REVIEW

Megatrends in Circular Economy: Avenues for Relevant Advancements in Organizations

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Abstract

The aim of this study is to systematize the main findings of 38 previous systematic literature reviews (SLRs) in circular economy. From this previous mapping, we outline main themes and limitations in the SLRs analysed, then we synthesize the findings of previous SLR to identify mega-trends in CE reserach. Finally, we propose avenues for future circular economy research. Our analysis indicates three main types of limitations of SLR in CE: The first are shortcomings in the SLR methods, the second is the low maturity of CE research and the third the limited dissemination of CE practices. These limitations coalesce to constrain the empirical and theoretical relevance of knowledge accumulated. A main contribution of our meta-analysis is to identify a paucity of accumulated knowledge in critical areas needed for theory building, such as conceptual clarity, limited identification of antecedents, mediators and moderators and opaque understanding of boundary conditions. We conclude that more rigorous empirical research is needed to further build knowledge and generate CE-specific theory. Finally, 7 main areas for further research are proposed, indicating potential theoretical lenses when appropriate.

Keywords Circular economy · Systematic literature review · Meta-synthesis

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Introduction

The circular economy is a theme that has attracted the attention of the scientific and business environments [1, 2]. CE is consider a disruptive concept [3]. Accenture data indicate that the adoption of the circular economy can generate up to 4.5 trillion dollars for the world economy in the next 10 years [4]. In addition to a high potential to generate new business opportunities, organizations are moving to a new level of environmental and social engagement [5]. Specially to engage the supply chain [6] and reverse logistic practices [7] for creating and recovering value [8], we now have product planning in a way that allows dematerialization, the possibility of reuse, [9] of generating new value with few costs associated with transformation [10] and concern with resource transformation [11, 12]. What until then was considered waste is now seen as a nutrient to feed a new productive cycle [13]. Beneficial financial impacts occur through the new use of materials, with less expense devoted to the acquisition of virgin raw materials, and through the creation of comprehensive circular strategies [14]. Spending on final waste disposal is minimised. Sometimes, what was waste becomes a source of income for companies [15].

But, the journey to achieving that ideal status is still a long one. According to the Circular Economy Gap report 2019 [16], only 9% of the economy is circular. This figure corresponds to less than 10% of the 92.8 billion tons of materials used in production processes. In addition, the Circular Economy Gap report 2019 highlights the potential for circular processes to positively contribute to climate change prevention and mitigation. This requires a systemic transformation. In this transition to circularity, research and universities play an important role, specially to disseminate the CE concept and to investigate ways to overcome barriers in the transition to circularity [12]. In addition to disseminating good practices and consolidating channels to create conditions for systemic transformation, researchers need to be committed to connect with decision-makers in industry and government, aligning their discourse with global policy needs, and empowering the global business community. Changes are needed in the planning, design and implementation of processes that encourage the use of renewable materials, low carbon emmissions levels and the ability to disassemble and reuse materials. Further, consumers need to be more aware of engaging with circularity, whether at the moment they choose products to purchase or at the time of obsolescence and disposal, while focal companies need to have more control of all the flows of materials and products along the life cycle [17].

From this previous mapping, we outline avenues for the advancement of the circular economy. The justification for carrying out the study is associated with the need to expand knowledge of the circular economy field [18] its opportunities to generate advances for society [19], and to contribute to sustainable development [20]. The justification for limiting the SLR to systematic reviews and meta-analyses is associated with the fact that the studies portray an overview of the state of the art in CE. Looking at all previous SLRs to build a diagnosis of CE mega-trends allows mapping important gaps for the advancement of the research field investigated in this study. Identifying commonalities in the findings of SLR allows us to map megatrends are major movement, pattern or trend emerging in the literature, likely to have a significant impact reserch and policy in the foreseeable future.

Starting from a meta-synthesis, it is possible to build a more assertive look at paths and strategies to move towards full circularity of resources and materials. In particular, we expect this synthesis to inform us if there is enough aggregated knowledge to build a theory of Circular Economy (CE) that can guide future research. An overview of previous studies is necessary to obtain an overview of the field of knowledge. The SLR detected a heterogeneous

approach in the CE studies, and this highlights some research gaps that are presented in the final considerations of this study.

The study is structured in the following sections: in addition to this introduction, Section 2 deals with circular economy background. This section seeks to highlight recent studies in the field, opportunities and ways forward for the circular economy. Section 3 presents the methodological procedures, signaling the research path. Section 4 presents the results and propositions for advances in the field. Section 5 concludes the study presenting the practical and managerial implications of the meta-synthesis performed.

Circular Economy Background

The circular economy has as its main purpose to decrease the use of virgin resources, promoting sustainability [21]. Adopting circular economy business models drives the sustainable development agenda, both socially and environmentally [16]. It helps to align sustainability policies with best practices for business and to generate a systems perspective. Importantly, the transition can be driven by profitability and added value at the company level [22].

A circular economy describes an economic system based on business models that replace the concept of 'end of life' by reducing, reusing, recycling and recovering materials in the production/distribution and consumption processes, thus operating at the micro (products, companies, consumers), meso (eco-industrial parks), and macro (city, region, nation and beyond) [23] levels with the objective of achieving sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations [24].

Circular business models have been portrayed as economically attractive ways to increase energy efficiency, use renewable energies, reduce methane and deforestation, preserve biodiversity, and ensure the climate change agenda. The current industrialization process consumes increasing amounts of natural capital. In terms of metals, capital equipment used in production processes consumes half of our natural resources [16]. Examples of capital equipment are cars, medical scanner, solar panels, among others. Advances in digital technologies and intelligent design are creating new circular businesses, which generate opportunities for capital equipment with enormous transformational potential [25]. The long-term horizon of the circular economy has benefits and implications that go beyond the material footprint. New metrics for decision-making bring new opportunities for prosperity, driven by technology. The circular economy disseminates a set of actions to transfer resources from used products to new products. This helps to transform the social contract of organizations.

In addition, companies are interested in looking for business models that activate the circular economy, as, in addition to the eventual profitability, they can provide competitive advantages, such as reduced user turnover or less volatile revenue [26].

Methodological Procedures

For this phase, the meta-synthesis protocol of Hoon (2013) [27] was followed. Although this protocol was designed to synthesize qualitative case studies, for our study, it was adapted to fit the objectives of our research and systematize the main results of systematic literature reviews previously published. Hoon [27] proposes 8 steps to synthesize findings from qualitative

studies and to build theory. We follow the steps to systematize findigs from SLRs and evaluate the extent to which these studies suggest that there is enough accumulation of knowledge in the field for theory building. These steps are as follows:

1) Framing the Research Question: our research question is what are the main findings of previous literature reviews in circular economy?

2) Locating Relevant Research: The second step in this meta-synthesis included the search for systematic literature reviews previously published in the Scopus database. Scopus is the largest, most comprehensive, and most relevant database in the scientific community of administration and business.

3) Including/Excluding Criteria: The search terms used were "circular economy" and "systematic literature review". We included all papers published in english in journals in the Business, Management and Accountig area. Conference papers and working papers were excluded. This search resulted in 38 items. All were available in full format. The search was carried out on January 17, 2020. It is important to highlight that the search period was not defined. That is, all indexed studies that were aligned with the inclusion criteria established for the creation of the bibliographic portfolio were included in the analysis, regardless of the year in which it was published

4) Extracting and Coding Data: This stage included reading the full content of the papers to profile the articles, extracting information about geographical context, data source, sample, evidence, limitations and results.

5) Analysing on a SLR-Specific Level: This stage focused on analysisng main aspects of circular economy that have been investigated in the SLR. We also looked at the main gaps and opportunities for advances described in the SLRs.

6) Synthesing on a Cross-SLR Level: In this stage, we identified cross-study variables associated with circular economy that were explored in depth. These variables characterize the circular economy and influence the transition towards the circularity of materials and resources.

7) Analysing the potential to build theory From Meta-Synthesis: The first point of inquiry was to evaluate the extent to which accumulated CE has enough theoretical specification to guide research. We followed Dubin's seminal work of theory building [28]. According to Dubin, a good basis for theory exists when there is (a) clearly articulated constructs or variables of interest; (b) identification of explanatory mechanisms linking the constructs or variables; (c) well-delineated boundary conditions — the scope within which such mechanisms operate; and (d) moderators or conditions that influence the integrity of the system. These theory characteristics guide a gap-finding analysis [29] in the theoretical underpinnings of CE. Accordingly, variables were synthesized around these conditions for theory building alluding to the circular economy. From this general diagnosis, several proposals were made to contribute as potential advances to the theme. In this stage, we also articulate the general limitations on heterogeneity in primary studies and the way in which the meta-synthesis was presented.

Figure 1 provides a visual representation of the process.

