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Literature Review

IS CIRCULAR ECONOMY THE WAY TO SUSTAINABILITY? CURRENT LIMITATIONS AND SUGGESTED SOLUTIONS.

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ABSTRACT

This literature review sought to give an overview of the limitations presently impeding the transition to a circular economy (CE). The methodology initiated with a search of articles from reputable sources on a key-word basis equal or synonym to 'circular economy' and 'limitation'. Key results found were divided into three categories of limitations: CE's concept, CE's processes, and the current society processes limitations to the transition; and one category on suggested solutions. All things considered, it can be noted that CE is at its early stages and often presents an overly optimistic vision while evaluating performance through limited scopes. Further research possibilities involve all domains, and at all levels – especially including studies with large scopes and empirical data – and focusing on net environmental sustainability on a project basis and with results that remain flexible to future development paths.

CONTENTS

1 Introduction

Nowadays, some of the most highly debated topics revolve around climate change mitigation. Amongst the brainstorm of goals and solutions, the circular economy concept has been gaining traction through its tide-breaking vision to change the take-make-waste linear model of today. This concept represents a restorative and regenerative economy based on designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (Ellen MacArthur Foundation, 2017); and has been promoted especially in the European Union (Korhonen, Honkasalo, & Seppälä, 2018). Nevertheless, CE is not and should not be viewed as the sole solution to the global environmental woes. In fact, this concept presents several limitations and key aspects that have not yet been addressed that could crucially determine the future of sustainability. This communicative piece aims to analyse works published on CE to draw insights on the current stance of CE's progress and the next steps required to work towards a successful CE. The limitations discussed relate to the CE concept, the limitations regarding its processes, and aspects observed in societies that are impeding progress.

2 Methodology

Data collection for this literature review was undertaken in Google Scholar, Science Direct, Circle Lab, Ellen MacArthur Foundation, Drift, ResearchGate, and the European environment Agency. The forementioned search engines were considered due to their literature on circular economy being shaped by practitioner writings, thus rendering their reliability high. The keywords chosen to obtain a large range of papers to analyse were: circular economy, closing the loop, cradle-to-cradle, circularity, circular principles, limitations, disadvantages, constraint, drawback, downside. No geographical restrictions were applied, and the search was limited to publications from 2014 to 2020. The studies selected focused on limitations across any industry in relation to CE. In total, 19 publications were gathered, of which: 14 are journal articles, one is a research article, two are research reports, one is a website article, and one is an editorial.

Furthermore, this paper is structured as follows: section 3 goes into depth on the trending limitations put forth by the publications regarding the CE concept, its processes, and society processes' limitations; this section presents the trends found in the writings as well as the suggested solutions for change. Following, section 4 concludes on the overall findings on the topic of CE limitations and their solutions. Lastly, section 5 presents some research paths to be further developed to improve the present knowledge on CE and pave the way towards a more sustainable future.

3 Circular economy limitations and solutions

3.1 Limits of the CE concept

The analysis of the literature revealed a consensus that the CE concept is still premature (Rodriguez, Pomponi, Webster, & D'Amico, 2020) (Korhonen, Honkasalo, & Seppälä, 2018) (Ghisellini, Cialani, & Ulgiati, 2016) and lacks critical interrogation (Korhonen, Honkasalo, & Seppälä, 2018) (Buchmann-Duck & Beazley, 2020); (Bakator, Dordevic, & Dordevic, 2019); (Mirabella, Castellani, & Sala, 2014); (Lett, 2014) (Rodriguez, Pomponi, Webster, & D'Amico, 2020); (Bakker, Wang, Huisman, & den Hollander, 2014) (Lazarevic & Valve, 2017) (Aguilar-Hernandez, Dias Rodrigues, & Tukker, 2020). In fact, several authors mentioned its lack of attention to the socio-political implications and the possibilities for shifting linear practices, therefore highlighting the need to research the macro and micro level on

