Received: 10 September 2020 | Revised: 5 November 2020 | Accepted: 19 November 2020

DOI: 10.1002/bse.2699

RESEARCH ARTICLE

Business Strategy and the Environment

WILEY

Elucidating a holistic and panoptic framework for analysing circular economy

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Abstract

Circular economy (CE) has been proposed as a concept to help address sustainability issues. CE was first proposed in 1928 as a way of understanding causal relationships in the economic sphere. Recently, CE has been focused, mainly, on environmental issues main typically represented by closing material loops through recovery. Literature on CE has been increasing during this time, where a number of bibliometric analyses have been carried out with, mainly, descriptive outputs. This paper uses a nested approach, with grounded theory's constant comparative analysis as the overarching one and bibliometric analyses within it. A total of 4,045 documents from CE during the period 1999–2019 were analysed against an initial framework composed of economic issues, recovery and CE levels. The results helped to improve the economic category, to change the level category into a scope one and to add two categories (collaboration and themes). The results were then integrated to propose the holistic and panoptic framework for analysing circular economy, which can help to understand the economic, environmental and scope interlinkages of CE literature, in order to better position CE theory and practice and to detect gaps that should be addressed. For CE to achieve its potential in helping societies become more sustainable, theory and practice must take a holistic approach that integrates the economic and environmental dimensions, the scope of CE, and collaboration.

KEYWORDS

bibliometric analysis, circular economy, economic issues, grounded theory, holistic framework, recovery

1 | INTRODUCTION

Circular economy (CE) has been proposed as a concept to help address sustainability issues, particularly focusing on environmental issues (European Commission, 2018; Murray, Skene, & Haynes, 2015). CE was first proposed by Leontief (1928, 1991) in 1928 as a way of understanding causal relationships in the economic sphere through a combination of three ratios, called technical coefficients, to provide the best solution to achieve a circular flow: (1) cost coefficients, a ratio between the number of units of an input used in a given production process against the number of units of another specified input (or cost group); (2) productivity coefficients, a quantitative relation between costs and returns; and (3) distribution coefficients, the distribution of total output between the various uses in the circular flow.

Recently, CE has been focused, mainly, on environmental issues, as attested by the German Parliament law on CE passed in 1996 (Kreislaufwirtschaft) (Bilitewski, 2012) and the CE promotion in

China and other Asian countries since the end of the 1990s (Andersen, 2006; Yong, 2007). CE is typically represented by closing material loops through recovery (European Commission, 2014; Preston, 2012; Urbinati, Chiaroni, & Chiesa, 2017; Yong, 2007; Yuan, Bi, & Moriguichi, 2008), for example, through the 3Rs to 9Rs (Fernández & Kekäle, 2005; King, Burgess, Ijomah, & McMahon, 2006; van Buren, Demmers, van der Heijden, & Witlox, 2016).

Pesce et al. (2020) provided a discussion of the three main CE definitions, discussing their use in different countries and contexts. The definition used in China is based on the 3R rules "reduce, reuse, recycle" for resources in production and consumption as base for economic and social development resource recovery in productio n, circulation, and consumption (Liu, Liang, Song, & Li, 2017). According to the Ellen MacArthur Foundation (2015), "A circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. This new economic model seeks to ultimately decouple global economic development from finite resource consumption." The European Commission (2020) defined CE as "a system where the value of products and materials is maintained for as long as possible through minimising waste and resource use, and reusing products when they reach their end of life, which can bring economic benefits, and contribute to innovation, growth, and job creation." The latter one is the most complete definition, since it provides a better connection between environmental and economic issues; however, it does not provide guidance for different scopes of operationalisation.

According to Yong (2007) and Yuan et al. (2008), CE activities focus exclusively on one of three levels: the macro-level, focusing on regions, cities, municipalities or provinces; the meso-level, focusing on eco-industrial networks, where the waste (material or energy) from one company becomes the raw material of another; and the micro-level, which focuses on improving the environmental performance of an organisation. The majority of CE efforts have been at the macro- and meso-levels, with limited ones on the micro-level, mainly on companies (e.g. reducing food waste, eliminating hazardous waste and recycling critical raw materials) and with a disconnection between theory and practice (Barreiro-Gen & Lozano, 2020).

A number of bibliometric studies on CE have been carried out (see Table 1 for a summary of the key ones), including the search strategies used, the period of study, the number of results obtained, and the database used (Web of Science [WoS] and Scopus). The majority of these studies have used bibliometric indicators focusing on descriptive analyses of scientific outputs, particularly on yearly trend, keyword co-occurrence, and/or coauthorship.

In spite of CE having its origins on the economic sphere, and the EU explicitly stating its links to it, most of the CE literature are based on the principles of industrial ecology and have environmental connotations (Andersen, 2006; Preston, 2012). The aim of this paper is to provide a CE framework that comprises economic and environmental issues, as well as to consider the scope of operationalisation.

The rest of the paper is organised into the following sections: Section 2 describes the methods used; Section 3 presents the results; Section 4 integrates the results into a framework; and Section 5 provides the conclusions.