Therefore, the interest of the study is to identify the profile of the articles, which includes information about the journal where the publication was made, authors, total citations of the study, geographical context, systematic literature review protocol adopted, breadth and scope of the studies, relevant evidence from studies, limitations and recommendations for future
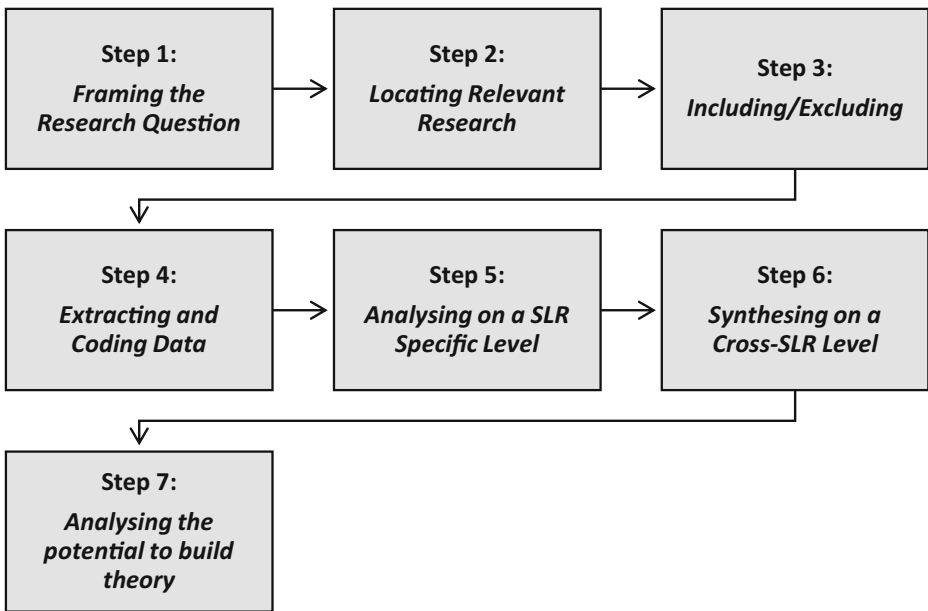
Fig. 1 Methodological steps

investigations. Based on these systematized data, propositions were presented as potential avenues for advancing scientific research on circular economy.

Data Presentation and Analysis

This meta-synthesis mapped 38 systematic literature reviews to be analysed. The distribution of the analysed studies is concentrated in 4 recent years (Fig. 1).

Figure 2 shows the behaviour of the circular economy field, which has grown substantially in the last three years. Similar behaviour is found in systematic literature reviews, which concentrate the largest number of publications in the year 2017. The year 2020 signals a dramatically higher growth, since in mid-January, there were already 16 systematic reviews of literature published in the field. Table 1 presents the profile of the studies analysed.

Table 1 shows that the average of citations from previous studies is 31.13 citations (of the 32 articles that have received citations so far). However, 6 studies have not yet been cited by others. The study that had the most citations to date is by Merli and colleagues [30] with 183 citations. As it is an emerging topic, the oldest systematic literature review was published in 2017 and was prepared by [31]. In terms of the geographical context in which the authors who develop SLR in the field of circular economy reside, Italy, Brazil, France, UK and Denmark stand out. Highlight for the author Sassanelli of Politecnico di Milano, who had 3 studies included in the sample of articles analysed in this research. Also noteworthy is the *Journal of Cleaner Production*, which published 25 of the 38 systematic literature reviews analysed in our study, which corresponds to 65.79%. In addition, the journal *Sustainability* published 3 SLRs while the journals *International Journal of Physical Distribution & Logistics Management*, the *International Journal of Production Research* and *Business Strategy and Environment* published 2 SLR each. Other 4 journals published only one study each.
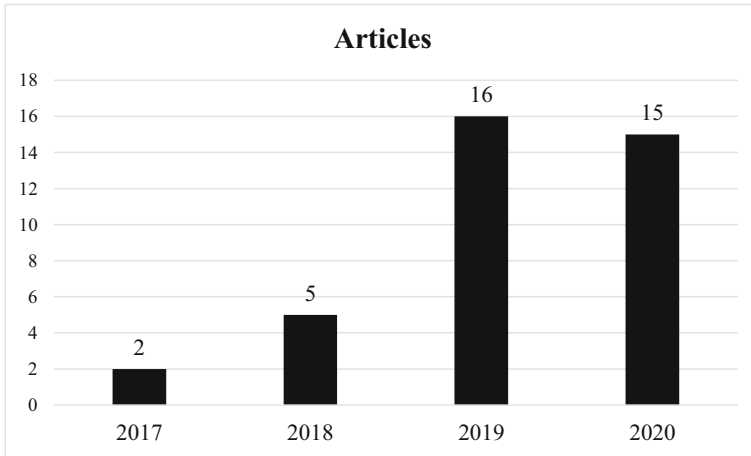
Fig. 2 Year of publication of the analysed studies

Figure 3 shows that the *Journal of Cleaner Production* is the leader in the publication of systematic reviews of circular economy literature. This shows a relevant positioning for the field, since Table 2 also indicates that this journal excels in publishing articles on the topic of circular economy in different formats, namely, case studies, reviews, surveys, etc.

An analysis of the process of conducting the systematic literature reviews shows that studies that use at least 2 academic databases predominate in the investigated field of knowledge. Table 3 shows the bases that are most often used to conduct systematic literature reviews.

Note that Scopus and WoS are the most commonly used databases. They are considered the largest databases and most representative in the publication of scientific studies in the area of management, business and accounting. Soon after, Table 4 shows the total number of articles analysed among the studies.

See in Table 4 that the sample analysed in most studies is fewer than 100 articles. It varies, predominantly, between 30 and 92 consulted studies. Only 29.03% of the analysed studies examined more than 200 articles to conduct their systematic literature reviews. Table 5 shows the time period analysed by the SLRs.

Furthermore, there is no standard to define how long *a priori* articles will be sought in the field of circular economy. However, it is noted that studies that use a period of time greater than 20 years to diagnose the scientific behaviour of studies alluding to the theme circular economy predominate. This helps to show the panorama of the field of knowledge along a timeline. It allows mapping the behaviour of the field along cycles of scientific production. Table 5 presents the research protocols that are most frequently used when performing SLRs.

According to Table 5, [32] and [33] are the most representative authors in the research protocol. It is these studies that are most used to serve as the main guideline for conducting the SLR development process. Examples of users of the [32] protocol are the studies by [31], [34], [35], [36] among others. As users of the protocol of [33], [37] and [38], they made use of both protocols mentioned earlier [30]. After analysing the SLR content, this study shows that the sample of studies analysed by these articles was 6213 studies. They had been published in 9 different journals.

Table 1 Profile of the studies analysed

N.	Title	Year	Journal	Impact factor	ABS ranking	Google citations	Scopus citations	Authors	University(ies)	Country
1	How do scholars approach the circular economy? A systematic literature review	2018	Journal of Cleaner Production	6.395	2	145	183	Merli, Preziozi, and Acampora (2018) [9]	Roma Tre University	Italy
2	Towards a consensus on the circular economy	2017	Journal of Cleaner Production	6.395	2	144	170	Prieto-Sandoval, Jaca, and Ormazabal (2017)	University of Navarra	Spain
3	The circular economy umbrella: trends and gaps to integrating the pathways	2018	Journal of Cleaner Production	6.395	2	110	135	Homrich et al. (2018) [39]	Universidade de São Paulo	Brazil
4	Business model innovation for circular economy and sustainability: A review of approaches	2019	Journal of Cleaner Production	6.395	2	76	113	Pieroni, McAloone, and Pigosso (2019) [15]	Technical University of Denmark	Denmark
5	A taxonomy of circular economy indicators	2019	Journal of Cleaner Production	6.395	2	58	111	Saidani et al. (2019)	Université Paris-Saclay	USA
6	Green supply chain management and the circular economy: Reviewing theory for advancement of both fields	2018	International Journal of Physical Distribution & Logistics Management	5.212	2	30	50	Liu et al. (2018) [40]	Shanghai Jiao Tong University, and Worcester Polytechnic Institute, Worcester	USA
7	Circular economy performance assessment methods: A systematic literature review	2019	Journal of Cleaner Production	6.395	2	22	63	Sassaneli et al. (2019) [44]	Politecnico Di Milano	Italy
8	Challenges in supply chain redesign for the Circular Economy: a literature	2019	International Journal of Production Research	3.199	3	21	47	Bressanelli, Perona, and Saccani (2019)	University of Brescia	Italy

Table 1 (continued)

N.	Title	Year	Journal	Impact factor	ABS ranking	Google citations	Scopus citations	Authors	University(ies)	Country
	review and a multiple case study									
9	The bullwhip effect in closed-loop supply chains: A systematic literature review	2018	Journal of Cleaner Production	6.395	2	15	21	Braz et al. (2018) [34]	Universidade de São Paulo – USP	Brazil
10	Towards Circular Business Models: A systematic literature review on classification frameworks and archetypes	2019	Journal of Cleaner Production	6.395	2	14	40	Rosa, Sassanelli, and Terzi (2019) [42]	Politecnico di Milano	Italy
11	Circular economy business models and operations management	2019	Journal of Cleaner Production	6.395	2	12	44	De Souza Jabbour et al. (2019)	Montpellier Business School and UNESP and Qatar University	France, Brazil and Qatar
12	Drivers, barriers and enablers to end-of-life management of solar photovoltaic and battery energy storage systems: A systematic literature review	2019	Journal of Cleaner Production	6.395	2	10	24	Salim et al. (2019)	Griffith University	Australia
13	Circular Business Models versus circular benefits: An assessment in the waste from Electrical and Electronic Equipments sector	2019	Journal of Cleaner Production	6.395	2	8	18	Rosa, Sassanelli, and Terzi (2019) [42]	Politecnico di Milano	Italy
14	Eco-innovation pathways to a circular economy: Envisioning priorities through a Delphi approach	2019	Journal of Cleaner Production	6.395	2	9	22	Jesus et al. (2019) [43]	Universidade Nova de Lisboa	Portugal
15		2018		5.212	2	8	8			Dinamarca