public investments, products as a service (PAAS) and their implications, consumer's purchase motivations, the evolution of projects through an Life Cycle Analysis (LCA), Life Cycle Costing (LCC) and Social Life Cycle Analysis (SLCA) approach, and on the overall awareness to access and adapt to CE (Aguilar-Hernandez, Dias Rodrigues, & Tukker, 2020); (Ghisellini, Cialani, & Ulgiati, 2016); (M. W. Mak, Xiong, C. W. Tsang, K. M. Yu, & Sun Poon, 2020); (Lett, 2014); (Lazarevic & Valve, 2017). Moreover, at a meso level, the papers find it imperative to analyse how organisations understand CE and implement it, explore how to allow conceptual improvements in CE, evaluate different stakeholders and their motivations, and finally link micro, meso, and macro levels (Barreiro-Gen & Lozano, 2020); (Rodriguez, Pomponi, Webster, & D'Amico, 2020); (Lett, 2014); (Hobson & Lynch, 2016). Moreover, Korhonen et al. mention the lack of knowledge of short- and long-term impacts of CE as well as the focus of investments being on short-term action only and suggest shifting to a large and long-term vision for global net sustainability (2018). Furthermore, Gennari & Cassano add that a transition to CE requires considering risk related to the future and to what companies will do at certain points; thus, organisations should integrate risk management into their entire process (2020). Additionally, Rodriguez et al. mention that most literature on CE appears to be too optimistic; very few papers explain how they modelled the future of CE and seemed quite disconnected from realistic economic models (2020). In fact, CE needs a structural process for transition. The authors propose to use Future Studies methods to bring CE into sharper focus and determine 'pathways' of transition to help decision-makers and business actors to explore and prepare their future efforts.

Furthermore, the literature highlights CE's tendency to focus on eco-effectiveness, thus receiving judgement from authors, as it promotes the idea of increasing economic growth while minimizing the ecological impacts. Whereas, a better approach would be eco-efficiency or eco-sufficiency, which would aim to lower consumption and emissions by improving the materials used simultaneously (Buchmann-Duck & Beazley, 2020) (Llorach-Massana, Farreny, & Oliver-Sola, 2015) (Barreiro-Gen & Lozano, 2020). Nevertheless, both eco-effectiveness and eco-efficiency or eco-sufficiency have their pros and cons. As Figge et al. (2014) explain, eco-efficiency can be subject to positive effects such as a 'double dividend' – where a more sustainable product is purchased more due to its efficiency and eliminates the use of another perfect substitute product which is not sustainable – as well as negative effects such as the 'backfire' effect where one of two or more complementary products and/or services becomes more sustainable and efficient but the environmental gains are more than compensated by its associated complementary product(s) and/or service(s) which are not sustainable and are bought more often along with the first product and/or service. Moreover, eco-efficiency or eco-sufficiency can also be subject to the rebound effect – occurring when the production sustainable efficiency of a product or service increases, causing its cost to decrease and eventually the price to decrease which in turn boosts consumption. Subsequently, the increased consumption of this product or service offsets the initial sustainability gains – or a double eco-sufficiency effect led by consumers or suppliers through supply and demand (Figge, Young, & Barkemeyer, 2014). For instance, a decrease in supply could increase prices, resulting in a reduction of consumer's purchasing power, which would decrease overall consumption. Therefore, neither strategies guarantee lower resource consumption and emissions, nor a rebound or backfire effect. Thus, Figge et al. (2014) mention that it is a matter of prioritising eco-efficiency or sufficiency to aid decision-making on environmental policy to balance economic growth and lower resource consumption and emissions.