TABLE 1 Summary of the bibliometric studies and its approaches

Authors and publication year	Search strategy used	Period of study	No. results and database
Homrich, Galvão, Abadia, and Carvalho (2018)	"circular economy" (TS)	2006–2016	327 unique articles (WoS + Scopus)
Cattelan and Tavares (2017)	"circular econom*" with an additional strategy using (e.g. Circulatory Economy, Circular Ecology) (TS)	2006–2015	32,550 documents in Scopus
Geissdoerfer, Savaget, Bocken, and Hultink (2017)	"circular economy," "sustainability" and "circular economy AND sustainability" (TS)	1950–2016	295 in WoS
Türkeli, Kemp, Huang, Bleischwitz, and McDowall (2018)	"*circular* *econom*" (TS)	2006–2016	1,290 papers in Scopus
Ruiz-Real, Uribe-Toril, Valenciano, and Gázquez-Abad (2018)	"circular economy" and "environment" (N.S.)	2006–2017	743 articles in WoS
Araujo Galvão, De Nadae, Clemente, Chinen, and De Carvalho (2018)	"Circular Economy" AND "Barrie*" OR "Challeng*" AND "Opportunit*" (TS)	2005–2017	195 in WoS and Scopus
Saavedra, Iritani, Pavan, and Ometto (2018)	"Circular Economy," "Industrial Ecology," "Industrial Symbiosis," "Industrial Metabolism," "Eco-Town," "Eco-Industrial Park" and "Industrial Ecosystem" (TS)	N.S.–2016	110 in WoS
Camón Luis and Celma (2020)	"Circular economy" (N.S.)	2013–2019	3,391 in WoS, 1,901 in Scopus

Note: TS means a search in the title, abstract and keywords.
Abbreviations: N.S., "not specified"; WoS, Web of Science.

2 | METHODS

This paper uses a nested analysis approach. The overarching one was Grounded Theory's (GT) constant comparative analysis, which offers the potential to generate theory systematically (see Glaser & Strauss, 1999). Bibliometric analyses were nested in the constant comparative analysis.

Constant comparative analysis is an iterative process with four stages (Corbin & Strauss, 1990; Glaser & Strauss, 1999; Saunders, Lewis, & Thornhill, 2007; Strauss & Corbin, 1998):

1. comparing incidents applicable to each category, that is, classifying the data into meaningful categories, which may be derived from the data, theoretical framework or the researchers' readings, life experiences, research and scholarship;
2. integrating categories and their properties;
3. delimiting the theory by reorganising relationships and developing new categories; and
4. writing the theory, which could then be taken forward by developing or testing new hypotheses or theories.

The constant comparative analysis is based on continuously improving the categories being created from the data during the analysis process.

For Stage 1, the initial framework for analysis was done in the context of CE, including (1) the recovery loops; (2) the economic issues (cost, productivity, distribution, value creation and value added); and (3) the levels (micro, meso and macro).

For Stage 2, bibliometric analyses of 4,045 peer-reviewed papers were carried out based on the initial framework. The bibliometric analysis was guided by the following questions:

RQ1. How has the research on CE developed over time? This question seeks to understand when the CE concept appears on the scientific literature.

RQ2. What are the research topics addressed in the CE? This question analyses the main research topics studied in the scientific literature at the publication level.

For the bibliometric analysis, the following steps were followed in this study: (1) data collection and formulation of a search strategy to identify the CE literature; (2) development of bibliometric indicators.

The data were downloaded on 2 March 2020 from Clarivate Analytics' WoS Core Collection (SCI, SSCI, A&HCI) and Proceedings databases. The search strategy proposed by Türkeli et al. (2018), using search terms such as "*circular* *econom*" in order to include concepts such as "circular bio-economy" in the "Topic" field (abstract, title and keywords). The search strategy is broad enough to capture all the papers on this topic. All types of documents were considered, including proceeding papers (which have not been considered in previous bibliometric studies). Proceedings allow to determine previous awareness on the topic before the publication in a journal (see Ingwersen, Larsen, Garcia-Zorita, Serrano-López, & Sanz-Casado, 2014). The information on the documents on CE was exported (in *.txt format), and a relational database was formulated with MySQL, in which all the records were entered.

The following indicators were analysed for the final dataset:

1. Research patterns:

- Yearly trend in scientific output in CE overall during the period of analysis (1999–2019).
- Contribution of the scientific output of this topic to WoS database.
- Reference and keyword cocitation cluster analysis to detect research specialties with Citspace software. To detect the different specialties, the criterion used was the g-index (Egghe, 2006) used for node selection that accounts for citations of the value of the articles. A correction factor of 5 was applied to create data clusters. The different nodes are cocited papers, and the edges represent the cocitation links. The cocitation values were normalised using the cosine index and the edges were pruned from the network with the pathfinder algorithm. The labels of each cluster were determined using the log-likelihood ratio (LLR) by considering the abstracts information. The clustering quality is measured in terms of the mean silhouette value (i.e. the higher that value, the more distinctly defined is the cluster). Another metric was used to measure the combined strength of the structural and temporal properties of a node of the clusters: sigma value (see Chen, 2016). This value is calculated with the betweenness centrality and citation burst on each node.