Table 1 (continued)

| N.	Title	Year	Journal	Impact factor	ABS ranking	Google citations	Scopus citations	Authors	University(ies)	Country
	How the reverse supply chain impacts the firm's financial performance: A manufacturer's perspective		International Journal of Physical Distribution & Logistics Management					Larsen et al. (2018) [38]	Technical University of Denmark	Denmark
16	Towards the ex-ante sustainability screening of circular economy initiatives in manufacturing companies: Consolidation of leading sustainability-related performance indicators	2019	Journal of Cleaner Production	6.395	2	7	21	Kravchenko, Pigosso, and McAloone (2019) [20]	Technical University of Denmark	Denmark
17	Sustainable packaging for supply chain management in the circular economy: A review	2019	Journal of Cleaner Production	6.395	2	5	18	Meherishi, Narayana, and Ranjani (2019) [36]	National Institute of Industrial Engineering,	India
18	Assessing relations between Circular Economy and Industry 4.0: a systematic literature review	2019	International Journal of Production Research	3.199	3	4	38	Rosa et al. (2019) [42]	Politecnico di Milano, Milano and Università Cattaneo, Castellanza, Italy	Italy
19	Circular economy: benefits, impacts and overlapping	2019	Supply Chain Management: an International Journal	4.296	3	4	9	Sehnem et al. (2019) [35]	Unoesc and Unisul and University of Portsmouth and Fundação Getulio Vargas and Federal University of Santa Catarina	Brazil and UK
20	Organic solid waste management in a circular	2019	Journal of Cleaner Production	6.395	2	3	17	Paes et al. (2019) [47]	Unesp	Brasil

Table 1 (continued)

N.	Title	Year	Journal	Impact factor	ABS ranking	Google citations	Scopus citations	Authors	University(ies)	Country
	economy perspective – A systematic review and SWOT analysis									
21	How does servitisation affect supply chain circularity? – A systematic literature review (ahead of print)	2019	Journal of Enterprise Information Management	–	2	–	0	Kuhl et al. (2019) [37]	Cranfield University	UK
22	Recycled fibers in reinforced concrete: A systematic literature review	2020	Journal of Cleaner Production	6.395	2	–	21	Merli et al. (2020) [30]	Roma Tre University and University of Rome "La Sapienza"	Italy
23	Defining lean product service systems features and research trends through a systematic literature review	2020	International Journal of Product Lifecycle Management	–	–	–	5	Sassanelli et al. (2020)	Politecnico di Milano and University of Bergamo and The Federal University of Rio Grande do Sul	Italy and Brazil
24	Circular business models: Current aspects that influence implementation and unaddressed subjects (ahead of print)	2019	Journal of Cleaner Production	6.395	2	–	9	Salvador et al. (2019) [13]	Universidade Tecnológica Federal do Paraná (UTFPR)	Brazil
25	A review of factors affecting closed-loop supply chain models	2020	Journal of Cleaner Production	6.395	2	–	6	Shekarian (2020)	Eindhoven University of Technology	The Netherlands
26	The circular economy in the construction and demolition waste sector – A review and an integrative model approach	2020	Journal of Cleaner Production	6.395	2	–	22	Lópes Ruiz, Rámon, and Gassó Domingo (2020)	Universitat Politècnica de Catalunya	Spain
27	Designing business models in circular economy: A systematic literature	2020	Business Strategy and Environment	6.381	3	–	34	Centobelli, Certioni, Chiaroni, Vechio,	University of Naples Federico II, Naples, Italy and Politecnico	Italy

Table 1 (continued)

N.	Title	Year	Journal	Impact factor	ABS ranking	Google citations	Scopus citations	Authors	University(ies)	Country
	review and research agenda							and Urbinatti (2020) [49]	di Milano, Milan, Italy and University of Salento, Lecce, Italy and Università Cattaneo, Castellanza, VA, Italy	United Kingdom
28	A Framework to Use Product-Service Systems as Plans to Produce Closed-Loop Resource Flows (ahead of print)	2020	Journal of Cleaner Production	6.395	2	–	2	Laan and Aurisicchio (2020)	Imperial College London	United Kingdom
29	Towards product-service system oriented to circular economy: A systematic review of value proposition design approaches (ahead of print)	2020	Journal of Cleaner Production	6.395	2	–	14	Fernandes et al. (2020) [51]	University of São Paulo and Technical University of Denmark	Brazil and Denmark
30	A Systematic Literature Network Analysis of Existing Themes and Emerging Research Trends in Circular Economy (ahead of print)	2020	Sustainability	2.075	–	–	9	Kithous et al. (2020) [18]	LIUC Università Cattaneo	Italy
31	Circular Economy in Textile and Apparel Industry: A systematic Literature review	2020	Journal of Cleaner Production	6.395	2	1	21	Jia et al. (2020)	University of York	United Kingdom
32	Supply Chain Configurations in the Circular Economy: A Systematic Literature	2017	Sustainability	2.075	–	73	85	Masi, Day and Godsell (2017) [58]	University of Warwick	United Kingdom

Table 1 (continued)

N.	Title	Year	Journal	Impact factor	ABS ranking	Google citations	Scopus citations	Authors	University(ies)	Country
	Review									
33	Towards circular and more sustainable buildings: A systematic literature review on the circular economy in the built environment	2020	Journal of Cleaner Production	6.395	2	1	8	Munaro, Tavares and Bragança (2020) [57]	Federal University of Parana	Brazil
34	How fashion can achieve sustainable development through a circular economy and stakeholder engagement: A systematic literature review	2020	Corporate Social Responsability and Environmental Management	5.513	1		4	Ki, Chong and Ha-Brookshire (2020) [56]	The Hong Kong Polytechnic Universit	Hong Kong
35	A Systematic Literature Review of Bio, Green and Circular Economy Trends in Publications in	2020	Sustainability	2.075	–	19	22	Gregorio, Pié and Terseño (2020)	Universitat Rovira i Virgili	Spain
36	Circular economy in the construction industry: A systematic literature review	2020	Journal of Cleaner Production	6.395	2	1	10	Benachio et al. (2020) [54]	Federal University of Parana	Brazil
37	Plastic recycling in additive manufacturing: A systematic literature review and opportunities for the circular economy	2020	Journal of Cleaner Production	6.395	2	–	16	Sanchez et al. (2020) [53]	Université de Lorraine	France
38	Circular economy in Latin America: A systematic literature review	2020	Business, Strategy and Environemt	6.381	3	–	3	Morales and Sossa (2020) [52]	Universidad Pontificia Bolivariana, Medellín	Colombia
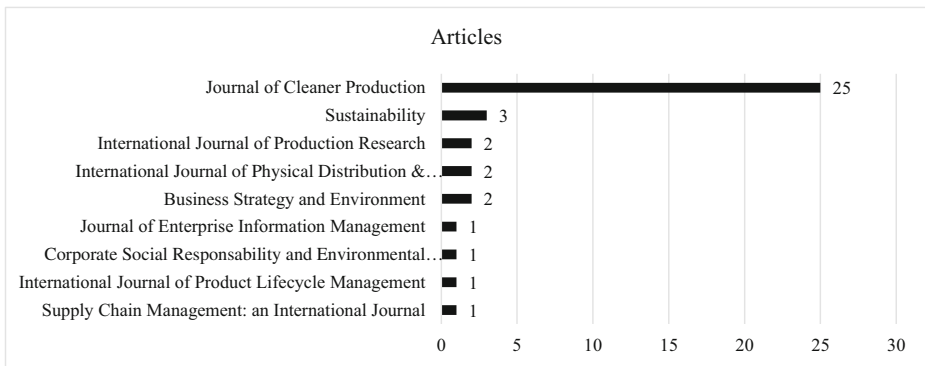
Fig. 3 Journals where the SLR were published

Content Covered by SLRs

When analysing the content of the 38 SLRs, it is possible to identify the source of the papers reviewed in each SLR, and therefore the more prolific journals in CE research. The top 20 journals that published the most studies on the circular economy theme can be seen in Table 6.

Highlights must be given to *Journal of Cleaner Production* (*JCP*), *Resources, Conservation and Recycling* (*RCR*), *Journal of Industrial Ecology* (*JIE*), *Sustainability*, and *International Journal of Production Economics* (*IJPE*). These 5 journals represent 54.29% of the studies that were analysed in the 38 SLRs explored in our article. Therefore, these 4 journals are the main references in the theme of the circular economy at a global level. They are journals that have an impact factor ranging from 2075 to 7044.

