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# A Systematic Literature Network Analysis of Existing Themes and Emerging Research Trends in Circular Economy

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**Abstract:** The debate about Circular Economy (CE) has been increasingly enriched by academics through a vast array of contributions, based on several theoretical perspectives and emanating from several research domains. However, current research still falls short of providing a holistic and broader view of CE, one that combines existing themes and emerging research trends. Accordingly, based on a Systematic Literature Network Analysis, this paper tackles this gap. First, a Citation Network Analysis is used to unearth the development of the CE literature based on papers' references, whilst the Main Path is traced to detect the seminal papers in the field through time. Second, to consider the literature in its broader extent, a Keywords Co-Occurrence Network Analysis is conducted based on papers' keywords, whereby all papers in the dataset, including the non-cited papers, are assessed. Additionally, a Global Citation Score analysis is conducted to uncover the recent breakthrough research, in addition to the Burst Analysis used to detect the dynamic development of CE literature over time. By doing so, the paper explores the development of the CE body of knowledge, reveals its dynamic evolution over time, detects its main theoretical perspectives and research domains, and highlights its emerging topics. Our findings unfold the evidence of eight main trends of research about CE, unearth the path through which the CE concept emerged and has been growing, and concludes with promising avenues for future research.

**Keywords:** circular economy; bibliometric analysis; citation network; co-occurrence network; research trends; main path

## 1. Introduction

The term "Circular Economy (CE)" was introduced by scholars [1] attempting to model a closed loop economy applying a materials balance model. Since then, the lively interest of the scientific community in CE has flourished, with literature produced discussing its conceptualization, principles, strategies, models, and tools. However, the CE literature is still fragmented [2], lacks consensus [3], and remains largely unexplored [4].

Several scholarly contributions (e.g., [5–7]) assessed the CE concept and its potential for sustainability, mainly based on systematic literature reviews of the concept. Nonetheless, as far as we are aware, there is no academic work that explores CE literature in its extended format, highlighting its diverse research trajectories and its forecasted development. In other words, current research still falls short of providing a holistic and broader view of CE that combines existing themes, including the main path of the development of CE knowledge, and emerging research trends. Thus, this paper intends to fill this gap by exploring the overall pool of the CE scientific work. With this purpose, instead of giving a static portrayal of CE, we explore the process of knowledge conception, dissemination and progress through a dynamic lens, with the aim to unearth its ongoing evolution. Accordingly, our main research question is: What are the existing themes and emerging research trends in Circular Economy?

With this aim, we conduct a Systematic Literature Network Analysis (SLNA), which consists of a novel literature review method based on a dynamic approach that allows for uncovering how academics have addressed a specific topic over time since its early appearance. In other words, the SLNA results would complement the already existing systematic literature reviews about CE, in the sense that they supplement the reader with a synthesis of the dynamic development of the field, and a set of CE research development themes based on objective measurements.

Scholars designed the SLNA as a quantitative-based method that builds on both systematic literature review and bibliographic network analysis [8]. The SLNA allows for embracing the knowledge of a field in its broader view and inherent value by identifying the main paths and key issues shaping its growth in a more rigorous way compared to conventional literature reviews [9]. Indeed, a conventional literature review usually relies on content analyses, which omit the dynamic evolution of the research. Moreover, the selection and categorization of literature relies on subjective, rather than objective tools. On the contrary, the SLNA relies on objective tools and algorithms (e.g., Citation Network, Keywords' Network) in assessing the bibliometric networks of data generated from databases (e.g., Scopus). To conduct the SNLA, the Citation Network Analysis (CNA) is used, for it is a method that uncovers the influence of prior research on subsequent research based on the references list of the selected body of literature. In this case, a given citation is supposed to mirror the impact of the cited paper on the citing one [10]. However, papers could be cited for subjective motives (e.g., Mathew effect) or overlooked because of their limited number of citations or recent appearances. Therefore, the CNA outcomes should be enhanced through other tools, such as the Keywords Co-occurrence Network Analysis and the Global Citation Score analysis (GCS). Examples of leveraging the SLNA include [11] exploring trends of project management, and [9] reviewing the literature of the "Smart Factory".

The applied Systematic Literature Network Analysis (SLNA) relies on various quantitative bibliometric tools, algorithms and software. It results in a dynamic depiction of the progress of CE research over time. Thereby, eight major research trends are depicted: assessing the conceptualization of CE and its relationship to sustainability and limitations (RT 1); CE as sustainable development paradigm and its implementation (RT 2); the transition to CE at the Macro and the Meso levels (RT 3); the implementation of CE at the micro level (RT 4); resources and materials efficiency underpinned by CE principles (RT 5); the shift from waste management to resource management, based on existing and new technologies (RT 6); CE measurements and indexes (RT 7); the role of digital technologies for enabling CE transition (RT 8).

The paper adopts the following structure: Section 2 delineates the rationale of the methodology, intended as the process of papers selection and data assessment; Section 3 highlights the outcome of the analyses; Section 4 provides a discussion of the results and a promising research agenda; and Section 5 concludes with the main research takeaways.

## 2. Material and Methods

The paper assesses the academic publications about Circular Economy (CE) that are available on Scopus bibliographic database, selected for its size and variety of publications. Indeed, Scopus is estimated to be both 60% larger than Web of Science (WoS) and the largest database in academia [10]. Moreover, when compared to its peers, Scopus encompasses a wider range of journals and offers the possibility for citation analysis especially for papers published after 1995 [12]. Lastly, Scopus displays 19% more materials related to the CE compared to WoS (i.e., we searched for the keyword "Circular Economy" in both Scopus and WoS databases and estimated the ratio on the basis of the research results in each of them).