2. Initial framework (see Figure 1):

- Definition of a theoretical framework for CE based on content analysis of the scientific papers identified. Abstract, title, and keywords from the documents were used to firstly classify into recovery, economic issues and the three levels of CE. These terms were searched on the dataset in order to analyse to what extent CE practices are linked to this perspective.

For Stage 3, during the analyses, two new categories appeared on the economic issues (which connect also to the recovery loops): supply chains and efficiency, whereas the levels were modified in an iterative process because many peer-reviewed papers belonged to two of the levels or did not fit within the levels categorisation. The iterative process helped to rename the levels category into scope to the following subcategories: assessment, review, individual, organisation, process, sector, cluster, and country/region. The process also allowed to develop a collaboration pattern category (percentage of documents in national and international and no collaboration from each of the categories previously defined in the framework; this is based in the affiliations of authors) and research specialties and to connect categories (refer to section 3.2.4).

For Stage 4, the insights from the previous stages were used to develop a CE framework, holistic and panoptic framework for analysis CE, described in Section 3.2.

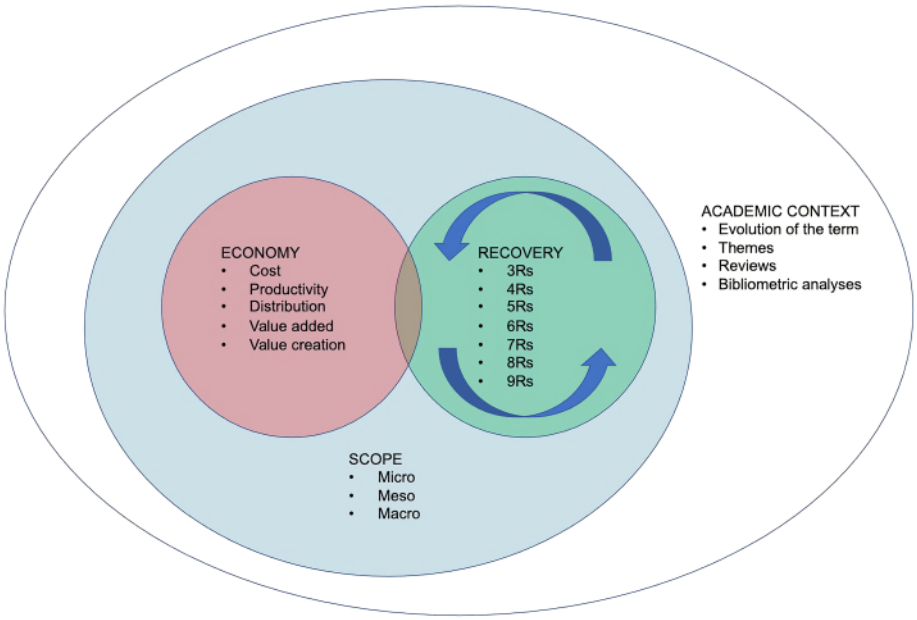


FIGURE 1 The initial circular economy (CE) framework for the grounded theory (GT) constant comparative analysis [Colour figure can be viewed at wileyonlinelibrary.com]

2.1 | Methods limitations

Some of the critiques to GT include the danger that an approach that is described as GT is simply a form of data analysis, with no real theoretical content, and the assumption that the researcher approaches the topic without any preconceived conceptual frameworks and that the framework is formed entirely by the data (Jupp, 2006); however, these critiques do not consider that the researcher's perspective shapes the inquiry by using the constant comparative analysis (Glaser, 2004; Glaser & Strauss, 1999). Data should guide theorising, but not to place limits on it (Jupp, 2006). GT is time-consuming, intensive and reflective (Saunders, et al. 2007).

Some of the limitations of the bibliometric analysis include: (1) by considering only WoS database the study may have limitations owing to the underrepresentation of other published works in other databases (e.g. Scopus or Google Scholar); however, this source has unequal coverage across scientific fields or the underrepresentation of non-English-speaking countries; (2) the keywords were chosen according to definition of the CE and previous bibliometric studies. These keywords used may not be exhaustive, and some papers that fit our inclusion and exclusion criteria could have been omitted; and (3) The source type was limited to English-language documents published in journals or conference proceedings.

3 | RESULTS

This section presents the results in three subsections: (1) against the initial framework, providing descriptive analysis and insights into the categories that were not modified; (2) for those categories that were modified (economic issues, scope, themes and collaboration); and (3) the integration of categories.

3.1 | Initial framework from the bibliometric analysis

3.1.1 | Descriptive research patterns

A total of 4,045 records (all typologies of documents considered) were retrieved during the period 2003 to 2019. The first peer-reviewed paper identified in the scientific literature is titled "Education for regional sustainable development: experiences from the education framework of HHCEPZ project" (Gao, Hou, Zhang, Zhang, & Gong, 2006).