With regard to the main contents covered by previous studies, it is possible to summarize the following avenues investigated:

a) Opportunities and reverse supply chain contributions to the company's financial performance and contingency factors [38]

b) Lack of consensus on CE terminology and theoretical aspects that gave rise to it, namely, ecoparks and industrial symbiosis located in China and the supply chain, closed loops of materials and business models [39]

c) The need to change social and economic dynamics at the macro and administrative levels and to support companies in implementing circular processes at the micro level [30]

Table 2 Total databases used

Number of databases	Total
1 academic database	11
2 academic databases	12
3 academic databases	11
4 academic databases	0
5 academic databases	2
9 academic databases + 4 non-academic databases	1
Used delphi technique	1
Total	38

Table 3 Databases used to conduct the SLRs

Databases used	Total
Scopus	33
Web of Science (WoS)	22
Science Direct	9
Emerald	4
ProQuest Citation Search	3
ISI Web of Knowledge	2
EBSCO	3
ABI	1
Sage	1
Springer	2
Taylor and Francis	1
JSTOR	1
Google Scholar	2
No academics	1
Scielo	1
Total	86

d) Concepts, principles and determinants of the circular economy supported by eco-innovations [31]

e) Theories that have been applied in the GSCM and CE studies. 12 theories identified, the most often used complexity theory, transaction cost economics, agency theory and information theories [40]

f) How closing a supply chain can reduce the bullwhip effect, which could lead to positive impacts on the environmental performance of supply chains [34]

g) How Product Service Systems business models affect Supply Chain Circularity through greater product durability [41]

h) How circular business models can be designed using hybrid categories derived from the circular economy and industry 4.0 [42]

i) Drivers, barriers and enablers for the management of photovoltaic panels. Classification of indicators with the objective of evaluating, improving, monitoring and communicating the performance of the CE [1]

j) CE trends and a reflection on the interface of the innovation scopes of the business model oriented towards the circular economy and the business model oriented towards sustainability [15]

Table 4 Total articles analysed to perform a systematic literature review

Number of articles analysed	Total
Up to 100 articles	17
From 101 to 200 articles	10
From 201 to 300 articles	4
From 301 to 400 articles	3
From 401 to 500 articles	1
From 501 to 600 articles	1
Above 601 articles	2
Total articles analysed: 6213	38
Average	159 artigos/estudo
Variation	From 33 to 1558 articles/study

Table 5 Time period analysed to conduct a systematic literature review

Analysed time period	Year of paper publication	Total
Not disclosed	De Souza Jabbour et al. (2019)	17
	Sehnem et al. (2019) [35]	
	Kavchenko et al. (2019)	
	Merli et al. (2020) [30]	
	Sassaneli et al. (2019)	
	Sassaneli et al. (2020)	
	Salvador et al. (2019) [13]	
	Shekarian (2020)	
	Laan and Aurisicchio (2020)	
	Fernandes et al. (2020) [51]	
	Khitous et al. (2020)	
	Rosa, Sassaneli and Terzi (2019a)	
	Bressanelli, Perona, and Saccani (2019)	
	Jia et al. (2020)	
	Mais, Day and Godsell (2017)	
	Munaro et al. (2020) [57]	
	Benachio et al. (2020) [54]	
Period from 2000 to 2018	Rosa, Sassanelli, and Terzi (2019b)	5
	Meherishi et al. (2019)	
	Saidani et al. (2019)	
	Salim et al. (2019)	
	Rosa et al. (2019)	
Period from 1995 to 2017	Larsen et al. (2018)	1
2018	Braz et al. (2018)	1
Period from november 2018 until March 2019	Lópes-Ruiz et al. (2020)	1
Did not quote	Merli, Preziozi, and Acampora (2018)	1
Up to December 2016	Homrich et al. (2018)	1
2007	Prieto-Sandoval, Jaca, and Ormazabal (2017)	1
Not applicable	Jesus et al. (2019)	1
Until 2018	Paes et al. (2019)	2
	Pieroni, McAloone, and Pigosso (2019)	
End of year 2018	Centobelli et al. (2020)	1
2019	Liu et al. (2018)	2
	Kuhl et al. (2019)	
2015 until 2019	Ki et al. (2020)	1
1970 until 2017	Gregorio et al. (2018)	1
2009 until 2019	Sanchez et al (2020)	1
2016 until 2020	Betancourt Morales et al. (2020)	1

k) Main characteristics of Circular Economy transitions and conceptualiation of the fundamental strategies and trade-offs that must be understood and managed for the transition [43]

l) CE performance assessment methods proposed in the literature and, based on the main conclusions, a framework to measure and evaluate the degree of circularity of a company [44]

m) Benefits arising from the adoption of CE from the perspective of sustainability [45]

n) Specific changes that operations management decision making must make to support CE business models [46]

Table 6 Research protocol used

Protocol	Total
Tranfield, Denyer, and Smart (2003)	11
Denyer and Tranfield (2009)	6
Does not indicate	5
Smart et al. (2017)	3
Biolchini et al. (2005)	1
Blomsma and Brennan (2017)	1
Borrego et al. (2014)	1
Brereton et al. (2007)	1
Centobelli et al. (2017)	1
Cui (2018)	1
Dresch et al. (2015)	1
Durach et al. (2017)	1
Duriau et al. (2007)	1
Govindan and Hasanagic (2018)	1
Hansen et al. (2015)	1
Homrich et al. (2018)	1

o) Overlaps between the concepts of CE, reverse logistics, closed loop, industrial symbiosis and industrial ecology and identification of main operational, economic, social and environmental benefits and disbenefits of CE and related concepts [35]

p) Sustainable packaging in supply chain management for Circular Economy. Highlights the dominance of reuse and return strategies [36]

q) Threats, weaknesses and strengths of the use of alternative materials derived from organic waste from the perspective of the CE [47]

r) Indicators to measure the impacts on sustainability of circular economy strategies. It propsoed a set of indicator to be applied ex-ante when selecting CE practices [20]

s) Challenges that can hinder supply chain redesign for circular economy. In addition to 18 challenges common to supply chain redesign, the paper identifies 8 challenges unique to CE supply chains: cannibalization, fashion change, taxation, indicators, lack of standards, persistent linear mindset, data privacy and security, willingness to pay for CE products [10]

t) Classification methods, typologies and archetypes used in Circular Business Models (CBMs) literature [42]

u) How recycled fibers can be part of a construction industry oriented and inspired by the principles of circular economy [9]

y) How the digitization of manufacturing, product service systems (PSS) and smart connected products can be used as artifacts that drive a market transition from selling products to selling user solutions and, on the customer side, reshaping the concept of value [44]

w) What are the main aspects that influence the implementation of the circular business model [13]

z) Factors that influence the implementation of closed loop suppy chains [48]

z1) Factors that could influence the adoption of the Circular Economy concept in the construction and demolition sector [14]

z2) How companies design their business model according to the principles of the circular economy [49]

z3) How Product Service Systems elements can contribute to closed loops. They identify 26 elements and categorized them by six architectural levels, i.e. services, resources, stakeholders, contract, value delivery, and systems and tools [50]

z4) Business model innovation approaches that can support the design of value propositions for circular systems and/or product services systems. 46 approches are identified [51]

z5) Network analysis of existing themes and emerging research trends in CE [18]

z6) CE principles and ways of implementing the CE [52]

z7) The opportunities for CE of plastic recycling in Additive Manufacturing. It highlights the opportunities of Distributed Recycling via Additive Manufacturing (DRAM) [53]

z8) Circular economy practices adopted at each stage of the life cycle [54]

z9) Comparative analysis of trends in Bio-Economy, Circular Economy and Green Economy research. [55]

z10) How fashion companies can institute true circularity, involving external stakeholders in their ventures related to circular fashion [56]

z11) The extent and modalities of implementation of CE in the Built Environment and Construction [57]

z12) Supply chain configurations in the Circular Economy [58]

z13) Main challenges, drivers, barriers, practices and indicators of sustainable performance when applying a circular economy in the textile and clothing industry [59]

Therefore, the main findings of the research show that the circular economy is a field that dialogues with the area of operations management, innovation, technology and the territorial context, to seek solutions to close cycles, use materials more efficiently and produce more effective results for companies. It is supported by the sustainability field and makes use of specific business models to be implemented in companies. Further, it creates short cycles and closed production cycles, and it resembles the premises of sustainable supply chains. Themes related to Technical cycles continue to dominate CE research at the expense of analysis of circularity in biological cycles. Cases for developed countries are stil dominant but the attention to developing economies is growing. More recent reviews have a more contingent approach with narrower focus on specific issues (e.g. plastic recycling in additive manufacturing) and implementation in specific industry contexts (construction, fashion).

The themes related to these findings be categorised in the following Table 7.

Table 7 shows that Circular Business Models, Circular Supply Chains, Eo- innovations/ technology for CE, Waste Management and Product Services Systems are the topics most frequently considered in systematic reviews. They are followed by studies addressing benefits/ impact, indicators, eco-parks/symbiosis and Triple Bottom Line.

Table 8 presents the emphasis given by previous studies.

The evolutionary perspective of circular economy studies has been emphasized by several SLRs. The combination of the circular economy constructs with others, such as, for example, GSCM, PSS, Industry 4.0, Innovation has also been the object of analysis in several studies. The concern with indicators for measuring the performance of the circular economy and the business models required for its implementation is reflected in the frequency of these topics in recent reviews.

Although thematically we have identified a wide scope covered by SLR, next, we analyse the extent to which the relations investigated satisfy the conditions for theory building. Table 10 maps the findings of SLR to the fulfilment of such conditions: (a) clearly articulated constructs or variables of interest; (b) identification of explanatory mechanisms linking the

Table 7 Journal that published the articles that served as samples for the analysed RSL

N.	Name of Journal	Total
1	Journal of Cleaner Production (JCP)	618
2	Resources, Conservation and Recycling (RCR)	199
3	Sustainability (Switzerland)	164
4	Journal of Industrial Ecology (JIE)	99
5	International Journal of Production Economics (IJPE)	77
6	International Journal of Production Research	71
7	Construction and Building Materials	43
8	Waste Management	37
9	Business Strategy and the Environment	28
10	Procedia CIRP	25
	Journal of Industrial Ecologiy	23
	Quality - Access to Success	19
11	Production Planning and Control	18
12	European Journal of Operation Research	17
13	Procedia Manufacturing	17
	IOP Conferecens Series: Earth and Environmental Science	14
	International Journal of Green Economics	14
14	Transportation Research Part E	13
15	Environmental Science and Technology	12
16	Production and Operations Management	11
17	International Journal of Human Resource Management	9
18	Journal of Environmental Management	9
19	Journal of Materials in Civil Engineering	8
20	Mathematical Problems in Engineering	8
21	Outros...	578
	Total	2131

constructs or variables: b1-antecedents of CE practice: b2-consequences of CE practice, b3-mediators of the relation between CE Practice and CE consequences, b4-moderators of the relation between CE practice and CE consequences; (c) well-delineated boundary conditions — the scope within which such mechanisms operate (small vs. large, new vs. old, inter-industry differences, technical and biological cycles, temporal and geographical boundaries); and (d) moderators or conditions that influence the integrity of the system.