A following discussion point made in the publications regarded economic growth through circularity and decoupling. Lazarevic & Valve (2017) describe the expectation where a win-win scenario is envisioned through resource and impact decoupling in turn benefiting the environment and the economy. Additionally, the EMF also promotes a 'growth within' mantra, where value would be captured from existing circulating products and materials which would increasingly drive growth and offer a new growth paradigm controlled by Europe, resulting in less pressure to compete with low-cost countries (Lazarevic & Valve, 2017). However, Lazarevic & Valve also explain the divergences of economic growth in the CE; in fact, CE can be seen as an 'alternative growth' since the Western principles of consumption and production remain non-negotiable and ecological sustainability remains subordinated to economic growth and absolute negative impacts decoupling in that case has not been observed (Rodriguez, Pomponi, Webster, & D'Amico, 2020) (Lazarevic & Valve, 2017). In fact, it can be observed that economic growth can play a key role in hindering sustainability, for instance, through Javon's paradox (Korhonen, Honkasalo, & Seppälä, 2018); (Aguilar-Hernandez, Dias Rodrigues, & Tukker, 2020); (Ghisellini, Cialani, & Ulgiati, 2016); (Figge, Young, & Barkemeyer, 2014), in which case it is recommended that if growth must happen, growth of the physical economy i.e., physical material and energy flows should be limited. Ghisellini et al. (2016) suggest a shift to a steady-state oriented system where efficiency and environmental protection would become crucial factors orienting policies for the transition to new production and consumption patterns.

Another author agreeing with economic growth being incapable of sustainability is Buchmann-Duck (2020), who states that biodiversity has been and will be greatly impacted through a linear economic course. However, regarding CE, the author along with Bakator et al. (2019) state that when it comes to biological systems, CE is not fully investigated or considered. For instance, although Figge et al. (2014) suggest that eco-efficiency strategies have the potential to reduce environmental burden at no cost, Buchmann-Duck (2020) argues that these strategies could be done at the expense of biodiversity. Furthermore, the little attention accorded to both CE and biodiversity is reinforced by conceptualising the latter solely as an asset. Moreover, this can translate in negative impacts to biodiversity, namely regarding its protection. In fact, although seeing biodiversity as an asset in carbon-related services can be important, it is often the sole service considered, thus leaving gaps for the protection of other synergies among regulating services not deemed most economically or socially valuable as well as making certain biodiversity vulnerable to replacement with non-native or technology alternatives (Buchmann-Duck & Beazley, 2020). Moreover, the demand for specific areas or type of biodiversity for services can alter the ecosystem's functionality, which in turn would damage it. This specific demand for services also becomes an issue for countries to create local policy to protect biodiversity. Therefore, its protection requires a global lens considering multiple actors. Regarding biodiversity's protection, a common misconception is that biodiversity offsetting is fully effective. However, Buchmann-Duck (2020) argues that it is to be handled cautiously, as the offset frame assumes that one biodiverse system is replaceable with another, which removes the place-based intrinsic values of nature with market-based capital valuations in a system prioritising production and development. Furthermore, it must also be noted that renewable energy is to be evaluated in light of biodiversity's health, as it has been known to have a certain pressure on it (Buchmann-Duck & Beazley, 2020). In addition, it cannot be considered that renewable energies have zero environmental

impact, as it is promoted by some (Llorach-Massana, Farreny, & Oliver-Sola, 2015).

All things considered, the CE concept's implementation worldwide still seems at early stages, and in need of further research in several domains to start a plan of transition that can truly work towards sustainability. In fact, some fundamentals of the CE concept must be reviewed in terms of their positive and negative contributions to sustainability, seeing that at times they might do more harm than good. Additionally, the literature revealed that apart from the CE concept, its processes are still to be further questioned.

3.2 Limits of CE processes

The readings revealed several limitations that should be considered. Firstly, Korhonen et al. (2018) as well as Aguilar-Hernandez et al. (2020), Ghisellini et al. (2016), Buchmann-Duch & Beazley (2020), and Figge et al (2014) mention that CE practices can be victims to the forementioned rebound effect, also known as 'Jevon's paradox' or the 'Boomerang effect'. This paradox may also happen in the economy, as overall economic growth offsets the initial gains created by better efficiency.