3.1.2 | Yearly trend

Figure 2 shows the evolution of records by year of publication, where it can be seen that the output on rose from 1 publication in 2003 to 1,424 in 2019, with 67.41% of the total output appearing in the last

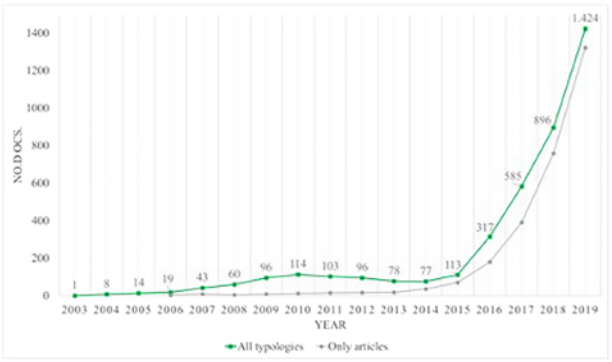


FIGURE 2 Scientific evolution of circular economy (CE) papers during the period of study (2003–2019) [Colour figure can be viewed at wileyonlinelibrary.com]

5 years of the study. The cumulative average growth rate shows an increasing tendency during the period (57.43% of all typologies from 2003 to 2019; 56.25% articles from 2006 to 2019). The growth of these publications was much greater than for the WoS database, which grew at an average of 3.71% in those same years.

3.1.3 | Identifying research specialities

Figure 3 shows the co-occurrence of references and keywords from the whole documents analysed. The cluster labels were drawn from the abstract in the citing papers using LLR; however, other labelling results are presented (see Table SA.1). According to the values identified, 4,014 references meet the *g*-index criterion ($k = 5$) with a total of 393 nodes and 608 edges. The network has high modularity (0.6874), a measure that shows the extent to which a network could be decomposed. This value indicates that the different clusters are well defined in terms of the features of the cocitation clusters. The biggest cluster (according to the co-occurrence values) is #0 "circular economy," #1 "industrial park," #2 "Developing level" and #3 "Industrial symbiosis." The #8 cluster, "collaborative circular oriented innovation," was found to be the most recent (2017), followed by #7 "circulatory gap" and #5 "ce activities" (2016). The less recent are #2 "developing level" and #3 "industrial symbiosis" from 2008 and 2009. Another interesting value is the silhouette value, which is related to the clustering configuration. In this dataset, Clusters #6 and #9 had a value closer to 1, meaning that they are more distinctly defined (Table SA.1).

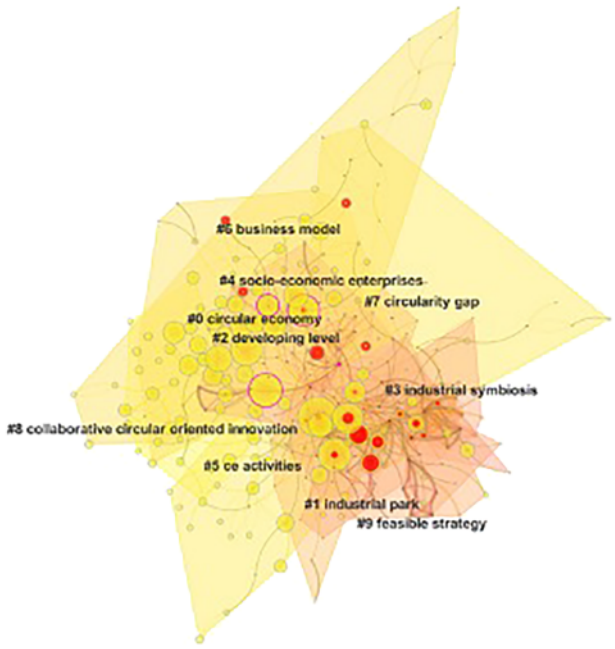


FIGURE 3 G-index generated landscape of the cocited references and keywords in circular economy (1999–2019). Colours of the cluster indicate the year (yellow, more recent; purple, older). Red labels indicate the citation bursts (the sudden increase in a keyword citation that denotes the hotness of a topic) [Colour figure can be viewed at wileyonlinelibrary.com]

Figure 4 shows a timeline of the CE specialities. The research specialities were created according to keywords and references using the LLR, and the clusters are arranged on a horizontal timeline and ranked by frequency in descending order, based on Chen (2016). The curves are citation links, and their colour is associated with the period of analysis. The references and keywords are shown as circles, and the red nodes indicate high burst values, whereas the purple colour indicates high betweenness values. Large nodes are of particular interest, because they are highly cited or have citation bursts or both. It can be observed that #3 and #1 clusters are pioneering specialities that last longer, and the rest of the clusters were formed later. Some clusters were short-lived (e.g. #5 and #7), whereas others have recently appeared (#8).

3.1.4 | Recovery perspective

Figure 5 shows the evolution of documents mentioning that the 3R is the focused most approached, with 63 papers (1.56% of the total CE output and 74.12% of the papers with this perspective). The first document mentioning this approach was in 2004. 4R was the second term more mentioned, with 10 papers. 6R was firstly mentioned in 2010 and 9R in 2018. From the dataset, 85 unique papers (2.10% of the dataset) mentioned a term related to the recovery perspective. In addition, there were three papers that mentioned different R in the same document. This shows that recovery tends to be limited to the most basic loops, whereas the more detailed ones tend to be neglected.

3.2 | Developing new CE categories

This section presents the categories that were modified in the constant comparative analysis iterative process. In this sense, the abstract, title, and keywords of 4,045 documents were checked based on an iterative process of refinement and improvement.