The selection and analysis of papers is based on the Systematic Literature Network Analysis (SLNA) methodology (Figure 1), which builds on the two following steps:

- Systematic Literature Review, which allows for delineating the research scope and generating the papers to be used as inputs for the subsequent step.
- Bibliographic Analysis and Visualization, which aims to outline the evolution of the main existing themes and emerging research trends using Citation Network Analysis, Global Citations Score, Keywords Co-Occurrence Network and Burst Detection of Keywords.

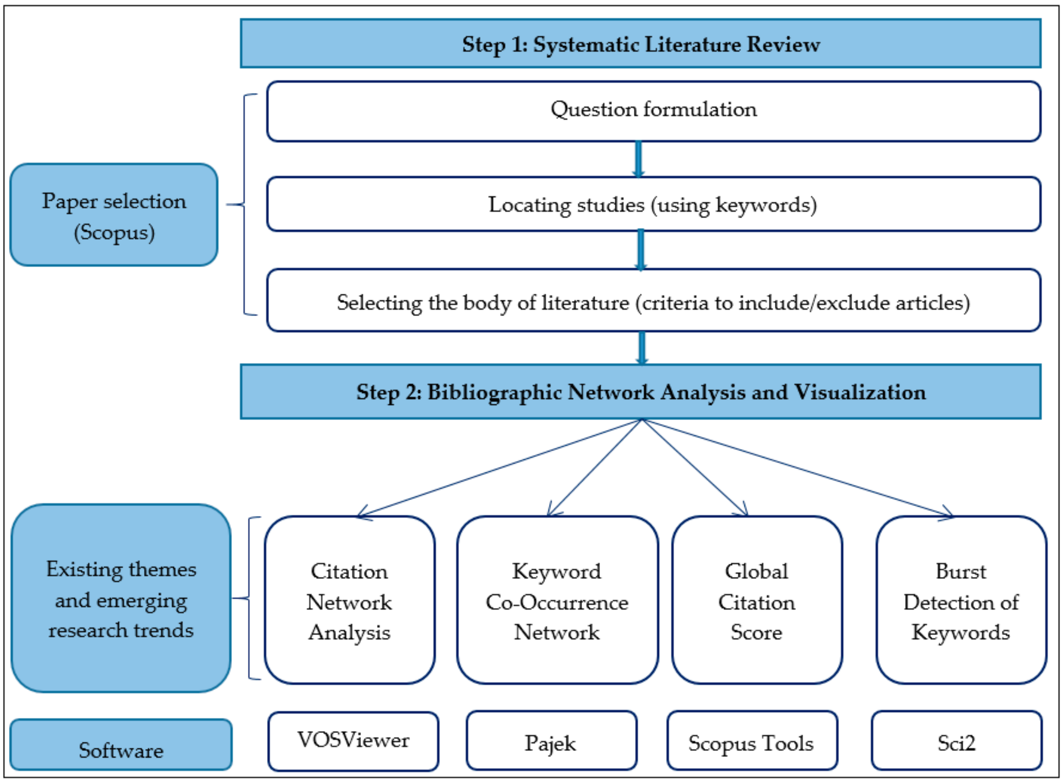


**Figure 1.** Steps and software used for the SLNA.

### *2.1. Systematic Literature Review*

Exploring the existing Circular Economy (CE) literature with the above-stated research question in mind requires tracing the research on the basis of the keyword "Circular Economy", and looking for its synonyms to be used to select the relevant papers for the bibliographical research (Figure 1).

First, to define an effective set of synonyms for "Circular Economy", we studied the highest ranked literature reviews on Scopus addressing CE, namely the reviews by [2,3,5,6,13,14]. Nonetheless, our investigation did not yield any additional synonyms of CE. Indeed, the concepts usually related to CE are: (i) new instruments for CE implementation, i.e., *Product-Service Systems (PSSs)* [13], (ii) principles of CE, i.e., *Reduction, Reuse and Recycling (3R)* [2], (iii) characteristics of value or supply chains, i.e., *closed loops* [2,14]. Other concepts either refer to an economy featuring some aspects of CE, i.e., *loop economy* [5], or to theories for CE development, i.e., *regenerative design, performance economy, cradle-to-cradle, biomimicry* and *blue economy* [14]. Accordingly, we conclude that the concept of "Circular Economy" is unique, that is, it has no clear synonyms, although it is analyzed through numerous theoretical perspectives and in several research domains.

Second, we use the keyword "Circular Economy" to conduct research on Scopus (Figure 2), limited to "Title" or "Keywords" in order to identify papers dealing with CE as a central topic. We restricted the document type to "articles", "conference papers", and "reviews" published in English, while considering all subject areas related to environment, engineering and business, since CE is embedded both in the fields of ecological economics, environmental economics, and industrial ecology [14] . On the other hand, we excluded other fields, such as earth and planetary sciences and physics and astronomy, which might create noise in the data analysis (i.e., the ratio of the excluded literature to the literature without restriction on subject areas represents only 3% of the whole Scopus CE database). Other fields were left without any restrictions. By the end of year 2018, our Scopus research resulted in 1558 papers (Figure 2).