Tables 9 and 10 suggest that knowledge accumulated has not yet built critical mass for theory development. Articulation of constructs and variables has been widely investigated but most studies still report a lack of convergence in terms of definition and inclusion/exclusion to determine what practices are CE. SLRs are now focusing on antecedents (e.g. eco-innovation) and consequences of CE, yet again findings reveal inconsistencies and gaps, particularly in terms of understanding mechanisms for CE as a system and CE as a process. More complex mechanisms such as mediation or moderation are starting to be conceptualized in discussions of drivers, barriers and enablers but analysis is still more descriptive than analytic and — for instance — there is no clear separation conceptual between adoption and implementation, when enablers are discussed, it is unclear if the mechanismis described are those of mediators or moderators; the separation between practices implemented and outcomes achieved is often blurry or not specified; finally, the systematic identification of boundary couinditions is still in early exploratory stages. A remarkable exception is Bressanelli (2019). His study of supply chain management challenges effectivekly advances our understanding of boundary conditions with the identification of CE-specific challenges for different stages in the product- life-cycle and differet groups of stakeholders. This type of knowledge is particularly important because

Table 8 Main findings of the analysed SLRs

Authors	Main findings of the SLRs analysed
Larsen et al. (2018, p. 1)	"Opportunities and contributions from reverse supply chains to the company's financial performance. And contingency factors".
Homrich et al. (2018, p. 525)	"Lack of consensus on CE terminology. A standard concept is proposed. Highlight for two main groups of CE, with different origins, from different leading research groups in different geographic regions. One cluster focuses on *ecoparks and industrial symbiosis*, located in China. The second cluster emphasizes *supply chains, closed loops of materials* and *business models*".
Merli, Preziozi, and Acampora (2018, p. 1)	"CE studies emphasize: changing social and economic dynamics at the macro and administrative levels; supporting companies in implementing circular processes at the micro level, to disseminate new forms of consumption and product design; when developed at the meso level, it discusses experiences of *industrial symbiosis*. The CE is associated with a variety of concepts. *Waste management* emerges as the most relevant subsector. The CE is also strongly connected to the concept of sustainability, proposing ways to operationalize its implementation at the environmental and economic levels. The social and institutional implications have not yet been addressed in depth in the field".
Prieto-Sandoval, Jaca, and Ormazabal (2017, p. 1)	"It presents a consensual view of the structure of the circular economy and its relationship with *eco-innovation*. The study is a knowledge map of the circular economy, an analysis of the main notions of the concept, principles and determinants of a circular economy. It describes notable examples of eco-innovations developed for implementation in the circular economy".
Liu et al. (2018, p. 1)	"It shows that 12 theories are applied in the GSCM and CE studies. Among them, we highlight the theory of *complexity*, economy of *transaction costs*, agencies and information theories".
Braz et al. (2018, p. 2)	"The studies examined in our review indicate that the causes of the bullwhip effect in closed-loop supply chains are similar to those in advanced supply chains. The authors infer that *closing a supply chain could reduce the bullwhip effect*, which could lead to positive impacts on the environmental performance of supply chains".
Kuhl et al. (2019, p. 1)	"A conceptual model is developed to illustrate how *PSS business models* affect SCC through increased product durability, closing resource flows and resource efficiency. firm sustainability strategy; politics and social environment; product category; supply chain relationships; and technology".
Rosa et al. (2019, p. 2)	"They have hybrid categories derived from the circular economy and *industry 4.0.* An innovative structure was created showing the links between these two constructs and the avenues for future research".
Saidani et al. (2019, p. 2)	"They propose a classification of *indicators* with the objective of evaluating, improving, monitoring and communicating the performance of the CE".
Salim et al. (2019, p. 4)	"Synthesize *drivers, barriers and capacitors* for the management of photovoltaic panels".
Pieroni, McAloone, and Pigosso (2019, p.198)	"It presents the trends and a reflection on the interface of the innovation scopes of the *business model oriented towards the circular economy and oriented towards sustainability*. In addition, several gaps are identified and a structure is outlined that maps a future research agenda to simultaneously advance the two flows".
Jesus et al. (2019, p. 1494)	"The study explores the main characteristics of Circular Economy and assesses the fundamental *strategies and trade-offs* that must be understood and managed for the transition. The Circular Economy is a holistic concept and an operational tool. The results strongly suggest *systemic eco-innovation*, fueled by multidimensional policies, as the key to promoting a profound transition".

Table 8 (continued)

Authors	Main findings of the SLRs analysed
Sassaneli et al. (2019, p. 440)	"It presents the CF performance assessment methods proposed in the literature and, based on the main conclusions, develop a positioning structure to *measure and evaluate the degree of circularity of a company*".
Rosa, Sassanelli, and Terzi (2019, p. 940)	"It provides a list of the *benefits* arising from the adoption of CE through a systematic review of the literature, declined from the perspective of sustainability (Triple Bottom Line - TBL), validating and substantiating them in four practical use cases. Second, the work links the benefits of CE to a set of *CBMs - based on product service systems (PSSs)* - through a set of interviews with experts from the *waste* electrical and electronic equipment (WEEE) sector, trying to support the industrialists of both i) to detect benefits related to the adoption of *CBMs*, ii) to raise awareness about the benefits and iii) to achieve them in practice".
De Souza Jabbour et al. (2019, p. 1525)	"The new demands faced by *OM*'s decision-making in relation to changes in capacity, work procedures, intra and interorganizational technologies and relationships; (2) the specific changes that OM decision-making must make to support *CE business model*s (based on the *ReSOLVE framework*); and (3) guidelines that will help designers and operations and logistics / supply chain managers to develop the *skills* necessary to meet society and the emerging demands of the global market".
Sehnem et al. (2019, p. 784)	"It presents the overlaps between the concepts CE, reverse logistics, closed-loop, *industrial symbiosis* and industrial ecology. It analyses *economic, operational, environmental and social benefits*".
Meherishi, Narayana, Ranjani (2019, p. 1)	"Investigate published studies in the field of *sustainable packaging* in supply chain management (SPSCM)".
Paes et al. (2019, p. 1)	"It presents threats, weaknesses and strengths of the use of alternative materials derived from *organic waste* from the perspective of the CE".
Kravchenko, Pigosso, and McAloone (2019, p. 1)	"Estimates the *sustainability effects* of circular economy strategies".
Bressanelli, Perona, and Saccani (2019, p. 1)	"It identifies and systematizes 24 *challenges* that can hinder the redesign of the circular economy's *supply chain*".
Rosa, Sassanelli, and Terzi (2019, p. 1)	"It presents the existing *Circular Business Models* (CBMs) and their classification methods, selecting the promising ones".
Merli et al. (2020, p. 1)	"Investigates published studies on the use of recycled fibers. It seeks to understand how recycled fibers can be part of a *construction industry* oriented and inspired by the principles of circular economy".
Sassanelli et al. (2020, p. 38)	"Investigates *manufacturing digitization*, *product service systems (PSS)* and smart connected products as artifacts that drive a market transition from selling products to selling user solutions and, on the customer side, reshaping the concept of value".
Salvador et al. (2019, p. 1)	"It identifies the main aspects that influence the *implementation* of the *circular business model*".
Shekarian (2019, p. 1)	"Investigate factors that influence Closed Loop Supply Chain Models". Economic factors are the most influential: sales adverstising and discounts.
Lópes Ruiz, Rámon, and Gassó Domingo (2020, p. 1)	"It identifies *factors that could influence the adoption* of the Circular Economy concept in the *construction and demolition* sector. The concept of Circular Economy (CE) is a potential solution in many sectors, as it involves the more efficient use of resources and energy, which leads to the minimisation of waste and the reduction of the environmental impacts of product cycles. Furthermore, it represents potential economic opportunities".
Centobelli et al. (2020, p. 1)	"It understands how companies design their *business model* according to the principles of circular economy".
Laan and Aurisicchio (2020, p. 1)	"*Product-Service Systems (PSSs)* have the potential to produce closed-loop resource flows. Focused on the use phase and obsolescence. We

Table 8 (continued)