3.2.1 | Economic approach

The economic dimension is explicitly indicated in the term CE and highlighted in the original definition by Leontief (1928, 1991), with three key issues (cost, productivity, and distribution) and in the European Commission (2020) one, with two key issues (value added and value creation). During the iteration process, two more terms complemented the economic perspective: supply chain and efficiency. These seven keywords were searched in the documents collected through bibliometric analysis. In this regard, 1,675 papers (41.41%) that present an economic perspective were identified. The evolution shows an increase of economic issues over time and in particular during the last 5 years (Figure 6). The concept mentioned the most is efficiency (813 documents, 48.54% of the documents with economic perspective), followed by cost (594 documents, 35.46%), and then

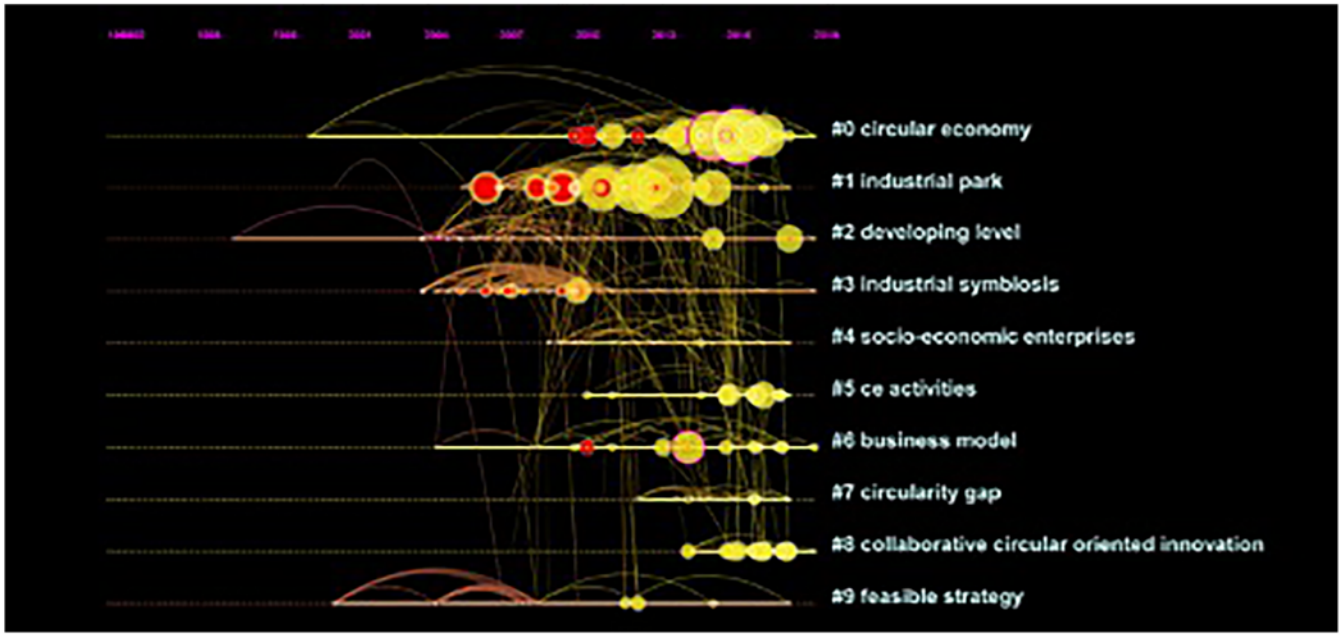


FIGURE 4 Timeline of the research specialities of circular economy (CE). Cluster labels are created based on references and keywords [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE 5 Evolution of papers mentioning recovery perspective [Colour figure can be viewed at wileyonlinelibrary.com]