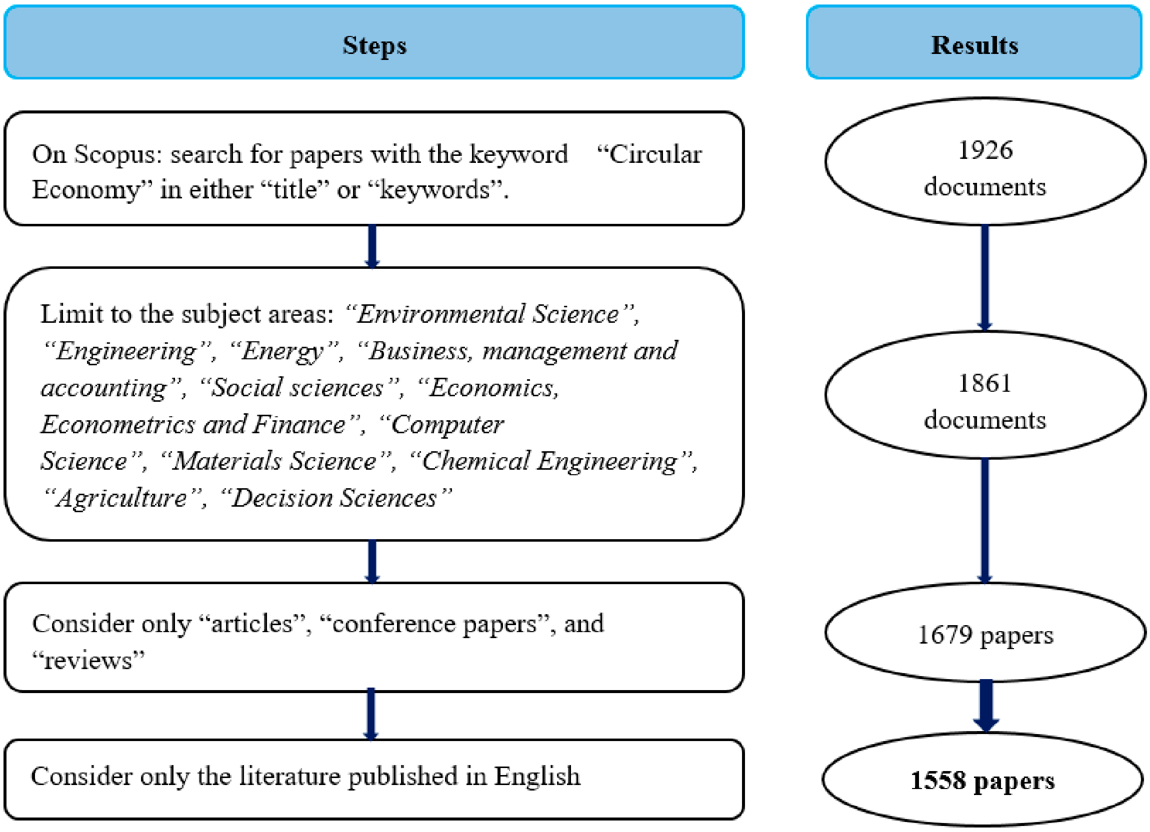


**Figure 2.** Papers selection procedure and results.

*2.2. The Bibliographic Network Analysis and Visualization*

The 1558 papers retrieved from Scopus constitute the input of the subsequent bibliographic analysis, based on *Citation Network Analysis*, *Global Citation Score*, *Keywords Co-Occurrence Networks, and Burst Detection of Keywords*.

2.2.1. Citation Network Analysis (CNA)

CNA is a network analysis approach that allows papers to appear as nodes, while citations are depicted as linking arrows. In the network, an arrow extends from the cited paper (i.e., the source) to the citing paper (i.e., the sink), which allows for the chronological tracking of citation networks, yielding a clearer understanding of the influence of past research on subsequent studies. Under this approach, the non-connected nodes correspond to non-cited and non-citing papers; thus, they are excluded from the analysis, since the CNA builds on citations.

In this paper, the CNA analysis is implemented using the software Pajek, based on three main techniques, namely: (i) "Community Analysis", used to process big communities of connected nodes; (ii) "Vector Analysis", used to consider specific properties of clusters; and (iii) "Main Path", used to uncover the papers that represent pivots of knowledge in the field.

The Community Analysis of a network allows for clustering papers based on how they are linked by citations, with the aim to detect sub-areas of research or specialty. The Vectors Analysis allows for selecting the most cited papers inside each cluster. Finally, the Main Path is generated using the Key Route technique [15], which reflects the incremental development of knowledge over time, by identifying papers published at different times that were vital to knowledge progress [16].

The choice of the Pajek software to perform network analysis is motivated by its characteristics, mainly its ability to handle very large networks, its ability to handle multi-level algorithm based on network modularity optimization, and its powerful visualization tools. Moreover, compared to other software, Pajek is the only one that allows for generating the Main Path of a given research field (Section 3.2).

#### 2.2.2. Global Citation Score (GCS), Keywords Co-Occurrence Networks, Burst Detection of Keywords

These tools allow for considering all the papers in the dataset, including the isolated nodes (i.e. papers with no-citations).