Authors	Main findings of the SLRs analysed
	identified twenty-one PSS elements that contribute to closed loops and categorised them by six architectural levels, i.e. services, resources, stakeholders, contract, value delivery, and systems and tools".
Fernandes et al. (2020, p. 1)	"It presents a systematic analysis of 46 approaches that can support the design of value propositions for circular systems and/or product services in the context of *business model innovation*".
Kithous et al. (2020, p. 1)	"It provides a holistic and broader view of the CE, combining existing themes and emerging research trends". Scholars are both developing frameworks, indexes and exploring technologies for CE, focusing mainly on environmental costs and impacts, while paying less attention to the managerial perspectives.
Jia et al. (2020, p.28)	"As far as the role of incentives is concerned, actions should not only target the recycling of waste resources, but also take measures to support cooperative business organizations (for example, joint research and development strategies, resource exchange or other possible options), which may also stimulate the birth of CE projects. The inter-organizational cooperation may require a new participant who did not play a role initially. The implication here is to consider the possibility that after innovation, a new entity enters the scene, making industrial symbiosis possible, and collecting resources from existing entities."
Masi, Day and Godsell (2017, p.18)	"Integrating the different supply chains (SC) configurations into a truly CE supply configuration and then aligning it to a commercial strategy in the absence of strong government support remains difficult in theory and practice."
Munaro, Tavares and Bragança (2020, p.15)	"The main trend in the area is the reuse of t Construction and Demolition (C&D) waste. The most exploited practices are related to cleaner production, aiming to reduce the extraction of natural resources, the environmental impact and waste throughout the building life cycle, in addition to optimising the performance and efficiency of the processes. The axes also highlight the need to elucidate the link between CE and the literature of business models foreseeing the economic and sustainable development of the built environment, through evaluations of circular practices in reducing the environmental impacts"
Ki, Chong and Ha- Brookshire (2020, p.19)	"The findings imply that it is internal fashion stakeholders, who design, manufacture, distribute, and sell fashion products that can enable the acceleration of circular fashion (CF) the most. Our findings further imply that the infrastructural support, provided by both fashion corporations and the government, and the social support to encourage consumers to take more part in fashion firms' CF initiatives are also critical in facilitating the creation of a truly CF."
Gregorio, Pié and Terseño (2020, p.39)	"We have observed that the term blue economy has emerged to complement the concept of green economy, with the goal of managing the oceans. Within this concept we also find blue bioeconomy, based on the part of the blue economy that uses renewable biological resources from the sea, for example, fish, seaweed and microorganisms to produce food, materials and energy. Both are recent concepts in the academic literature, but given the importance of the seas and oceans, a future line of research should be to analyse these concepts and their inter-relationships in greater depth"
Benachio et al. (2020, p.10-11)	"There is a need to further the development of standard practices for the reuse of building materials, as several articles found this fact as one of the biggest barriers for the adoption of Circular Economy in the Construction Industry. r the Circular Economy in the Construction Industry are aiming at reducing the amount of waste generated at the end of the life cycle of a building, as well as better manage the resources used throughout it. T"
Sanchez et al. (2020, p.22)	", it is concluded that the recovery and preparation stages are less studied. Research efforts need to be taken in the pre-treatment of the recycled

Table 8 (continued)

Authors	Main findings of the SLRs analysed
	material, including efficient models to collect waste material, technology and methodologies to develop quality indicators of the waste material. Then, based on these indicators, strategies of local cleaning and sorting process could be potential opportunities to promote. Thus, a systematic definition of the process to perform for cleaning, sorting and size reduction including quality indicators for each of them is a major research path. In addition, it is important to identify sectors which produce homogeneous waste streams and that are feasible to collect are important with the purpose to connect particular niche waste with potential applications with add value thanks to the 3D printing advantages".
Morales and Sossa (2020, p.10)	"this review highlights the importance of achieving a simplification of the concept so that its dissemination and understanding are lowered to all social levels through education, and thus the transition to CE is faster and more efficient because it would be society itself that would pressure industries and governments to generate new sustainable policies".

better understanding of unique CE challenges will help to differentiate phenomema that can be explained with the application or "translation" of existing theory (from management, social sciences or sustainability), and phenomena that requires building new theoretical constructs. Theory in CE has so far been focused in translating and applying existing theories, what we call a Contextualizing approach to theory building. The overall fuzziness of knowledge accumulated so far makes it difficult to assert if such approach is enough. Contextualizing transaction costs economics or institutional theory may be good enough to understand CE adoption in mafufacturing and sales, but perhaps not enough to understand the implementation issues faced in produc-life cylcle stages such as product renovation and by stakeholders such as CE service providers (According to Bressanelli, 2029, CE-specific challenges are more likely in the product renovation stage and for service providers).

Several limitations have been self-reported by previous studies and we classify them according to the 6 first stages in the methodology presented in Fig. 1 (the last stage refers to theorizing, already analysed in the previous paragraph):

Table 9 Aspects of circular economy that have been investigated in previous studies

Themes	Articles
Circular Business Models	15
Supply Chains and Closed Loops	8
Eco-innovation/new technologies (Including Industry 4.0)	5
Waste Management (General: 2, Organic: 1, Electrical:1, Construction: 1)	7
Product Service Systems	4
Eco-Parks & Industrial Symbiosis	3
Triple Bottom-line	3
Factors influencing Adoption/Design of CE	3
Factors influencing Implementation of CE	3
Benefits/Impacts of CE	3
Sector Specific (Construction)	3
Indicators/measurement of CE	2
Definition and dimensions of CE	1

Framing the Research Question

Narrow scope of the study: For instance, focus only on manufacturers, with the circular economy demanding the engagement of all links in the supply chain [38], and stakeholders such as service providers and users identified as those more likely to suffer CE-specific challenges [10]

Locating Relevant Research

Search criteria for the analysed materials and methodological choices: referring to the search sequence and filters [39]. This argument is also highlighted by[31], who emphasize the type of material consulted. Cross-references were subjected to the inclusion criteria and a screening process, but specific rules for choosing papers in the first instance could mitigate selection variability, according to [51]. Also, non-peer reviewed publications, which do not follow a scientific rigor, were included [51].

Restricted databases consulted: only ISI Web of Science [31] were consulted. [39] also highlights this limitation. [40] emphasize the lack of full coverage of all emerging theories of GSCM and which may be relevant to address issues of circular economy, whereas [18] highlight that Scopus represents only a fraction of the existing scientific literature. Finally, the use of only one database limits access to some important journals for the investigated field [35, 59].

Inclusion/Exclusion

Narrow Inclusion and Exclusion Criteria: the review focused on peer-reviewed articles written in English, without considering results published in other languages [41]. No access [20] or neglect [57] of grey literature and archives of market professionals which would cover corporate research [20] and researcher's bias [57] or books and reports by professionals that could contain important discoveries[36].

Keywords chosen: they represent a limitation for the article because they partially cover the field of circular economy and its taxonomies [47]

Use of non-peer-reviewed materials: which generates a bias [15]. In this case, the inclusion of grey literature is considered a limitation. This suggests the need to consider a case-by-case approach to grey literature inclusion, and the inclusion of qualitative screening mechanisms.

Extracting and Coding

Selected research mechanisms, methodological choices and applied filters: does not cover the different terminology correlated with similar concepts of circular economy [47].

Narrow scope of mapping the literature: use of techniques that do not cover the entire conceptual framework of the investigated field [15].

Form of screening of the analysed texts: the use of filters based on title, keyword and abstract can generate a bias [46]

Use of the snowball technique: it generates a bias generated by the indicators [15].

Matthew effect: researchers tend to cite prominent articles (that is, already highly cited) and possibly ignore the value of other scientific contributions [18].

Analysing

Subjective evaluation of articles: generates bias and analysis by researchers [31] and content analysis generates interpretation bias [39].

   Lack of discussion of methodologies and tools: that explain how to link potential theories to solve circular economy problems [40] and use of data-based theory[56].

   Limitations associated with the specific methods: for instance, the use of Delphi method provided better results with application in real time, making it difficult to apply [43]. Content analysis generates interpretation bias [47]. Case study selection bias: which implied neglect of representativeness, external validity of the results [10]. In [44] the analysed contributions derive from a single European project. Thus, they report a limited perspective, even if applied to a sectorial sample of cases [44].

   Cognitive component: may have affected the interpretation of the analysis [46].

   Limiations related to the fit with CE challenges of the frameworks used for analysis: For instance, in [57] the use of the triple bottom line to classify the indicators did not capture the interdependence between them

Synthesing

Emerging themes: possible bias in studies based on a body of literature which is still incipient and fragmented [41][58].

   Limitations of the proposed findings based in state-of the art theme: for instance [1] acknowledges that the taxonomy proposed demands some areas of improvement that need to be further investigated;

   Limitations on the external validity of the results: association with the possibility of generalizing the results. Need to expand the research by studying different databases and including articles published in other languages [34]. [13] notes that empirical validity is constrained by limitation on the use of the circular economy: only 9% of the world economy is circular. In [10], the authors note that the levers to face the challenges of the circular economy cannot be generalized and require an extension of the research [10].

   Failure to present detailed proposals: linking the elements that would be necessary for the next step in the investigated field [35].

   Self-fulfilling bias: For instance, in [20], the authors note that strategic structure of the circular economy guided the logic of classification and the result ws largely affected by the strategies chosen in the structure [20]

   Problems to bridge CE research with other themes addressed by the review: The shared economy has unintended weaknesses, and may not have been designed for circularity. It only meets requirements and circular principles by chance. Such weaknesses can include overuse and/or transient commitment [13].

   Therefore, limitations and gaps can be coded in 3 major categories:

a)   Limitations related to the method: associated with the way the SLR was conducted, the process of screening the studies, types of materials accessed and practices recognized by the scholars, although they may generate bias.

b)   Limitations related to the stage of maturity of the theme: associated with the embryonic stage of the field. Although the number of studies being published is representative, the profile of the studies adopts a pattern of a field of knowledge in development.