Furthermore, other limits emerge through the increase of CE practices regarding energy and emissions. Firstly, energy presents a significant limit in closed material loops due its levels needed to repair, reuse, refurbish, and recycle products in perpetuity which would lead to increased energy use (Lazarevic & Valve, 2017). Nevertheless, a contradiction to this argument was found by Korhonen et al. who state that closing material loops is possible through renewable energy (2018). However, it was also found that energy use difficulties could also be encountered while attempting to achieve a circular system based solely on renewable energies (Llorach-Massana, Farreny, & Oliver-Sola, 2015); and their use would be problematic in terms of environmental effects to biodiversity as mentioned in the previous chapter (Buchmann-Duck & Beazley, 2020). Regarding emissions, Llorach-Massana et al. (2015), mention that implementing processes such as Cradle-to-Cradle (C2C) in which the waste of one process becomes the resource of another, requires worldwide social and infrastructure changes that do not automatically ensure an environmental improvement due to transport and management activities.

Moreover, certain papers also agree on the latter, arguing that CE systems will never attain full circularity and always consume energy, produce waste, or be unsustainable in the long-term (Ghisellini, Cialani, & Ulgiati, 2016); (Lazarevic & Valve, 2017); (Llorach-Massana, Farreny, & Oliver-Sola, 2015). For instance, a counterpoint to a perfect circular system mostly forwarded by industry associations includes technological and environmental limits (Lazarevic & Valve, 2017), such as recyclability as it is the least sustainable of all the CE activities as its benefits reach a cut-off point at which it is no longer beneficial environmentally or economically. Furthermore, when recycling certain materials such as plastic or paper, adverse health effects are known to occur due to unwanted micro-pollutants (e.g., phthalates) that re-enter the system (Lee, Pedersen, & Thomsen, 2014). As a solution, strategies and regulations for sustainable development should be implemented as well as institutionalising recycling systems to avoid these unintended risks as well as keep the harms of these processes within tolerable limits (Park & Chertow, 2014).

Furthermore, recycling processes are not effective enough as most products are notoriously difficult to recycle due to them being most often mixed with other materials. To solve this, Bakker et al. (2014), Rodriguez et al. (Rodriguez, Pomponi, Webster, & D'Amico, 2020), and the European Commission (2014) suggest to develop designing for circularity, through standardisation of components for

better disassembly for instance; this would avoid the shredding processes currently in place that turn materials into secondary resources at a lower quality level.

Nevertheless, despite recycling being a method to solve society's unsustainability, it is a mere improvement. As the publications point out, CE should not mainly focus on recycling but rather on reusing materials, as it can contribute to reduce negative environmental impacts more effectively as well as revitalise the competitiveness of local economies and improve well-being of some populations (Ghisellini, Cialani, & Ulgiati, 2016). Furthermore, reusing should have a more important role in CE given the limits and risks of recycling. Therefore, it can be noted that the priority should be on reusing, as well as on service-life extension and preparation for reuse before recycling according to the European Commission (2014). However, service-life extension also encounters several limits such as missing technology linked to optimising the remaining service-life of used components and considering material fatigue (European Commission, 2014). Additionally, different products require different product life extension strategies (Bakker, Wang, Huisman, & den Hollander, 2014). Therefore, more in-depth research for product design is needed to educate designers, along with research on products' emotional durability and product attachment due to consumer habits based frequently acquiring fresh new products; moreover, once this is done, it is necessary to find which business models support each design strategy (Bakker, Wang, Huisman, & den Hollander, 2014).

Next, another challenge mentioned is the tendency for environmental problems to be shifted along the life cycle of a product (Korhonen, Honkasalo, & Seppälä, 2018); (Aguilar-Hernandez, Dias Rodrigues, & Tukker, 2020) (Lazarevic & Valve, 2017). For instance, high eco-efficiencies achieved in local biomass-based industries create difficult problems at the exports of this industry, or the imports of this industry violate the ecosystem biodiversity in the country of origin (Korhonen, Honkasalo, & Seppälä, 2018). In terms of a C2C economy, similar issues arise due it not promoting environmental improvements in all life cycle, but rather focusing on material extraction and recycling into technical and biological nutrients (Llorach-Massana, Farreny, & Oliver-Sola, 2015). Therefore, industry associations often call for a life cycle perspective not only addressing environmental impacts across the product life cycle, but also the shift of environmental burden between impact categories (Lazarevic & Valve, 2017).