- *Global Citation Score (GCS)*: indicates the cumulated citations a paper received in the whole database (e.g., Scopus), whether it is part of a set of connected nodes in a citation network or of the Main Path. Thereby, seminal papers in a given field would display a high GCS [17]. Furthermore, promising new papers in that field are spotted based on the normalized GCS, i.e., the ratio of the most recent GCS (i.e., year 2018) to the total yearly period since its first appearance [9].
- *Keywords Co-Occurrence Networks*: rely on a combined methodology of clustering and network mapping developed by [18] and is realized based on VOS clustering (Visualization of Similarities), using the software VOSviewer for dataset mining and keyword selection. VOSviewer is selected for its capacity to analyze bibliometric networks. It allows for creating maps based on network data and for visualizing and exploring these maps, whereby a map could be created either based on an existing network, or a network constructed using the software itself, based on the data input [18]. In this paper, the data selected from Scopus (i.e., 1558 papers) are used to construct networks of scientific publications based on the co-occurrence of keywords in the papers. In other words, VOSviewer is used to cluster publications, based on their keywords co-occurrence, and to analyze the resulting clustering solution. In doing so, the use of VOSviewer will allow for complementing the results obtained from the CNA analysis conducted using the Pajek software. The analysis conducted using Pajek is of ultimate importance, as it allows for identifying the network of papers and clustering them based on the papers' citations. It also allows for constructing the Main Path, whereby seminal publications are identified. Yet, the CNA may fail to consider an important body of the literature that is not connected by any citation, hence the need to support the CNA analysis using the Keywords Co-Occurrence Networks analysis based on the software VOSviewer. Based on the data inputs (i.e., 1558 papers), the VOSviewer visualization generates a Network of Keyword Co-Occurrence, whereby the most important keywords co-occurring in the publications are assigned to various clusters. The VOS analysis is conducted based on three steps. First, a thesaurus file is used to perform data cleaning (i.e., merge synonyms, merge abbreviated terms with full terms, and correct spelling differences). Second, these data inputs are used by VOSviewer to generate maps containing one type of item (i.e., keywords). Any pair of items could be connected with a link, which has a strength mirrored via a positive value representing the number of papers where keywords appear together. Items may be grouped into clusters, which are non-overlapping (i.e., an item may belong to only one cluster). The weight of an item reflects its importance (i.e., the frequency of a keyword occurrence), which also appears in the network visualization throughout the size of its label and circle. Finally, a set of items and their links constitute a network.
- *Burst Detection of Keywords*: relies on Kleinberg's Burst detection algorithm [19], and allows for detecting the evolution of the literature of a given field, which can be perceived as a sequence of topics that emerge at a time, evolve for a certain period, and then fade away [19]. In particular, Kleinberg's Burst Detection approach relies on modelling the stream of keywords that generates bursts characterized by their transitional state, where a burst would fade away when it becomes common [11]. Burst Detection is implemented to normalized keywords (i.e., all words in lower case, stop words not considered, the plural "s" of words

and periods from acronyms/initialisms are deleted) using the software Sci2 [20]. The software's algorithm generates a list of bursts for themes, where the weight of a given burst reflects the extent of variation in its frequency.

## 3. Results

### 3.1. Citation Network Analysis (CNA)

The first analysis (Table 1) results in five groups: the first group comprises 845 non-connected (i.e., isolated) nodes; the second group represents the biggest connected component, as it includes 704 nodes connected by links (i.e., citations); and three other groups, each including 3 nodes.

Therefore, CNA tools are crucial to explore the biggest connected component in order to uncover the patterns of development of Circular Economy (CE); while group 1 (i.e., isolated nodes) and groups 3, 4, and 5 (i.e., small connected communities) will be considered in Sections 3.3, 3.4 and 3.5.

**Table 1.** Citation network of the 1558 papers.

| Communities | Frequency |
|---|---|
| 1 | 845 |
| 2 | 704 |
| 3 | 3 |
| 4 | 3 |
| 5 | 3 |
| **Total** | **1558** |

Based on the obtained results, it is hard to depict any patterns in the biggest connected component of the 704 nodes due to its large density. Thus, it is necessary to further analyze it using Pajek software tools in order to: first, detect the existence of clusters, meaning cohesive sub-groups, based on the "Louvain" method; second, detect the most cited papers within each cluster, based on the "Create Vector" method. Finally, to further detect the main trends in the evolution of the papers' content, we extract the "Main Path".

The "Community Analysis" and "Vector Analysis" processes result in identifying 11 clusters of different sizes, including papers published between 2004 and 2018. These 11 clusters represent 11 different topics of research, as illustrated in Table 2.

In order to identify the research topics of the clusters, we analyzed the main references (i.e., papers with the highest number of citations) and summarized the results in Table 2.

**Table 2.** Research topics based on clusters in the biggest connected component.

| Research Topic | Main Subjects | Examples of Most Cited Papers | Publication Dates | Size in the Biggest Connected Component (i.e., 704 Connected Nodes) (100%) |
|---|---|---|---|---|
| Topic 1 | Implementation of CE, with a focus on China's case | [21–24] | 2007 to 2018 | 19% |
| Topic 2 | Circular product design and Circular Business Models | [13,25–27] | 2008 to 2018 | 16% |
| Topic 3 | Resource efficiency, design and process engineering underpinned by CE | [28–30] | 2008 to 2018 | 14% |
| Topic 4 | Development of Industrial symbiosis and eco-industrial parks | [31–33] | 2006 to 2018 | 11% |

| | | | | |
|---|---|---|---|---|
| Topic 5 | Implementation of CE, performance indicators, enablers and barriers | [6,34,35] | 2006 to 2018 | 9% |
| Topic 6 | CE indexes and measurements | [36–38] | 2007 to 2018 | 9% |
| Topic 7 | Conceptualization of CE, its relationship to sustainability and limitations | [3,39,40] | 2011 to 2018 | 9% |
| Topic 8 | Transforming wastes into valuable resources, technologies and barriers | [41–43] | 2007 to 2018 | 6% |
| Topic 9 | How sustainable are current CE strategies, measurements and alternatives | [44,45] | 2013 to 2018 | 4% |
| Topic 10 | Transition from linear economy to CE and its benefits for the environment | [46,47] | 2004 to 2018 | 2% |
| Topic 11 | Enabling CE through new technologies | [48,49] | 2016 to 2018 | 1% |

The CNA shows that research about CE is fragmented and multidisciplinary. Interestingly, most of the identified research topics were initiated by Chinese scholars, highlighting their leading role in setting the foundation of CE research. However, some research trajectories have been consolidated over time, with others emerging and growing, and still others fading away.

