritize supply over demand and to use both bottom-up and top-down approaches.

HIGHLIGHTS

- Circularity strategies (Rs) are critically reviewed.
- Rebound effect within the Circular Economy (CE) is evaluated.
- The various roles of individuals (I) in CE are analysed.
- The sufficiency concept is linked with CE.

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1. Introduction

The first step in solving a problem is recognizing its existence. Climate change is undeniably a significant threat, rather than an opportunity. We are all aware of the ongoing existence of this problem, which continues to worsen over time. One may wonder why we, as humans, have not yet succeeded in finding a solution. The reality is that there is indeed a multitude, and perhaps even an abundance, of solutions. You can easily see the Eureka moment in the conclusion section of many publications on state-of-the-art technologies, claiming to be the solution to put an end to the climate change problem. Moreover, nearly every company assures us of its commitment to sustainability in their new products or services. Scholars have discussed concepts like

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the Circular Economy (CE), ecosystem services, industrial ecology, and resource efficiency as solutions for transitioning towards a sustainable society (Weetman 2021; Bocken et al. 2022). A clear pathway towards sustainability is still lacking within this stream of ideas.

Few ideas in the sustainability field have achieved the level of popularity and influence as the CE (Figge et al. 2023). While the CE continues to gain popularity, it also faces criticism (Villalba-Eguiluz et al. 2023). The CE is both transformative and ambitious, yet it remains open to interpretation, leading to ambiguity (Saidani et al. 2019; Morsetto 2020; Hatzfeld et al. 2022; Jerome et al. 2022; Nylén et al. 2023). While strategies and policies for the CE have been formulated, their actual implementation is still in its early stages. The transition from a linear to a circular economy requires organizational, technical, financial, and behavioural initiatives (Shevchenko et al. 2023) and there persist numerous challenges and gaps between the CE and sustainable development (Chen 2021; Hobson 2021).

The term circular economy was introduced by Pearce and Turner in 1990. However, even before that, Nicholas Georgescu-Roegen discussed the concept in 1971 (Georgescu-Roegen 1971) and Kenneth Boulding introduced the concept of a closed economy in 1966. Nowadays, nearly any environmental policy, particularly in Europe or Asia, mentions the CE (Brandão et al. 2020). It is based on the absence of waste in the system, while nature is regenerated (Ellen MacArthur Foundation 2023). Nonetheless, the idea of nature having zero waste has been questioned by various authors (Skene 2018; Iskrzyński et al. 2022).

The CE takes inspiration from nature's biological cycles, applying similar principles to technical material cycles. It emphasizes the cradle-to-cradle idea, contrasting it with the linear cradle-to-gate approach, to slow down and close resource loops (Bocken et al. 2016). Closing the loop implies using the same resources repeatedly, and therefore, more sustainably. In an ideal state, a CE does not require any further virgin materials (Figge et al. 2023). There are various perspectives on the definition of the CE. Hobson (2021) believes that even though the Ellen MacArthur Foundation is a leading voice on the CE, their interpretation is just one among many. Figge et al. (2023) emphasize that a good definition is neither overly broad nor overly narrow and has no counter-examples. In a recent article, (Kirchherr et al. 2023) discuss how the CE was once seen as superficial or incomplete, but now it is acknowledged as the most celebrated sustainability concept of the last decade, gaining attention from diverse academic disciplines. They further note that the CE has evolved into a well-established field of study, evident in its robust institutionalization in both academia and practice. This perspective allows for more comprehensive, interdisciplinary, and multi-methodological approaches. CE has been linked to other domains, such as bioeconomy (Langendahl et al. 2022; Mesa et al. 2024), sustainable development (Suárez-Eiroa et al. 2019; Garcia-Saravia Ortiz-de-Montellano et al. 2023), and Industry 4.0 (Awan et al. 2021, 2022; de Mattos Nascimento et al. 2024). Ultimately, to understand the CE as an umbrella concept, we need to grasp its relationship to sustainability.

The link between CE and sustainability is well recognized. However, research has mainly focused on strategies for achieving circularity and less focus has been placed on the role of individuals in this transition. This essay aims to address that gap by critically analysing existing circularity strategies and highlighting the significant contributions

individuals can make. It also examines the rebound effect and explores how the principle of sufficiency integrates with the broader concept of CE.