Table 10 Aspects of circular economy that have been investigated in previous studies

Authors	Aspects researched
Larsen et al. (2018, p. 1)	"Identify how Reverse Supply Chains can contribute to the company's financial performance and examine the exogenous contingency factors that determine the size of the contribution".
Homrichetal. (2018, p. 525)	"Provide a comprehensive view of academic studies on CE, identify gaps in research and provide possible future directions for research on the topic".
Merli, Preziozi, and Acampora (2018, p. 1)	"Present the results of a systematic literature review that explores the state of the art of academic research in CE".
Prieto-Sandoval, Jaca, and Ormazabal (2017, p. 1)	"Propose a consensual view of the basic notions of the structure of the circular economy and highlight its relationship with eco-innovation".
Liu et al. (2018, p. 1)	"Clarify the links between the concepts of ecological supply chain management (GSCM) and the circular economy (CE)".
Braz et al. (2018, p. 2)	"Compare the causes and mitigating factors of the bullwhip effect in linear supply chains ahead and closed loop supply chains".
Kuhl et al. (2019, p. 1)	"Test the connection between servitization and circular economy, synthesizing the effect of product service systems (PSS) on the circularity of the supply chain (SCC)".
Rosa et al. (2019, p. 2)	"Develop an innovative structure, highlighting the links between Industry 4.0 and CE, revealing future research fields".
Saidani et al. (2019, p. 2)	"Propose a classification of indicators with the objective of evaluating, improving, monitoring and communicating the performance of the CE".
Salim et al. (2019, p. 4)	"Conduct a systematic quantitative review of the literature on studies of properly managed end of life (EoL). of solar energy systems conducted to examine the time trend of current research, as well as methodological and geographical distributions of published articles".

Conclusions are often put forward despite gaps in conceptual foundations. For example, circular systems: even if they are designed intentionally, they can still have repercussion effects — insufficiently understood — that compromise their primary intention and are affected by insufficient substitutability of goods, as well as price and long-term growth effects [13]

c) Limitations regarding the dissemination of circular economy practices: CE is still considered to be unrepresentative, given the traditional and linear production pattern, and when they exist, they are incorporated into traditional business models, which requires an adaptation process and the formation of a new culture. This also neglects the external validity of the data, compromising the consolidation of the investigated field (Table 11). The problem increases when reserchers attempt to explore a marginal phenomena within the CE. For instance, CBMs generally neglect the social dimension of sustainability: CBMs tend to respond first for the environmental dimension and second for the economic dimension, in order to provide eco-efficient solutions, while the social dimension can remain largely ignored [13], accordingly analysis of the topic cannot do much more than highlight a gap without conceptualizing why this happens.

Table 11 shows that the interests of circular economy studies converge especially for sustainability, business models, innovation, closed-loop supply chain, PSS and measurement

Table 11 Relations investigated satisfy the conditions for theory building

Theory building condition	Articles
a-Articulation of constructs and variables	11
b1Explanatory Mechanisms: Antecedents	7
b2-Explanatory Mechanisms: Consequences	5
b3-Explanatory Mechanisms: Mediators	1
B4 - Moderators of the relation between CE practice and CE consequences	1
c-Boundary Conditions	3
d- Other Moderators	3

indicators. This allows us to reflect on the opportunities that exist to advance in the field of the circular economy. Based on this evidence, the study presents some propositions to be tested in future studies. These propositions can contribute to potential advances in the theme.

Discussion of Results and Identification of Megatrends

In the identification of megatrends, we looked at two major aspects: megatrends in concepts explored and megatrends in actors targeted. The SLRs analysed show that the landscape of CE research in the world is strongly based on the development of studies that focus on drawing an overview of the field, identity overlaps of themes related to circular economy [35] and provide guidelines for advancing studies on the topic [30, 39]. Conceptual mega-trends indicate an emphasis on waste management [19], via circular business models [23, 39], closed-loop life cycles [48], sustainable supply chains [46], product service systems [44] and innovations [43]. Most of the studies generate results that can contribute to the consolidation of sustainable supply chains [46] but there is limited evidence of emerging new CE-specific concepts. The topics analysed have been long discussed — for instance in ecological economics, industrial symbiosis, closed-loop, reverse logistics, product service systems and green supply chain research. What is new is that many of these topics were before siloed, and now they are increasingly understood from a more encompassing perspective. The trend is skewed towards integration of constructs and there is less critical understanding of the extent to which concepts are compatible.

In terms of agency, megatrends are still centred on private companies, and public organizations or non-governmental organizations are rarely mentioned as objects of analysis in the studies reviewed. Although we have this scenario, the governments of the world are essential to ensure that circular economy strategies are part of public policies, as well as organizations such as Ellen Mc Arthur Foundation or social movements energizing collective action. Another aspect that could be better explored with a multi-stakeholder focus is how CE practices contribute to generate a positive impact on climate change. This can occur via alignment with the UN Sustainable Development Goals [60] [61] and via public policies that encourage better use of natural resources, the use of second-hand materials, remanufactured raw materials, products derived from recycling processes and reverse logistics.

The need for metrics to measure performance in circular economy is also a gap that deserves further scientific investigation [20]. The transition from the linear to the circular system tends to become more agile from the moment it demonstrates with concrete indicators [44] what this represents: economic gains, resource savings, social alternatives, innovative and optimized closed cycles, added value to products and services, bringing sustainability to products and services offered to society and less waste that contributes to environmental contamination.

The engagement of specific sectors, such as civil construction [23, 30], electric [45] or agribusiness [47], is also an important asset for the success of circular economy. It facilitates mobilization, awareness and engagement of the parties. Above all, industry level engagement can generate efficient economic solutions and helps the orchestration of actors to create new business models and new social organizations capable of providing society with superior value.

Considering that the circular economy tends to be successful when it is implemented under the collaborative perspective [48] among networks and with the engagement of different actors, systems theory becomes a basic tenet for the advancement of circular practices in organizations. In this perspective, the analysis of circular value systems — exploring connections between multiple production grids, rather than supply chains — becomes an avenue of representative research. When globalized chains emerge, we see two distinct groups represented: global players (who meet the laws and requirements of different continents) and local enterprises (who meet the specificities of the local population). Separate legal guidelines apply to each of these groups, and synergies and tensions between these legal domains and between legal requirement and professional standards is an area rich in opportunities for multi-disciplinary research.

The roles of technology [50] and innovation [51], which are essential assets for the implementation of circular business models [49], also become a bottleneck for success in the circular economy. They demand investments in value proposition designs [51], lean models [44] and agile approaches [35]. In terms of theory building, as we have discussed, the field is still in early stages of agreggation of knowledge, and therefore, it is premature to attempt theory building.

Methodologically, we observe an exponential increase in literature reviews in the topic, with 33 more reviews appearing in 2020 after we completed our study. The analysis of sources revised by SLR reviews reveals a continued dominance of conceptual studies and modelling. Empirical studies remain a minority, and we strongly recommend that more stringent criteria are used to screen the contributions of such articles. A common problem are studies that draw conclsuions about CE using surveys or secondary data that mainly captures information about environmental management practices that can apply to either linear or circular economy. Issues of endogeneity and single respondent biases that would be closely scrutined in other fields tend to go unchallenged; again, this is associated with the low maturity of research in the field. The main take-away here is to bear in mind that quantity of research is not the same than maturity of research. There is need for two stage, multiple respondent surveys and longitudinal studies to capture causality, of ethnographies to understand how practices are embedded and experiments to advance knowledge when actual cases are scarce. Otherwise, there is risk of a circular economy "bubble" where conclusions and recommendations are advanced faster than conceptual clarity.

Considering the existing opportunities, this study traces some megatrends for advances in circular economy studies. Based on the limitations of the 38 previous studies analysed and the opportunities for advancing the circular economy through future studies, some avenues for future research were listed.

Areas for Future Research

Area 1: Bridging Systems Perspective and Process Perspective to Theorize Circular Economy

As noted by [21] and [39], the systems perspective underpins circular economy literature. More research at the systemic level of the company, supply chain, poles, and industrial clusters

level is needed to promote the transition to the circular economy. A process perspective, taken from innovation and entrepreneurship studies [62], emphasises that temporality is needed to understand the stages within CE. That processes involve transitions from design to adoption to implementation and diffusion. Mediators and moderators in different stages should be better conceptualized.

Area 2: Barriers to the Transition to the Circular Economy

Identifying the obstacles, barriers, bottlenecks and challenges to implementing the circular economy is a relevant aspect. Accordingly, [63] states that sustainable development problems are multi-objective problems. Therefore, they demand the confrontation of barriers of different orders, as investigated by [64] and [24]. Another barrier to be faced is the creation of public policies aimed at EC, along with legislative and economic barriers in each country [23]. Barriers and drivers are dynamic and in constant flux and what is today a barrier can be an opportunity tomorrow. While system theory and temporality can also be used as overarching leneses, the study of barriers and drivers would also benefit for more use of complexity theory and socio-technical transition theories in conjunction with insights provided by studies using traditional management theories such as institutional theory or agency theory.

Area 3: Circular Economy as a Mechanism for Implementing the UN Sustainable Development Goals

The interconnectedness of sustainable development problems [65] requires research on relevant aspects associated with the value chain, on the use of technical and biological nutrients as resources, to allow an accelerated transition to the circular economy. While there is growing interest in the relation of CE with SDG, reserachers should engage more closely with the SDG, analysing specific CE contributions for the UN SDG's 169 targets and 221 indicators. Rather than generically assuming positive impacts at the level of goals, researchers should focus on interdependencies and trade-offs between targets. This will allow CE research that is more relevant to policymakers. Collaboration theories and regime theory can provide alternative theoretical lenses.