This brings about the question of whether CE is beneficial in environmental terms. Several researchers suggest that all CE processes should be individually analysed for their net environmental sustainability, which includes analyses along the whole product life cycle as well as from a systems perspective to avoid incoherent CE actions (Korhonen, Honkasalo, & Seppälä, 2018); (Ghisellini, Cialani, & Ulgiati, 2016); (Rodriguez, Pomponi, Webster, & D'Amico, 2020); (Bakker, Wang, Huisman, & den Hollander, 2014); (M. W. Mak, Xiong, C. W. Tsang, K. M. Yu, & Sun Poon, 2020); (Llorach-Massana, Farreny, & Oliver-Sola, 2015); (Lazarevic & Valve, 2017). Moreover, there seems to be a discrepancy in whether CE could bring significant improvements socially and economically. On the one hand, many papers present CE as a method through which society can achieve substantial benefits (Llorach-Massana, Farreny, & Oliver-Sola, 2015); (Ghisellini, Cialani, & Ulgiati, 2016); (Bakator, Dordevic, & Dordevic, 2019); (M. W. Mak, Xiong, C. W. Tsang, K. M. Yu, & Sun Poon, 2020); (Rodriguez, Pomponi, Webster, & D'Amico, 2020); nevertheless, on the other hand, Aguilar-Hernandez et al. contest this through a study involving 300 CE scenario analyses in comparison to business-as-usual scenario and conclude that there are marginal changes in GDP, job creation, and CO2 emissions (2020); and add that key modelling features providing the highest impact are

resource taxes, technological change, and change in consumption patterns. Moreover, CE is viewed as a solution to renewal, security, and competitiveness – allowing the European companies to no longer depend on material imports (Lazarevic & Valve, 2017). Nevertheless, this would diverge from the essence of the CE concept that promotes the inclusion of actors worldwide and to create a win-win situation for all. Therefore, a detailed assessment of inter-organisational sustainability and their implications is needed (Korhonen, Honkasalo, & Seppälä, 2018) (Ghisellini, Cialani, & Ulgiati, 2016); (M. W. Mak, Xiong, C. W. Tsang, K. M. Yu, & Sun Poon, 2020); (Gennari & Cassano, 2020); (Mirabella, Castellani, & Sala, 2014). For instance, companies focus on their overall net sustainability contribution to a network system instead of their own standalone position.

Therefore, it can be noted that a cyclical flow does not secure a sustainable outcome. In addition, Lazarevic & Valve (2017) raise attention to a balance that must be met to work towards circularity and material efficiency. This balance includes energy efficiency, affordability, citizen welfare, safety, and lastly consumer choice. These factors all link to economic and social systems, thus raising the question on what the systematic societal changes limiting the progress of CE are.

3.3 CE limitations set by society's processes

Limits within societal and economical processes can be divided into three categories: misconception of the CE concept, company's effort limitations, and network creation limitations.

Firstly, there is a great need for education on CE as Barreiro-Gen & Lozano (2020) showcase through their study, revealing that some organisations, while engaging with the 4Rs (i.e., refusing, reducing, reusing, and recycling), did not do so under the CE umbrella, and some organisations claiming to apply CE had low levels of engagement with the 4Rs. Moreover, organisations having implemented CE policies often use different terminology and implementation practices (Barreiro-Gen & Lozano, 2020). In addition, difference in the CE concept can be observed per country. In the study done by Ghisellini et al. (2016), several countries' CE practices were compared, revealing a significant difference between China and Europe, Japan, and the USA. In fact, China defines CE as the achievement of harmony between society and the environment whereas Europe, Japan, and the USA view it as a strategy for waste management or for the implementation of environmental policies at the maturity stage of economic development, as well as a mean to increase welfare, and presupposes that innovation will have a higher pace than ever before.