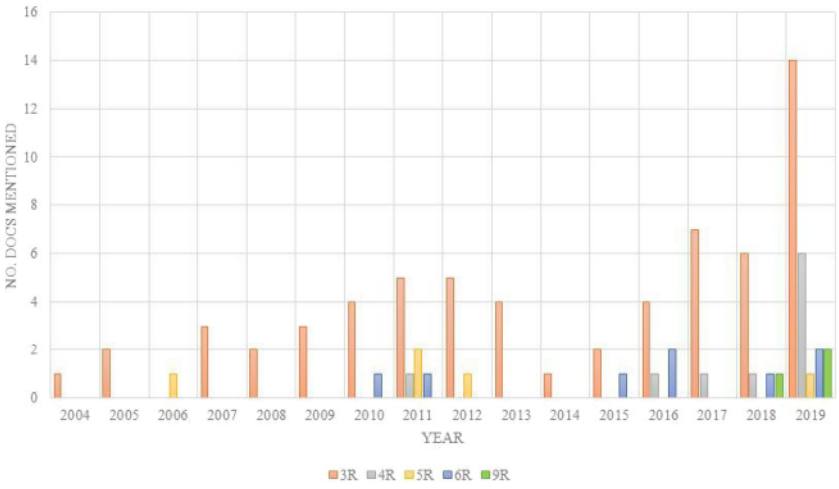
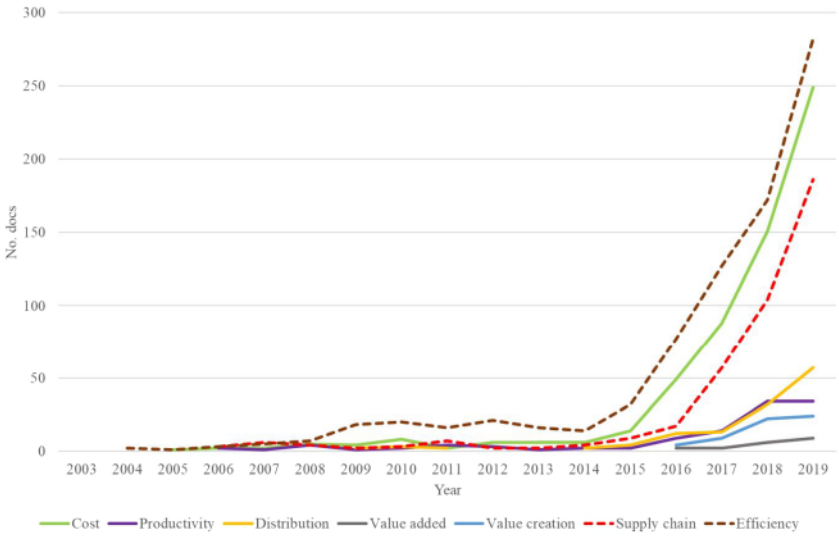


FIGURE 6 Scientific evolution of the concepts associated with the economic perspective of circular economy (CE) output [Colour figure can be viewed at wileyonlinelibrary.com]



supply chain (408 docs, 24.36%). It should be noted that in supply chain (first appearing in 1999) and efficiency (first appearing in 2004), there has been a large increase of documents mentioning efficiency and cost since 2015 (growth of 140% from cost and 250% for efficiency from 2015 to 2016) and supply chain since 2016 (growth of 235.29% from 2016 to 2017).

3.2.2 | Defining a new scope classification

The abstract, title, and keywords of 4,045 documents were checked against the CE levels and classified in a semi-automatic process according to their content. The process showed that the papers were not exclusive to a particular level (as proposed by Yong, 2007, and Yuan et al., 2008), but in many cases, the papers could be classified in two (and sometimes three) levels. The process shows that level classification was limited and did not provide a complete picture of CE; thus, a new classification based on scope (rather than level) was developed through iteration based on the papers and the CE definitions (which allows for classification in multiple categories):

- Country/national/regional: This subgroup focuses on papers on CE that presented a territorial aspect, such as CE practices in regions, cities, municipalities or provinces.
- Cluster: This refers to papers that mention a group of enterprises (e.g. steel and iron enterprises) or eco-industrial networks within CE.
- Sector: This subgroup encompasses the papers that mention a sector (e.g. building sector).
- Process: This concept is linked with papers that presented chemical or technical processes (e.g. improvement development in wastewater treatment plant).
- Organisation: This subgroup refers to a micro scale, e.g. CE practices of a particular company or other type of organisation.
- Individual: This encompasses papers that mentioned practices from individuals (e.g. citizens and group of neighbours). For instance, a neighbourhood survey to analyse waste practices is classified into this group.
- Assessment: This concept includes the papers that evaluate CE based on models or indicators, for instance, a model that evaluates the performance of eco-industrial thermal power plants. In addition, this group also includes bibliometric papers that evaluate the scientific output on the topic.
- Review: Papers on this group are more on theoretical aspects of CE.

It should be noted that assessment and review appeared to be transversal categories.

3.2.3 | Scope output by eight-level classification

It was possible to classify a paper in different categories, with four as the maximum number of categories. The final dataset includes a classification of 5,506 levels from the 4,045 documents. Review is the category with a higher number of documents (1,870 docs, 46.23% of the dataset), followed by country/national/regional with 1,448 (35.80%), cluster (558 documents, 13.79%), and assessment (494, 13.79%). The rest of the categories presented a classification lower of 10% of the papers: process (400 docs, 9.89%), sector (348, 8.60%), organisation (318, 7.86%), and individual (70, 1.73%). This indicates a higher number of documents on CE, which are referred to review and assessment papers (58.44%). Figure 7 summarises the evolution of the papers during the period by the categories established in this study. A growing tendency was observed in all categories and a considerable increase since 2015 of the country/national and regional (growth of 154.17% from 2015 to 2016) and review (growth of 235.56% from 2015 to 2016) categories (Figure 7).