2. The echoes of R

The CE concept was initially built upon the 3 R principles: reduce, reuse, and recycle. This 3 R initiative was introduced in 2005, inspired by the waste pyramid hierarchy, recognizing the necessity to reshape global consumption and production patterns. These principles have their origins in the Latin prefix “Re”, which signifies again and back (Reike et al. 2018). While there is no widely accepted categorization of R strategies, the 3 R principles have captured significant scholarly attention. Academics agree that these principles brought novelty to sustainability thinking, especially in waste management. Despite terminological and conceptual variations, a consensus exists on the essence of the 3 R principles. Academics also acknowledge its limitations and advocate for more strategies to enhance synergy and interdependence. Accordingly, CE researchers continue to introduce new Rs as novel circularity strategies. In this context, as they persist in their linguistic exploration with R as the starting letter, their definitions and understanding of these strategies may vary (Uvarova et al. 2023).

The framework of Potting (Potting et al. 2017), known as the 10 R framework, is among the widely accepted frameworks for circularity strategies. This includes R0) Refuse, R1) Rethink, R2) Reduce, 3) Re-use, R4) Repair, R5) Refurbish, R6) Remanufacture, R7) Repurpose, R8) Recycle, and R9) Recover. Uvarova et al. 2023 highlight that different sets of Rs have been introduced by various sources in the literature for the 10 R framework. For instance, some authors have introduced Re-mine instead of Re-think or combined Re-use with Resell. In a comprehensive review, Morsetto (2020) concludes that unlike R0-R7, the targets of R8–R9 do not necessarily promote CE as recovery and recycling can undermine product integrity and their continued presence in the economy. Another in-depth review by (Garcia-Saravia Ortiz-de-Montellano and van der Meer 2022) identifies eight value retention strategies, including Redesign, (Re)use, Re-sell, Remanufacture/Refurbish, Recycle, Recover, and Recirculate.

In their comprehensive review, Uvarova et al. (2023) outlined 60 circularity strategies that all share the commonality of starting with the letter R. The majority of these Rs are grounded in the “Re” prefix for both verbs and nouns. However, there are some cases where Rs deviate from this pattern, such as rent and route-tracking. Besides, some Rs might, at first impression, appear to contradict the CE principles as they imply increased production. For example, Recreate, Regenerate, Reprocess, Reproduce, and Resynthesize fall into this category. Furthermore, some Rs are associated with specific verbs, though in different forms with added nouns. For instance, the verb reduce appears in four different variations: Reduce packaging, Reduce resource usage, Reduce toxins, and Reduce weight and quantity. While additional nouns can be appended to Reduce, this does not necessarily establish a separate circularity strategy under a distinct R. Similarly, Replace is represented in four strategies: Replace to renewable, Replace with local resources, Replace with natural resources, and Replace with virtual products. The use of Rs as circularity strategies can be infinite and boundless. For instance, Valencia et al. (2023) developed a new framework for socioeconomic Rs, introducing novel Rs such as Remember, Reorganize, and Revitalize. Another illustrative example is the work by

(Milner-Gulland et al. 2021), in which they constructed a framework for restoring nature while addressing human needs by reconfiguring the terms avoid, minimize, remediate, and offset, to formulate new four Rs: Refrain, Reduce, Restore, and Renew.

While reviewing the array of Rs used to represent circularity strategies, one can easily notice that certain entries, if not many, are included mainly due to having the initial letter R, without always being relevant or truly beneficial. The potential for additional Rs is endless. For instance, verbs like Re-assemble, Replicate, Reposition, Revoke, and Rotate can be fitted within the Rs and appear relevant, although their direct alignment to circularity strategies might be somewhat stretched. While alliteration aids in raising awareness, particularly for non-experts, an excessive fixation on it can lead astray. I have a personal appreciation for alliteration in literature and poetry, but I also have reservations about its overuse and how it can distort the understanding of CE and the definition of effective and established circularity strategies. To exemplify, using my initial P, I could formulate my own Ps for CE: Prevent, Plan/Prioritize, Preserve, and Protect, which align with the Rs of Refuse, Rethink, Reuse, and Repair. Moreover, the utilization of the “post” prefix and its combinations could effectively advocate for extending the life of products beyond their initial life cycle. Further spicing things up, these P strategies perfectly correspond with the five pillars of sustainability: People, Planet, Prosperity, Peace, and Partnership. As evidenced, this exercise knows no bounds, with the creation of new names and their association with concepts being a relatively simple task, but not always contributing to the field.