- *Topic 1, Topic 2, Topic 3 and Topic 4* appeared around 2006 and 2008 and are the largest in the biggest connected component with 60% of its overall size. These topics are characterized by a growing number of publications, which may reflect the increase and consolidation of research trajectories focused on implementing CE; circular product design and circular business models; resource efficiency, design and process engineering underpinned by CE; and Industrial Symbiosis and Eco-Industrial Parks.
- *Topic 5, Topic 6, and Topic 8* emerged around 2006 and 2007, yet, it was in the years 2015 and 2016 that they gained scholars' high interests. They represent 9%, 9%, and 6% respectively of the biggest connected component, which may point to growing research trajectories focused on *CE* implementation, indicators, enablers and barriers; CE indexes and measurements; and transforming wastes into valuable resources.
- *Topic 7, Topic 9 and Topic 11* are new and might represent emerging research trajectories. *Topic 7* focuses on conceptualization of CE, its relationship to sustainability and limitations and represents 9% of the biggest connected component, yet, it emerged only in 2011, and gained scholars' high interest starting from 2016. *Topic 9* focuses on how sustainable current CE strategies, measurements and alternatives are (e.g., Life Cycle Assessment (LCA), and paradigms based on internet technologies.), and makes up only 4% of the biggest connected component. Yet, it only emerged in 2013 and is increasingly growing. *Topic 11* focuses on enabling CE through new technologies (e.g., zinc recovery from waste streams, and bio-refinery systems for deriving value from organics) and represents only 1% of the biggest connected component. However, it is by far the newest research topic, since its first publications appeared only as recently as 2016. In any case, considering its size, it is difficult to forecast its development or decline.
- *Topic 10* focuses on the transition to CE and its benefits for the environment and represents the oldest research trajectory in the biggest connected component (i.e., first paper in 2004). Nevertheless, its tiny size (i.e., 2%) could reflect scholars shying away from its focus.

### 3.2. Main Path Analysis

To uncover seminal papers, meaning those constituting the backbone of CE knowledge, we first extracted the Main Path using the Pajek software, which resulted in 36 nodes (Figure 3). Second, we went through the papers, defined their topics, publisher and publication year, authors' country and affiliations, methodologies, and funding bodies.

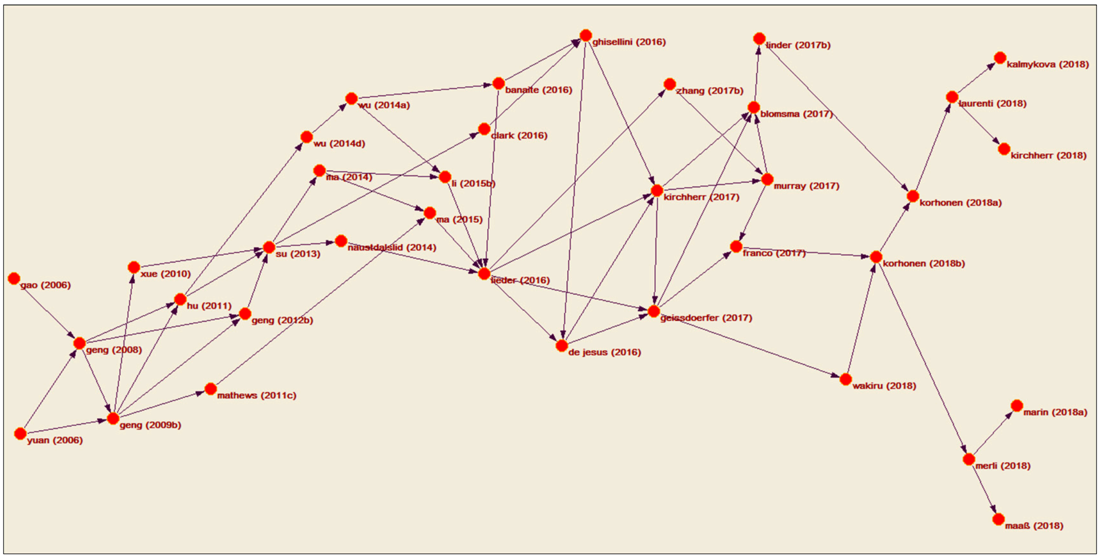


**Figure 3.** The Main Path of CE literature.

The Main Path track shows that research about CE began by addressing the topic of applying CE as a new development strategy at the national and regional levels in China (macro level), led mainly by [21,22,34,50,51]. These Chinese scholars are principally from the fields of Environment, Engineering, Ecology and Geography. By 2011, research about CE implementation developed further, addressing CE implementation at the micro and meso levels, appearing in the works of [52] and [53] from Management and Economics. In parallel, [54] from Environment and Management and [23] from Ecology mark the start of academic interest in measuring CE, and implementing CE at city level, respectively.