Area 4: Service Development and Product Cycling

The infrastructure required to carry out reverse logistics, one feature of which is the management of obsolete resources at the end of their useful lives, is clearly a complex challenge. Hence, there is a substantial demand for more research to establish economically viable possibilities for the full implementation of the circular economy. Previous studies that offer contributions in this regard are [66], [67], and [68], and different measures to help entrepreneurs to implement cleaner production, minimising emissions and simultaneously increasing competitiveness [55]. Future research could benefit for the application of more practically oriented tools, for example, 6R elements (redesign, reduce, reuse, recycle, remanufacture, repair) to create a conceptual model for an CE [59].

Area 5: Consolidation of Circular Economy Business Models

In this perspective, Product Service Systems (PSS) play an important role. PSS consist of systems in which products are offered as services, that is, there is no interest in making the sale

[69]. There are systems on the market oriented towards product, use and result [21]. Product-oriented PSS consist of leasing agreements and include after-sales services. The use-oriented PSS contemplates the payment made by paying only for the use of the asset (for example, payment per page, including maintenance and toner for printers). Results-oriented PSS refer to the solution of a problem, regardless of the use of specific products (for example, pest control instead of pesticides to guarantee a certain harvest yield) [70]. The three subcategories of PSS are not equally qualified for CE. The results-oriented PSS is seen as the most promising PSS to support the circular economy [21]. Finally, the design of the PSS must explicitly support the circularity and efficiency of resources to promote the consolidation of Circular Economy Business Models (CEBM) [71]. Overall, more clarity is needed to define how and to what extent CEBM differ from Sustainable Business Models.

Area 6: More Rigorous and Boundary Spanning Methods

As mentioned before, empirical CE research is largely based on mathematical modelling, cross-sectional surveys and interview-based case studies. With exceptions, surveys and case studies are methodologically limited. Surveys tend to be cross-sectional, single-respondent, and they may lack an endogeneity test. Case studies are often prepared from a limited number of interviews that does not provide confidence in theoretical saturation. Systems of indicators are developed but there is not an empirical testing of scales. More longitudinal studies are needed both in quantitative and qualitative studies; ethnographies or at least ethnographic interviews, action research, two-wave multiple respondent surveys, and experiments would provide more rigor.

Area 7: More Cross-Disciplinary Research Integrating Multiple Management Fields

Most CE research has been confined to the OM field and more recently has reached out to strategy and innovation (business models). Integration of organizational studies and human resources will help better understanding of organizational and human agency barriers, integration of accounting and finances research will contribute to refine measurement, indicators and economic impacts, and integration of international business, political sciences and comparative law will improve understanding of the challenges of circularity in global supply chains.

Final Remarks

The main practical contribution of the study is the signaling of avenues for companies, governments and universities to chart ways to consolidate the circular economy in organizations. The theoretical contribution is to analise how robust — as a basis for theory building — is the knowledge so far accumulated in a field that has been growing at an accelerated rate. This diagnosis of what has been published in the area is essential to build new, original and innovative paths for further investigations in the field.

We outline main themes and limitations in the SLRs analysised, then we synthesize the findings of previous SLR to identify mega-trends in CE research. Finally, we propose avenues for future circular economy research. Our analysis indicates three main types of limitations of SLR in CE: The first are shortcomings in SLR methods, the second is the low maturity of CE

Table 12 shows that circular economy studies converge especially for sustainability, business models, innovation, closedloop supply chain, PSS, and measurement indicators. This allows us to reflect on the opportunities that exist to advance in the field of the circular economy. Based on this evidence, the study presents some propositions to be tested in future studies. These propositions can contribute to potential advances in the theme.

Authors	Keywords
Larsen et al. (2018)	- Closed-loop supply chain - Reverse supply chain - Reverse logistics - Circular economy - Product recovery
Homrich (2018) et al.	- Trends and gaps on the pathways - Circular economy - Ecoparks and industrial symbiosis - Business models, suply chains, material closed loops
Merli, Preziozi, and Acampora (2018)	- Circular Economy - Sustainability - Industrial Ecology - Circular Business Models
Prieto-Sandoval, Jaca, and Ormazabal (2017)	- economy - Eco-innovation - Industrial Ecology
Liu et al. (2018)	- Green supply chain management - Circular economy
Braz et al. (2018)	- Closed-loop supply chain - Reverse supply chain - Bullwhip effect - Circular economy - Sustainability - Green supply chain
Kuhl et al. (2019)	- Supply chain management - Circular economy - Servitization - Product-service system
Rosa et al. (2019)	- Circular Economy - Circular Business Models - Archetypes
Saidani et al. (2019)	- Circular economy - Circularity indicators - Taxonomy - Selection tool
Salim et al. (2019)	- Solar panel - Photovoltaic - Battery energy storage system - End-of-life management - Recycling - Circular economy
Pieroni, McAloone, and Pigosso (2019)	- Business Model Innovation - Circular Economy - Circularity
Jesus et al. (2019)	- Circular Economy - Eco-innovation - Sustainability - Transition
Sassaneli (2019) et al.	- Circular Economy - Performance Measurement
Rosa, Sassanelli, and Terzi (2019)	- Circular economy - Circular Business Model

Table 12 (continued)

Authors	Keywords
	- Circular Benefits
	- Product Service System
	- Waste electrical
De Souza Jabbour et al. (2019)	- Product design
	- Production planning
	- Sustainable Supply Chains
	- Sustainable Operations
Sehnem et al. (2019)	- Closed loop supply chains
	- Agile systems
	- Circular economy
	- Overlaps
Meherishi, Narayana, Ranjani (2019)	- Supply Chain Management
	- Packaging
	- Organizational Theories
Paes et al. (2019)	- SWOT Analysis
	- Organic Waste Management
Kravchenko, Pigosso, and McAloone (2019)	- Leading indicators
	- Sustainability screening
	- Performance indicators
	- Sustainability dimensions
	- Business process
	- Circular Economy Strategies
Bressanelli, Perona, and Saccani (2019)	- Redesigning their supply chain for the Circular Economy
	- Challenges
	- Path towards Circular Economy
Rosa, Sassanelli, and Terzi (2019)	- Circular Business Models
	- Archetypes
	- Innovative Business Models
	- Industrial Strategies
Merli et al. (2020)	- Recycled Fibers
	- Recycle waste materials
	- Concrete reinforcement
Sassanelli (2020) et al.	- Product service system
	- Lean
	- Product lifecycle management
Salvador (2019) et al.	- Circular Business Models
	- Regenerative by nature
	- Maintaining resource value
Shekarian (2020)	- Closed Loop Supply Chains
	- Game Theory
	- Cooperation
	- Competition
Lópes Ruiz, Rámon, and Gassó Domingo (2020)	- Waste minimisation
	- Reduction of environmental impacts
	- Integral circular strategies
	- Life cycle of construction and demolition activities
Centobelli (2020) et al.	- Circular economy business model design
Laan and Aurisicchio (2020)	- Circular Economy
	- Product-service system
	- Obsolescence
	- Resource flows
	- Closed Loop
	- Function analysis
Fernandes et al. (2020)	- Business model innovation
	- Value proposition design

Table 12 (continued)

Authors	Keywords
	- Circular economy
	- Product-service system
	- Circular product-service system
Kithous et al. (2020)	- Circular economy
	- Citation network
	- Co-occurrence network
	- Research trends
	- Main path
Morales e Sossa (2020)	- Circular Economy
	- Sustainablity
	- Sustainable Development
Sanchez, et al. (2020)	- Distributed recycling
	- Plastic recycling
	- Additive manufacturing
	- 3D printing
	- Circular economy
Benachio, Freitas e Tavares (2020)	- Circular economy
	- Construction industry
	- Built environmen
Gregorio, Pié e Terceño (2018)	- Bioeconomy
	- Green economy
	- Circular economy
	- Sustainability Management
Ki, Chong e Ha- Brookshire (2020)	- Circular economy
	- Engagement
	- Environmental management
	- Sustainable development
	- Stakeholder
Munaro, Tavares e Bragança (2020)	- Circular Economy
	- Waste reuse
	- Cleaner Production
	- Process efficiency
	- Sustainable buildings
Masi, Day e Godsell (2017)	- Circular economy
	- Sustainable supply chains
	- Closed-loop supply chains
	- Industrial ecology
Jia et al. (2020)	- Circular economy
	- Sustainable supply chains
	- Closed-loop supply chains

research and the third the limited dissemination of CE practices. These limitations coalesce to constrain the empirical and theoretical relevance of the SLRs. A main contribution is to identify a paucity of accumulated knowledge in critical areas needed for theory building, such as conceptual clarity, limited identification of antecedents, mediators and moderators and opaque understanding of boundary conditions. More rigorous empirical research is needed to further build theory. Seven main areas for further research are proposed, indicating potential theoretical lenses when appropriate.

The limitation of the study is the authors' choice to focus only on the Business area, Management and Accounting. Other areas can also bring relevant contributions to the field and are recommended as opportunities for future studies, especially those areas that are complementary to the business area, such as social sciences and environmental sciences. In addition, a

specific combination of keywords was used to select articles to make this study feasible (Table 12). But, the circular economy has been present in the literature for many years. Furthermore, it is a field that is fastly evolving. Further research could use our methodology to analyse the extent to which the limitations we identify have been addressed by SLRs published after our study, and the extent to which the field has matured. Other possibilities of combining words are possible and can be explored in future studies.

Declarations

Competing Interests The authors declare no competing interests.

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