3. R like rebound

The term rebound effect refers to a reaction to reduce energy or resource use, as the resulting consequences are often overlooked in economic and social contexts. Initially referred to as the Jevons paradox in 1865 and also known as the take-back effect, it stands as the main weak point of efficiency strategies (Alcott 2008). Although measuring the rebound effect is complex, its occurrence is increasingly noticeable in diverse resource contexts across various domains. Within the context of CE, the rebound refers to the possibility that CE might trigger increased consumption, which might partly or entirely negate its benefits (Figge and Thorpe 2019). Chen (2021) highlights that CE is a double-edged sword; when appropriately applied, it can drive sustainable development, but if not, regardless of the number of Rs considered, an extra R always exists for the Rebound effect.

The existence of the CE rebound effect has been explored by several researchers (Figge and Thorpe 2019; Warmington-Lundström and Laurenti 2020; Chen 2021; Siderius and Poldner 2021; Gonçalves et al. 2022; Konash and Nasr 2022; Metic and Pigosso 2022; Zerbino 2022). The findings from a study conducted by (Makov and Font Vivanco 2018) indicated that the reuse of smartphones could result in an average rebound effect of 29% in terms of greenhouse gas (GHG) emissions. Similarly, the research by (Warmington-Lundström and Laurenti 2020) assessed the environmental rebound effects of a peer-to-peer boat-sharing platform, revealing that the rebound effect was observed among all lessees and one-third of lessors. Furthermore, (Siderius and Poldner 2021) demonstrated through their study that the rebound effect is not necessarily linked to a specific CE strategy or circular business model.

(Rabiu and Jaeger-Erben 2022) argue that the exploration of rebound effects in the literature often remains implicit rather than explicit. (Figge and Thorpe 2019) emphasize that striving for circular resource flows within and across firms increases interdependency. This interconnection means decisions by one impact others, leading to higher opportunity costs. Therefore, a comprehensive systemic view is essential for evaluating circularity strategies. They introduce a symbiotic rebound effect in CE, based on opportunity costs, and stress that a rebound effect can still occur unless waste is absent, and this is only the case when no opportunity cost exists or when it is negative.

4. The symphony of I

While the Rs have been the main focus of the circularity principles, business models, and policies, their actual implementation requires actions by individuals. This highlights the importance of acknowledging the roles of individuals and a need to focus on the I, representing oneself, as the central figure in this narrative. This evaluation is, however, sophisticated and multidimensional, requiring consideration of numerous aspects.

While earlier descriptions of CE contained links to human needs and social transformation concerns, these aspects were often neglected in later developments (Vidal-Ayuso et al. 2023; Villalba-Eguiluz et al. 2023). Shevchenko et al. (2023) discuss that research on the consumption aspects has been inadequate, and a measurement framework is lacking for the use phase and consumer behaviour in CE. Hobson (2021) also emphasizes that consumers are central and active agents in CE, rather than semi-passive nodes through which materials flow and individuals accept or decline offered options. Unlike other stakeholders in the value chain, consumers are not incentivized by monetary rewards and assessment, monitoring, and prediction of their behaviour are challenging (Gonçalves et al. 2022; Shevchenko et al. 2023). This challenge is particularly significant since consumption patterns, especially over-consumption, constitute a critical aspect of CE (Hobson 2021).