The year 2014 is marked by scholars' emerging interest in the role of policy in CE development through the works of [55] and [56], from Economics and Industrial Information, and Urban and Regional Research, respectively. These papers build on former papers from the disciplines of Science and Technology, Management and Economics, and were cited by scholars from Engineering. Moreover, the evolving interest in implementing CE at the meso level and measuring CE appears throughout the works of [57] from Engineering and Environment and [58] from Management and Economics. These scholars focus respectively on CE implementation in iron and steel industry and on measuring efficiency of recycling systems. In addition, these papers build on former papers from the fields of Ecology and Chemistry and were cited by scholars from Economics and Industrial Information, Industrial Ecology, and Engineering.

By 2015, the topics of cleaner production, resource efficiency and eco-efficiency in industrial metabolisms underpinned by CE appear through the works of [24] from Engineering and [59] from Industrial Ecology, respectively. These papers are sinks to former nodes from Engineering and Economics, and sources to the literature review of [2].

The year 2016 marks the emergence of CE research focused on the European context. In particular, [60] focus on CE indicators system in the European context, which highlights the dramatic shift of a research trajectory focused mainly on China. This paper is a source to the literature reviews by [14] and [2], and a sink to [55] from Economics. Moreover, [61] from Green Chemistry address the impact of chemists in the progress of CE and mark the advent of scholars' interest in design underpinned by CE principles. This work builds on the paper of [23] and is a source to [14].

Interestingly, three literature reviews appear on the Main Path in 2016, namely [2] from Production Engineering, [14] from Agri-Food Science, Economics, and Environment, and [62] from Environment, Business and Economics, which may point to the effort of scholars to consolidate CE knowledge.

By 2017, scholars' interest in conceptualizing and reviewing CE literature increased further. [3] From Innovation and Sustainability, [63] from Business and Biosphere, [5] from Manufacturing and Industrial Design, investigate the definition, concept, and origins of CE and its relationship to sustainability, respectively. These conceptual papers are both sinks and sources to various nodes, from diverse fields. Further interest in resource productivity appears in the literature review of [64] from Environmental Policy and Economics, which is a sink to literature reviews published in 2017 and a source to [65]. The latter is the first study in the Main Path to focus on metrics measuring products' circularity and is a source to the [4,66] from Business and Economics focuses on supply chain in a CE context and is a sink and a source to three conceptual papers. [67] addresses building theoretical foundation for circular chemical industry in China and is a sink to [2] and a source to [63].

By 2018, publications addressing conceptualization and measurement of CE become the heart of CE research, in addition to some new topics. [4,40,68–70] from diverse disciplines, focus on conceptualizing and reviewing the CE literature. [71] from Environment and Engineering address the socio-economic embeddedness of CE. [72] from Industrial Management address optimization through CE, which further consolidates former researchers' efforts investigating resource efficiency. Moreover, as in previous years, scholars from diverse disciplines build on each other's knowledge. Interestingly the Main Path concludes by ramifying into two distinguished directions (Figure 3). Indeed, the latest emerging topics address CE in cities by [73] from Architecture, and the institutions and governance structures role in linked value chains by [74] from Agricultural Engineering. In parallel, the tendency of scholars to review and conceptualize CE still holds through [70] from Sustainability, addressing the inhibitors of CE development in Europe, and [69] from Architecture, Civil Engineering, and Resource Recovery, who explore tools for CE implementation.

All in all, the resulting Main Path highlights the incremental development of CE knowledge over time, by designating the papers that were vital to its progress and which continue to be pivotal to subsequent research. The results also reveal the following aspects:

- Early research (i.e., from 2004 to 2015) is mainly dominated by Chinese scholars from Environment and Engineering, who wrote or contributed to writing 80% of the publications of that period. Yet, starting from 2016, they lost their position to European researchers. Moreover, the dominance of scholars from Environment and Engineering is still strong. Interestingly, scholars from Business and Economics first appeared on the Main Path in 2011 with the paper of [53], yet their contribution is still humble.
- CE research is characterized by interdisciplinary and international collaboration between scholars, which may create opportunities for cross-fertilization. Further, some authors were/are more active than others (i.e., [3,55,58,70], and [4,40]) as they appear twice on the Main Path.
- The level of analysis varies; until 2014, publications were focused on the meso and macro levels in China, while recent research explores micro and macro levels, with a tendency to investigate some specific industries (i.e., chemical, manufacturing).
- The research methodology was mainly empirical until year 2014. Indeed, 62% of the Main Path papers appearing during that period are either based on surveys or case studies. However, more recently, there has been an increasing tendency for conceptual and review papers, since around 70% of the Main Path papers published between 2017 and 2018 are either conceptual or literature reviews.
- The topics of CE research span into different areas. Yet, measuring CE has been among the most important subjects since early publications (i.e., [54,65]). However, other new research trajectories emerge on the Main Path, such as: socio-economic embeddedness of CE, circular cities, and value chain underpinned by CE.
- CE is a pervasive concept that evolves under various disciplines, which indicates the necessity to implement CE to the extent of the three levels of the economy (i.e., macro, meso

and micro), while fostering the interlinks among the various levels. Conducting research in the intersection between these levels would enable a holistic and systemic approach for advancing CE knowledge.