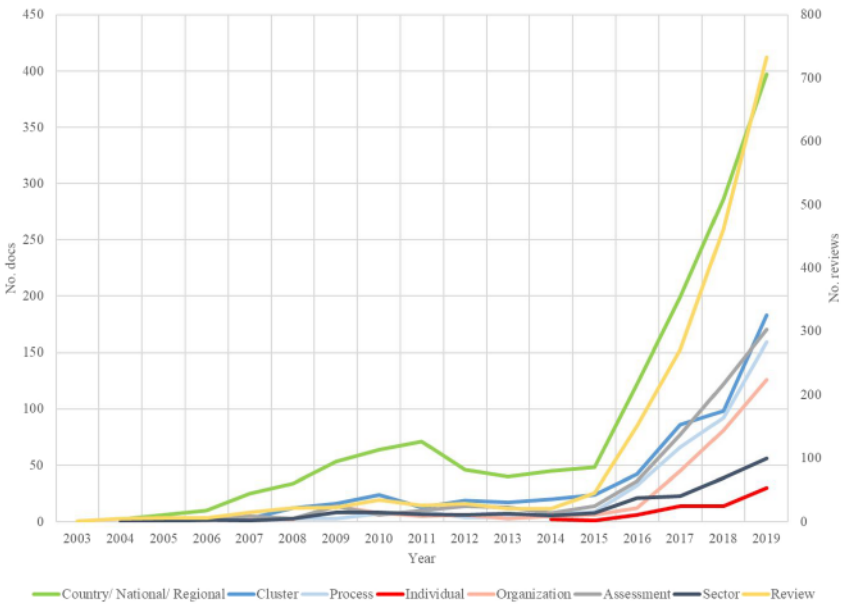


FIGURE 7 Scientific evolution of categories from circular economy (CE) papers (1999–2019) [Colour figure can be viewed at wileyonlinelibrary.com]

3.2.4 | Collaboration habits by levels

A total of 3,984 documents (98.5%) were classified according to collaboration between the peer-review papers' authors. From the dataset, 1,851 documents (45.8%) are without collaboration, 1,101 (27.2%) with international collaboration and 1,032 with national collaboration (25.5%).

Collaboration habits were checked with different sublevels proposed by the framework (Table 2). Most of the papers presented a higher number of documents without collaboration: the percentage was higher in country/national/regional (48.55%) and cluster (47.67%). The individual level was the one with the highest percentage of documents with international collaboration (37.14%). Organisation, process, and assessment had the highest percentages of national collaboration with 30.82%, 29%, and 26.92% respectively.

3.2.5 | Themes within the new CE scope

Table 3 shows the top five specialties obtained in each category. The software automatically labelled the subareas. The were some interlinkages between scope levels, for example, "industrial sector" in the country/national/regional level, and is also part of the sector level, and "Chinese manufacturer," which was classified in the process level, but it was also part of the country/national/regional level. The different topics were ranked according to co-occurrence values, from bigger (#0) to smaller (#4). Table 3 shows the different topics on each level, for example the individual level focuses on business cases and household waste. Sector papers focused more on economic gain and circular logistics development or recovering value.

4 | DISCUSSION

The results show that the CE goes beyond environmental connotations (i.e. closing loops through recovery) (see European Commission, 2014; Preston, 2012; Urbinati, et al. 2017; Yong, 2007; Yuan, et al. 2008). CE has to encompass economic issues, such as those proposed by Leontief (1928, 1991) (cost, productivity, and distribution) and adding value (see European Commission, 2020). The results link these two categories through efficiency and supply chains. The results also show that the literature on CE does not focus exclusively in one of the three levels (micro, meso, or macro) proposed by Yong (2007) and Yuan et al. (2008) but on multiple levels and in some ocassions in more than one level. Thus, the levels category was changed to a scope category (with eight subcategories) following the iterative process of GT's constant comparative analysis. Two academic categories were added from the bibliometric analyses: themes and collaboration.

The results from the constant comparative analysis (Stage 4) were integrated to develop the holistic and panoptic framework for analysing circular economy (see Figure 8), which consists of the integration of three components: (1) economy (nested red circles), with cost, productivity, distribution, value creation, and value added; (2) recovery loops (nested green circles) from the 3Rs to the 9Rs; and (3) the scope of CE activities (nested blue circles), including assessment, review, individual, organisation, process, sector, cluster, and country/region. Assessment and review are transversal categories within scope. It should be noted that the economy and recovery dimensions are linked through efficiency and supply chains. The three components are interconnected (through the blue arrows). The external circle shows the extent of academic work on CE, highlighting the themes and collaboration patterns.

The holistic and panoptic framework for analysing circular economy can help to understand the economic, environmental, and scope interlinkages of CE literature, in order better position CE theory and practice (see Barreiro-Gen & Lozano, 2020) and detect gaps that should be addressed. This framework could help organisations (e.g. companies, civil society and public sector ones) to close recovery loops and add value to them, as well as to link them to the other scope levels (i.e. individual, process, sector, cluster, country/region, assessment, and review). This is also applicable to all the scope levels, such as country/region, which is composed of the other levels, or the individual that is an integral part of all the levels.