When discussing individuals, various terms like customer, consumer, or user have been used interchangeably, yet each carries its implications and significance. (Macklin and Kaufman 2023) point out that the term consumer implies a passive role tied to consumption, which CE aims to move beyond. They propose categorizing user-product interaction into three types: get, use, and pass-on. Similarly, (Shevchenko et al. 2023) suggest that consumers play a threefold role in the CE transition: 1) as product customers purchasing goods/services, 2) as product users retaining the value of the product, and 3) as end-of-life product holders discarding items. In this context, customers contribute to CE by obtaining circular products as their role significantly impacts user and end-of-life product holder contributions. Moreover, they stress that engaging end-users is pivotal for the CE transition, influencing product demand and related circularity strategies. On the other hand, (Vidal-Ayuso et al. 2023) consider a pre-purchase stage, dividing the decision-making process into three phases: 1) antecedents, preceding decision-making, and encompassing need recognition, search, and evaluation. 2) decision-making, involving customer purchases based on antecedents, leading to 3) outcomes, the post-purchase phase. Although less explored in literature, this stage, influenced by factors like perceived quality, can impact decisions about repurchasing.

While awareness is crucial for fostering sustainable consumption behaviour and driving behavioural change, it alone is insufficient to ensure these outcomes. Despite claims of engagement in the circularity practices, the actual rates of participation often diverge. This highlights that awareness of environmental concerns and resource efficiency does not always lead to sustainable behaviour. For example, even though 76% of Europeans say they segregate e-waste, only 35% of generated e-waste is collected (Parajuly et al. 2020). Understanding the process of behavioural change is crucial as societal transformation emerges from individual actions and behavioural shifts (Fuchs et al. 2016). To grasp these changes, an interdisciplinary approach is essential, drawing insights from numerous scientific disciplines and more than 80 theories (Parajuly et al. 2020). Additionally, significant variations exist in individuals' behaviours, especially when transitioning to a more sustainable lifestyle.

When assessing the circularity behaviour of different individuals, various aspects must be taken into consideration. Parajuly et al. (2020) discuss reshaping consumer habits towards a CE involves addressing both extrinsic attributes (e.g. social norms, culture, finances) as well as intrinsic attributes (e.g. knowledge, beliefs, values). From a sociological perspective, different classes of society may behave distinctly. At the individual level, cultural and historical aspects also come into play (Gonçalves et al. 2022). These cultural factors can influence consumers (awareness), companies (hesitancy), markets (cost considerations for investment vs. virgin materials), and policymakers (regulatory barriers) (Chen 2021). In a survey conducted by the European Investment Bank (EIB 2021) on consumption behaviours (R0, refuse strategy), not owning a car was seen as the most challenging practice for EU citizens, while giving up flying was perceived as the easiest. Nonetheless, it was observed that the willingness for behavioural changes highly depends on factors such as gender, age, and country. Despite these contrasts, some researchers like (Rabiu and Jaeger-Erben 2022) argue that quantitative data, particularly online surveys, may not fully capture the dynamics of social practices.

In evaluating the implementation of CE into societies from an anthropological aspect, the context of where and how people live also matters. According to the United Nations, around 68% of the global population and 84% of the European population are expected to live in urban areas by 2050 (United Nations 2022). On the other hand, achieving full circularity in urban areas is challenging due to limiting factors such as resource scarcity, as explained by Liebig's law of the minimum. Paiho et al. (2020) categorize the challenges of implementing CE in cities into business, policy, technical, and knowledge challenges. They also highlight the need for established comparable indicators to measure the circularity at the macro level. In agreement, Eurostat developed a macro-level circularity rate, which was 11.5% in 2020, significantly lower than the recycling rate of 46% in the EU. This can be explained by the fact that circularity includes more than just material recycling, such as fossil fuels burned for energy or biomass used for food (Eurostat 2024). Haas et al. 2015 also identify a large share of materials (44%) used for energy generation as a barrier to achieving a higher circularity rate, along with the growing in-use socioeconomic stock. Similarly, (Mayer et al. 2019) mention these two reasons for low socioeconomic circularity.

5. Sufficiency

As we explore the influence of individuals and their sustainability practices, the concept of sufficiency gains significance (Konash and Nasr 2022). Fischer et al. (2013) emphasize that sufficiency encompasses both consumption reduction and shifts in consumption behaviours. They highlight various instances of sufficiency, like minimizing the usage of goods, choosing smaller sizes, and collaborating on usage, which aligns well with the discussed R strategies. Bocken et al. (2022) propose a sufficiency-based CE and discuss that industries can play a key role in shaping consumer demand through resources and market influence, thereby promoting societal sufficiency.