Furthermore, misconceptions of CE principles can also be observed regarding the definition accorded to waste. In fact, waste can be defined differently across societies, communities, cultures, and history and is greatly dependant on the level of societal development (Korhonen, Honkasalo, & Seppälä, 2018). Thus, it is difficult to assess environmental impacts, and in turn implement CE correctly, as the transformation in managing materials, particularly in closing the loop through reuse of waste, is closely related to how waste is viewed (Park & Chertow, 2014).

Therefore, a first step to be taken includes creating a common base of principles defining CE and its concepts. In fact, the European Commission (2014), points out the lack of teaching the economics of CE, and states that if we wish for there to be a transition to CE in SMEs, education must start amongst students. Moreover, Korhonen et al. (2018) point out that, as the material flow concept's definition depends on temporal, spatial and cultural factors, all CE proposals should also be placed into those same categories and evaluated as

so. To aid in this process, Park & Chetrow (2014) suggest their reuse potential indicator which provides information about the technical feasibility of reuse by addressing how development of a new technology alters the usefulness of waste materials.

Furthermore, limitations could be observed in several publications regarding company's actions and pathways for the future in relation to CE. Apart the forementioned concept misinformation amongst companies, it can also be noted that there is a limitation in efforts, currently focused solely on areas such as food waste, hazardous waste, plastic waste, recycling of critical raw materials, illegal waste shipments, and recycling of phosphorous (Barreiro-Gen & Lozano, 2020); this limitation in efforts causes limited outcomes of CE in civil society and public sector organisations. Moreover, Barreiro-Gen & Lozano (2020) also note that organisations favour the least sustainable of CE practices such as recycling and reducing in lieu of repairing and remanufacturing. These efforts can partially be caused by internal resources, as Bakator et al. (2019) point out, the limitation of some companies to work alongside the requirements of the future economy and social communities might be due to limited resources and outdated equipment.

Similarly, difficulties also arise regarding the necessary building of networks that CE requires, such as industrial symbiosis – a collaboration between companies in terms of finding ways use the waste from one company as raw materials for another. The success from these types of systems come from their capacity to link and involve all actors of society to create suitable collaboration and exchange patterns (Ghisellini, Cialani, & Ulgiati, 2016) enhancing the economic potential of its participants and to support the initial investment (Mirabella, Castellani, & Sala, 2014). However, to create such a supporting system, companies would need to be incited to join, which is currently a limitation hindering the transition. Ghisellini et al. (2016) point out that companies mainly engage in these projects with the sole purpose of gaining economic benefits such as shared infrastructure and knowledge to reduce risks from business disruptions, and otherwise consider it as a disadvantage. This presents a limitation as companies are not focused on CE exchanges and therefore it forces a selection exclusively comprised of optimal companies to assure stability and efficiency. Moreover, Mirabella et al. (2014) point out that the feasibility of an industrial symbiosis is also dependant on regional specificity regarding the availability of producers and of potential users of a same material. Additionally, success is also dictated by the economic return on investment which serves as a source of motivation for companies and investors (Ghisellini, Cialani, & Ulgiati, 2016). This might encounter difficulties regarding for instance the higher costs for by-products in comparison to raw material (Ghisellini, Cialani, & Ulgiati, 2016). Additionally, the profitability of these collaborations also depends on prices for other company's similar products; this can be observed regarding bio-based products' profitability which is greatly affected by the fluctuating oil price (M. W. Mak, Xiong, C. W. Tsang, K. M. Yu, & Sun Poon, 2020).

Furthermore, disadvantages for companies regarding these types of systems can add on to the delay in transition to CE practices; namely high costs, financial constraint, lack of demand-pull effect, availability of sufficient common materials limited by logistic, technologic, economic, and seasonal factors, and insufficient public awareness of circularity (Mirabella, Castellani, & Sala, 2014). Lastly, one can think further about the fact that, if resources consist of waste, then waste should be maximised – which raises the question: how can an individual firm convince stakeholders that waste maximization is beneficial to the environment and serve as a path towards sustainability (Korhonen, Honkasalo, & Seppälä, 2018)?