- Financial support awarded to CE research has been vital to its development. Indeed, more than 50% of Main Path scholars, regardless of their geographical areas or discipline, acknowledge the financial support of mainly public institutions.

In conclusion, there are four common factors driving research about CE, namely: (i) the active debate about CE's role to reach sustainability, (ii) the interdisciplinary background of scholars, (iii) the development agendas underpinned by CE established by either Chinese or European governments; (iv) the importance of financial support.

However, as already mentioned, some articles in the dataset were excluded from the CNA because they were not part of any citation network, which is typical of new fields of study that tend to display disconnected citation networks. The forthcoming additional analyses would allow for overcoming this limitation.

### *3.3. Global Citation Score (GCS)*

To explore recent breakthrough research, we classify papers based on the ratio of their cumulated citations on Scopus (until 2018) to the total yearly period of their existence. This normalized GCS results in pinpointing the top ten publications characterized by a "possibly" small GCS (i.e., total citations), yet which currently appeal to the scientific community (Table 3).

The first six papers are all reviews or conceptual papers, which confirms the recent scholars' tendency observed on the Main Path to consolidate CE knowledge. Interestingly, the remaining four papers do not belong to the Main Path but point out some of the chief recent research tendencies for CE. [75] discusses the development of green chemistry metrics and their application in quantifying the sustainability of manufacturing processes of pharmaceuticals and similar products; [13] reviews the PSS literature exploring how researchers addressed the design of PSS, its economic and environmental benefits, its implementation, enablers and inhibitors; [25] present a framework that outlines strategies for designers and decision makers to transit to CE; and [46] argue that embedding sustainability in supply chain management underpinned by CE would lead to clear environmental benefits.

**Table 3.** Top 10 papers in Scopus categorized based on the normalized GCS.

| | | | | | | | Citations received in | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rank** | **Title** | **Authors** | **Publication Year** | **Journal** | **Appear in the Biggest Connected Component** | **Part of the Main Path** | **<2014** | **2014** | **2015** | **2016** | **2017** | **2018** | **>2018** | **GCS** | **Citations 2018/Years since Publication** |
| 1 | A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems | [14] | 2016 | Journal of Cleaner Production | Yes | Yes | 0 | 0 | 0 | 14 | 102 | 154 | 4 | 274 | **51** |
| 2 | The Circular Economy – A new sustainability paradigm? | [5] | 2017 | Journal of Cleaner Production | Yes | Yes | 0 | 0 | 0 | 4 | 19 | 98 | 2 | 123 | **49** |
| 3 | Circular Economy: The Concept and its Limitations | [4] | 2018 | Ecological Economics | Yes | Yes | 0 | 0 | 0 | 0 | 4 | 37 | 0 | 41 | **37** |
| 4 | The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context | [63] | 2017 | Journal of Business Ethics | Yes | Yes | 0 | 0 | 0 | 2 | 24 | 65 | 1 | 92 | **33** |
| 5 | Conceptualizing the circular economy: An analysis of 114 definitions | [3] | 2017 | Resources, Conservation and Recycling | Yes | Yes | 0 | 0 | 0 | 1 | 3 | 54 | 0 | 58 | **27** |
| 6 | Towards circular economy implementation: A comprehensive review in context of manufacturing industry | [2] | 2016 | Journal of Cleaner Production | Yes | Yes | 0 | 0 | 0 | 13 | 57 | 81 | 3 | 154 | **27** |
| 7 | Metrics of Green Chemistry and Sustainability: Past, Present, and Future | [75] | 2018 | ACS Sustainable Chemistry and Engineering | Yes | No | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 24 | **24** |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | Product services for a resource-efficient and circular economy – A review | [13] | 2015 | Journal of Cleaner Production | Yes | No | 0 | 2 | 11 | 53 | 93 | 89 | 2 | 250 | **22** |
| 9 | Product design and business model strategies for a circular economy | [25] | 2016 | Journal of Industrial and Production Engineering | Yes | No | 0 | 0 | 0 | 1 | 27 | 59 | 1 | 88 | **20** |
| 10 | Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications | [46] | 2017 | Omega (United Kingdom) | Yes | No | 0 | 0 | 0 | 2 | 31 | 35 | 2 | 70 | **18** |

### 3.4. Keywords Co-Occurrence Networks

Author Keywords of the whole dataset retrieved from Scopus (i.e., 1558 papers) are analyzed using the software VOSviewer by setting the software at its default parameters (i.e., keywords should occur together in at least 5 papers). The process generated 12 clusters (Table 4) that reflect 12 diverse research topics. The research topics are ordered below, based on the keywords co-occurrences (i.e., the frequency of appearance of keywords in the dataset). The topic of each cluster is defined based on its papers' content. Note that the keyword "Circular Economy" is purposely discarded in order to put into evidence the differences between clusters.