Understanding sufficiency requires considering energy systems as socio-technical systems and re-evaluating the interplay between human needs, activities, and primary energy demand (Jonsson et al. 2011). This includes recognizing the services enabled by energy use, rather than just energy itself (Day et al. 2016). Scholars have explored human needs since Maslow's original hierarchy of needs in 1943. Determining what constitutes sufficient and differentiating between needs and wants is complex, influenced by cultural, temporal, and technical factors (Darby 2007). Personal differences (e.g. age, gender, and disability), environmental variations (e.g. climate conditions, pollution), social conditions, and community requirements further complicate this understanding (Day et al. 2016). This inconsistency might explain why policymakers often emphasize efficiency over sufficiency (Darby 2007).

(Spengler 2016) presents sufficiency as two opposing ideas: a minimum threshold and a maximum limit. Minimum sufficiency centres on individual well-being, while maximum sufficiency focuses on setting environmental limits. She notes that while minimum sufficiency is individual-oriented, maximum sufficiency has a global approach. Accordingly, two main approaches define sufficiency thresholds: a top-down approach that sets caps on energy use or emissions, and a bottom-up approach that starts by defining basic needs. For instance (Goldemberg et al. 1985), suggested fulfilling basic needs with 1 kW of primary energy per capita per year. Similarly, Spreng (2005) proposed a 2000-watt society taking into account global CO₂ emission limits per capita. On the other hand, (Chakravarty et al. 2009) calculated 320 kg CO₂ per capita per year for basic needs and 1 t CO₂ for a higher standard of living. The bottom-up approach receives less attention due to its complexity in defining needs and life satisfaction (Steinberger and Roberts 2010). The concept of Doughnut Economics by Kate Raworth, is a great example of positioning the sustainable space based on both bottom-up and top-down approaches, i.e. the social foundation and ecological ceiling (planetary boundaries).

6. The circular economy orchestra

There is a renowned quote that says, "The earth has music for those who listen". The concept of CE draws inspiration from nature, replicating similar principles in technical material cycles. The contrast between the current linear economy, resembling a poor musical performance, and the desired philharmonic orchestra, is clear. However, transitioning from discord to harmony is challenging, especially when acknowledging that the conductors, musicians, and even the audience are all integral components of the same

ensemble: humanity. In this analogy, circularity strategies are the musical instruments essential to the orchestra. They must be present, but it is up to us to master and play them in the end.

CE presents a notable solution, one of the most pivotal approaches, towards achieving sustainability. While CE offers its benefits, concerns, and challenges, it is crucial to recognize potential issues like the rebound effect and overconsumption, even within this ideal framework.

Circularity strategies (Rs) serve as pathways towards achieving a circular society. It is important for CE scholars and practitioners not to dilute these strategies by loosely labelling any word starting with R as a new circularity strategy. Ultimately, individuals (I) form the foundation and central figure of this narrative, where circularity strategies revolve around them.

In CE, the role of individuals extends beyond that of consumers or users. They also play a pre-use role as customers selecting a product and a post-use role in determining its fate afterwards. In all these phases, awareness does not necessarily lead to behavioural change or result in a fully circular society. Factors influencing this include the country and urban/rural setting, social and cultural norms, financial status, beliefs and values, age, and gender.

Environmental awareness is a starting point, but genuine progress depends on behavioural change. The Sustainable Development Goal (SDG) 12, suitably named “Responsible Consumption and Production”, emphasizes prioritizing responsible consumption over production and shifting the focus from supply to demand. Toward that, prioritizing sufficiency and questioning the needs are critical steps in crafting effective, sustainable solutions before exploring efficient production methods.

Future studies could explore the linkage between the sufficiency concept and a circular society by examining how it can help stay within planetary boundaries while providing a social foundation. This requires both bottom-up approaches (to identify minimum thresholds, such as basic needs) and top-down approaches (to determine maximum limits, such as planetary boundaries). It is especially important to measure the effectiveness of circularity strategies in achieving these goals using circularity and sustainability assessment methods and indicators.

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