All things considered, Mirabella et al. (2014) point out the essentiality of feasibility studies to organise industrial sectors and activities best fitted for collaborations; additionally evaluations are necessary for assessing the sustainability of the whole recovery process of materials to avoid the risk of burdens shifting from an environmental compartment to another (e.g. extraction procedures of compounds that might involve the use of potential polluting chemicals). Furthermore, these studies should be done at a large scale, as currently most focus on pilot-scale laboratory experiences and contain limited data about economic and technical feasibility (Mirabella, Castellani, & Sala, 2014).

Finally, to facilitate the transition to these CE collaborations, attention should be accorded by public authorities creating adequate support to companies through policies, national collaboration initiatives, environmental legislative framework, and economic instruments (e.g., taxes, subsidies) (Ghisellini, Cialani, & Ulgiati, 2016); as well as guidelines to increase trust, CE focused management in companies, and supply chain management evaluations.

Thus, apart from the CE concept's and processes limitations, today's society's processes also present some difficulties stemming from CE misinterpretations, company's insufficient and limited efforts, as well as networking limitations. Next, the question on how to face and overcome these limitations arises.

3.4 Suggested changes towards improvement

Across all literature researched, three main factors were found to determine and potentially help solve the present limitations to circular economy: the actions of public authorities, companies, and consumer culture.

In fact, most of the literature deemed public authorities' involvement critical to the development of CE on multiple levels (Ghisellini, Cialani, & Ulgiati, 2016); (Llorach-Massana, Farreny, & Oliver-Sola, 2015); (Bakator, Dordevic, & Dordevic, 2019); (European Commission, 2014) (Lazarevic & Valve, 2017), for instance regarding a required change in environmental policies and legislations that burden waste flows with permits, which in turn make it difficult for companies to use it as a resource (M. W. Mak, Xiong, C. W. Tsang, K. M. Yu, & Sun Poon, 2020); (European Commission, 2014); (Korhonen, Honkasalo, & Seppälä, 2018). Moreover, focusing on removing taxes from renewable resources including human labour and value-preservation activities of the CE, giving carbon credits for the prevention of green-house gas emissions, and taxing non-renewable resources should be prioritised (European Commission, 2014). Additionally, the involvement of public authorities can be beneficial due to the efficiency of a top-down approach observed in China's transition (Gennari & Cassano, 2020).

Furthermore, public authorities can also help control environmental private certifications through promoting supervision by independent third parties. Llorach-Massana et al. (2015) mention this as a necessity and add that an eco-labelling scheme should be followed to distinguish all types of environmentally preferable products due to certain certifications being vague and potentially misleading. In fact, the C2C certification does not imply that a product is fully circular and good for the environment as it only focuses on the processes of extraction of materials; thus, making it useful merely as a tool to reduce the presence of hazardous materials in our society and ecosystems. Lastly, public authorities could also regulate which innovations are to be adopted to avoid path dependence and lock-in – a situation when products are used on a 'survival of the first' basis instead of the 'survival of the fittest' thus, creating a reluctance to adopt new modes of behaviour (Korhonen, Honkasalo, & Seppälä, 2018).

Nevertheless, despite the resounding call for public authorities to play a role in society's transition to CE, Lazarevic & Valve (2017) found that some companies argue that the transition should not be regulated by public authorities, and promote industry-led initiatives encouraging effective and economically viable circular economy models; maintaining market competition with no state interference, and allowing market forces to drive competition.