TABLE 2 Patterns of collaboration by levels (% in brackets)

	International collaboration	National collaboration	No collaboration	Number of documents
Assessment	131 (26.52%)	133 (26.92%)	230 (46.56%)	494
Cluster	142 (25.45%)	140 (25.09%)	266 (47.67%)	558
Country/national/regional	354 (24.45%)	368 (25.41%)	703 (48.55%)	1,448
Individual	26 (37.14%)	17 (24.29%)	26 (37.14%)	70
Organisation	80 (25.16%)	98 (30.82%)	137 (43.08%)	318
Process	134 (33.50%)	116 (29.00%)	147 (36.75%)	400
Review	555 (29.68%)	462 (24.71%)	826 (44.17%)	1,870
Sector	79 (22.70%)	94 (27.01%)	170 (48.85%)	348
Total	1,101	1,032	1,851	

TABLE 3 Top five specialities by subarea (from titles, keywords, and abstracts)

	Country/ national/ regional	Sector	Cluster	Process	Organisation	Individual	Review	Assessment
#0	Energy analysis	Economic gain	Historical course	Organic waste	2—a case study	Business case	Additive manufacturing	Economic assessment
#1	Spanish SME	Circular logistics development	Circular economy	Circular economy value	Circular economy paradigm shift	Household waste	Circular economy	Circular economy
#2	Australian automotive recycling industry	Recovering value	Organising self-organising system	manufacturer	Circular economy model	Consumer perception	Collaborative development	Critical review
#3	District heating	Sustainable waste management	Industrial symbiosis	Waste production	Medium-sized enterprises	Electronic equipment	Product service	Circular business model
#4	Industrial sector	Ecological utilisation	Eco-industrial park	Environmental value proposition	Environmental value	Influencer postconsumer gypsum recycling	Struvite precipitation	Eco-industrial park

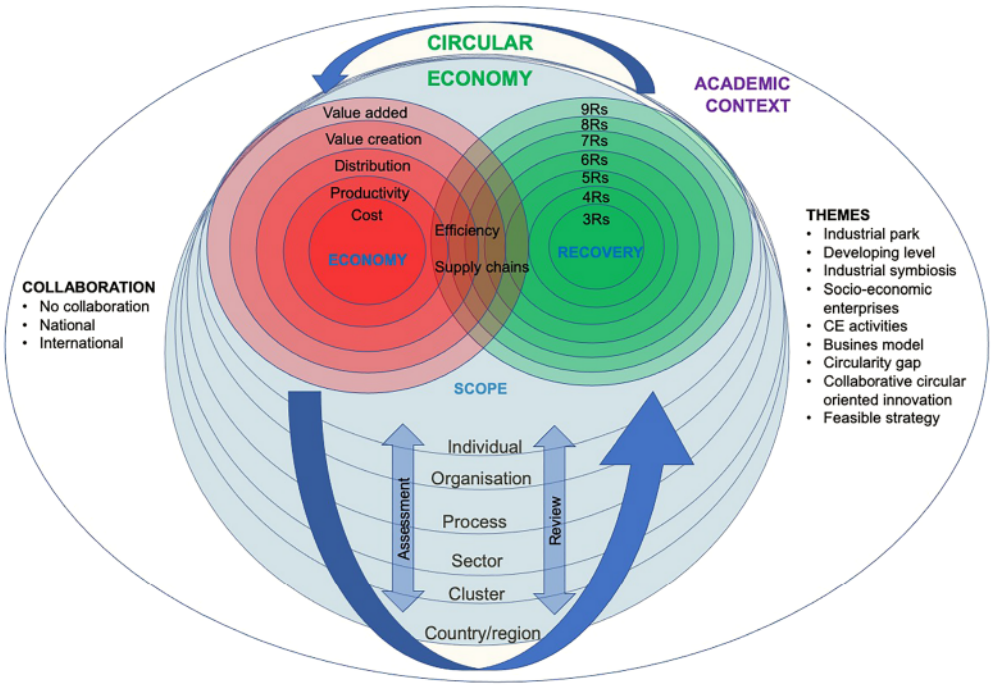


FIGURE 8 The holistic and panoptic framework for analysing circular economy [Colour figure can be viewed at wileyonlinelibrary.com]

5 | CONCLUSIONS

CE was first proposed in 1928 as a way of understanding causal relationships in the economic sphere; however, CE implementation has, in the last two decades, focused more on environmental issues, mainly by closing loops through recovery. The literature on CE has been increasing during this time, where a number of bibliometric analyses have been carried out with, mainly, descriptive outputs.

This paper uses a nested approach, with GT's constant comparative analysis as the overarching one and bibliometric analyses within it. A total of 4,045 documents from CE during the period 1999–2019 were analysed against an initial framework composed of economic issues, recovery and CE levels. The results helped to improve the economic category, change the level category into a scope one, and add two categories (collaboration and themes). The results were then integrated to propose the holistic and panoptic framework for analysing circular economy, which is aimed at helping to understand the economic, environmental, and scope interlinkages of CE literature, so that CE is better positioned in theory and practice and gaps can be detected and addressed to better implement CE. This paper demonstrates that bibliometric analysis can go beyond descriptive outputs and serve to develop theoretical frameworks.

For CE to achieve its potential in helping societies become more sustainable, theory and practice must take a holistic approach that integrates the economic and environmental dimensions, the scope of CE, and collaboration.

Future research should be carried out to test the framework in nonacademic environments (e.g. on grant applications), on the implementation of CE activities, and to uncover the drivers for and barriers to CE research.

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How to cite this article: Lozano R, Bautista-Puig N, Barreiro-Gen M. Elucidating a holistic and panoptic framework for analysing circular economy. *Bus Strat Env.* 2021;30: 1644–1654. https://doi.org/10.1002/bse.2699