Next, Gennari & Cassano (2020) state that CE principles' success is based on good corporate governance and is linked to the prerogatives of the board of directors in a company, which determine the company's growth approach. Other authors follow suit with the same theory, stating that CE goals can be achieved at a company level as well (Bakator, Dordevic, & Dordevic, 2019) and that the board of directors are responsible for a sustainable strategy to implement in a top-down manner (Gennari & Cassano, 2020). Moreover Gennari & Cassano (2020) mention that the pillars at the basis rests on a CE-focused management to control the spread of circular values and motivate employees. Furthermore, the transition requires strong governance oriented towards transparency, high adaptive and experimental capabilities, high investments in innovation for the study of alternative solutions, strong and extensive relational networks, as well as stakeholder engagement – all tying to previous limitations made above on research on industrial symbiosis, future developments, and innovation.

Finally, a point made in most publications on which approach to take when working towards CE is change regarding consumer culture (Korhonen, Honkasalo, & Seppälä, 2018); (Buchmann-Duck & Beazley, 2020); (Aguilar-Hernandez, Dias Rodrigues, & Tukker, 2020); (Ghisellini, Cialani, & Ulgiati, 2016); (Barreiro-Gen & Lozano, 2020); (Bakator, Dordevic, & Dordevic, 2019); (Lett, 2014); (Lazarevic & Valve, 2017); (Hobson & Lynch, 2016). In fact, consumerism is a key driver of environmental issues today and is not compatible with a CE future. Instead, society must be reshaped to facilitate the future of use and reuse, nevertheless, CE frameworks and analyses to date side-step broad socio-economic implications as previously mentioned (Hobson & Lynch, 2016). Other limitations include the shift from consumer to user that has not been sufficiently critiqued and requires more studies composed of empirical data and considering the collective and individual acceptance or rejection to new modes of consumption, unregulated marketplaces, and a creation of an uneven playing field (Lazarevic & Valve, 2017). However, it is not only up to consumers to change alone, but suppliers may also play a role in this matter by adopting eco-efficiency or eco-sufficiency strategies (Figge, Young, & Barkemeyer, 2014). Additionally, these new consumption patterns such as sharing-based models may be limited to certain communities or locations (Ghisellini, Cialani, & Ulgiati, 2016) – mimicking the limitation of industrial symbiosis to only be available regionally or in certain locations. Therefore, Hubson & Lynch (2016) emphasise the urgent need for further exploration on sharing consumer models and what they entail. Furthermore, one of the most important aspect that still needs improvement is the knowledge and awareness of European producers and consumers because of the important role accorded to them in policies (Ghisellini, Cialani, & Ulgiati, 2016). Lastly, CE was presented as inappropriate for a growth-oriented economy, which can present significant implications for today's consumerism (Ghisellini, Cialani, & Ulgiati, 2016), as it there are also no observations showing a successful achievement of decoupling growth (Rodriguez, Pomponi, Webster, & D'Amico, 2020).

4 Conclusion

This literature review showcased the current limitations of CE and their suggested solutions. Firstly, the findings presented limitations in the

CE's concept, namely its prematurity, lack of attention to social-political, economic, and biodiversity implications. Thus, emphasising that CE strategies need to be analysed on a situational basis for their net sustainability performance. Additionally, they must be analysed considering the divergence of economic growth and CE. Furthermore, CE processes are limited in terms of long-term unsustainability, such as energy emissions, product design and socio-economic benefits. Moreover, limits concerning society's processes include a misconception of CE practices, lack of effort from companies, and network system creation. Finally, suggested solutions showcased included three main stakeholders: public authorities, companies, and consumers – all needing interconnectivity to implement change.

All things considered, CE is an early concept that allows the opening of new and immense horizons for industries and provide multiple value creation mechanisms, thereby creating the next major political economy project.

5 Further investigation possibilities

Visible gaps in the literature review relate to the CE concept still being at its premature stages. This translates in research being needed in several fields, namely macro and micro socio-economic implications of CE, industrial symbiosis, public authority involvements, and net environmental sustainability. However, the priority should be placed on educating all stakeholders, creating a knowledgebase of CE practices to refer to for performance analyses, and categorising CE strategies based on their trade-offs to inform decision makers. Gaining insights into these aspects will allow the development of concrete pathways to follow for CE to progress.

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