**Table 4.** Topics based on Author Keywords with highest Co-Occurrences.

| Topic | Main Subjects | Keywords |
|---|---|---|
| Topic 1 | Sustainability, Industrial Symbiosis and the principles of Industrial Ecology | Sustainability; industrial ecology; industrial symbiosis |
| Topic 2 | Reaching resource efficiency through reuse and recycling, with a focus on waste electrical and electronic equipment (WEEE) and e-waste | Recycle; resource efficiency; reuse; WEEE; e-waste |
| Topic 3 | Waste management using environmentally friendly processes and new technologies with a focus on food wastes and municipal solid wastes | Waste management; bioeconomy; anaerobic digestion; municipal solid waste; biogas; food waste; bioenergy |
| Topic 4 | Instruments for Circular Economy (CE) implementation, with a focus on China | China; eco-industrial park; eco-design; environment; material efficiency |
| Topic 5 | Circular Business Models (CBMs) and Circular Supply Chains | Reverse logistic; business model (BM); CBM |
| Topic 6 | Waste management involving producers and specific indexes | Material Flow Analysis; waste; Extended Producer Responsibility |
| Topic 7 | Life Cycle Assessment (LCA) and cradle-to-cradle as tools for waste prevention and valorization | LCA, cradle-to-cradle, waste prevention, waste valorization |
| Topic 8 | Big data and internet of things as enablers of collaborative economy, resource recovery and remanufacturing | Remanufacturing; resource recovery; sharing economy; sustainable consumption; consumer behavior; breeding environments; collaborative consumption; green virtual enterprises; big data; collaborative economy; collaborative networked organizations; internet of things |
| Topic 9 | Achieving sustainable development through CE | Sustainable development; climate change |
| Topic 10 | Tools for Resource Productivity and Eco-Efficiency | Eco-efficiency; innovation; resource productivity |
| Topic 11 | Closing the loop through cleaner production, green supply chain, product design, and sustainable manufacturing | Cleaner production; product design; supply chain; closed loop; green supply chain |
| Topic 12 | Creating a low-carbon economy, and the needed instruments | Low-carbon economy; energy saving; evaluation index system |

- *Topic 1* investigates the relationship of Industrial Ecology (IE) and Industrial Symbiosis (IS) with sustainability. Examples include [76] investigating industrial processes that allow breakthrough waste recycling (i.e., industrial and urban symbiosis); [5] underlining the main similarities and differences between the concepts of "sustainability" and "CE"; [77] arguing that CE evolution relied on the existence of IE concepts and tools.
- *Topic 2* addresses recycling and reuse of waste electrical and electronic equipment (WEEE) and e-waste, and their relationship to resource efficiency. Examples include [78] emphasizing

Reduce, Reuse, and Recycle (3Rs) as CE strategies for "doing more with less", and [79] exploring Reuse and Recycling strategies for WEEE.

- *Topic 3* explores waste management (i.e., food wastes, municipal wastes) mainly through anaerobic digestion as a source of bioenergy (i.e., biogas). Examples include [49] demonstrating that urban waste bio-refining enables resource looping and increases resource efficiency, and [80] providing recommendations for the municipal solid waste (MSW) policy framework and MSW management practices.
- *Topic 4* addresses instruments for CE implementation (e.g., eco-design and eco-industrial parks) considering mainly the case of China. For instance, [50] and [31] address diverse factors for developing CE in China. Regarding Europe, [81] uncovers producers' positive perception of eco-design regulations, while [82] give recommendations to enhance the European Eco-design Directive.
- *Topic 5* evokes Circular Business Models (CBMs) and reverse logistics. Examples include [46] highlighting the environmental outcomes of integrating CE in supply chain management; [83] extending the CBM Canvas framework with two new actions, namely the take-back systems and adoption requirements, and [84] suggesting a framework indicating how different CBMs are driving circular supply chain in different loops.
- *Topic 6* emphasizes mainly the Material Flow Analysis (MFA) and the Extended Producer Responsibility (EPR) in dealing with wastes. Examples include [85] defining the barriers to the development of a typical EPR program for WEEE in South Korea, and [86] exploring the material content generated from waste, based on a MFA of the 2012 Swiss Waste Management System.
- *Topic 7* addresses Life Cycle Assessment (LCA), Cradle-To-Cradle, and urban metabolism and their relationship to waste prevention and waste valorization. Examples include [87] investigating the recycling of food waste from cruise ships to nurture aquaculture, and [88] exploring the guiding principle of the International Reference LCA Data System.
- *Topic 8* explores collaborative and sharing economies along with remanufacturing and their tools. For instance, [89] investigate the concept of "Green Virtual Enterprise Breeding Environment"; [90] investigate the paradigm of "Collaborative Economy".
- *Topic 9* explores sustainable development and its variables. Examples include [91] studying the essence, significance and inter-relationship of the concepts "environmental sciences", "sustainable development" and "CE"; [92] exploring the state of Waste-to-Energy in Norway over the next decade along with opportunities and barriers it may face, by considering climate change, CE and carbon capture and storage.
- *Topic 10* assesses possibilities for China to reach a factor 10 improvement in resource productivity [28]. Nowadays, resource efficiency is gaining momentum. Examples include [93] emphasizing the criticality of eco-efficiency and de-linking indices for ecological planning, and [94] exploring secondary materials recovery throughout urban mining.
- *Topic 11* focuses on sustainable product design and supply chain. Examples include [26] stressing the importance of "product life extension"; [25] proposing a framework outlining strategies for Circular Products Design and CBMs; [30] suggesting a revised model for recovery routes to secure material resource; [95] providing guidelines to designers and marketers based on consumers' reaction to refurbished products.
- *Topic 12* tackles low-carbon economy, energy saving, and evaluation index system. Examples include [96] addressing energy saving and CE in processing sectors in China and suggesting some solutions at the policy level and key technologies; [97] urging to foster an intra-country cyclic economy in China underpinned by low-carbon economy.

### *3.5. Burst Detection of Keywords*

Kleinberg's algorithm is applied to Author Keywords of the 1558 papers constituting our dataset to detect the emerging research trends characterizing CE literature and infer its future directions (Figure 4).

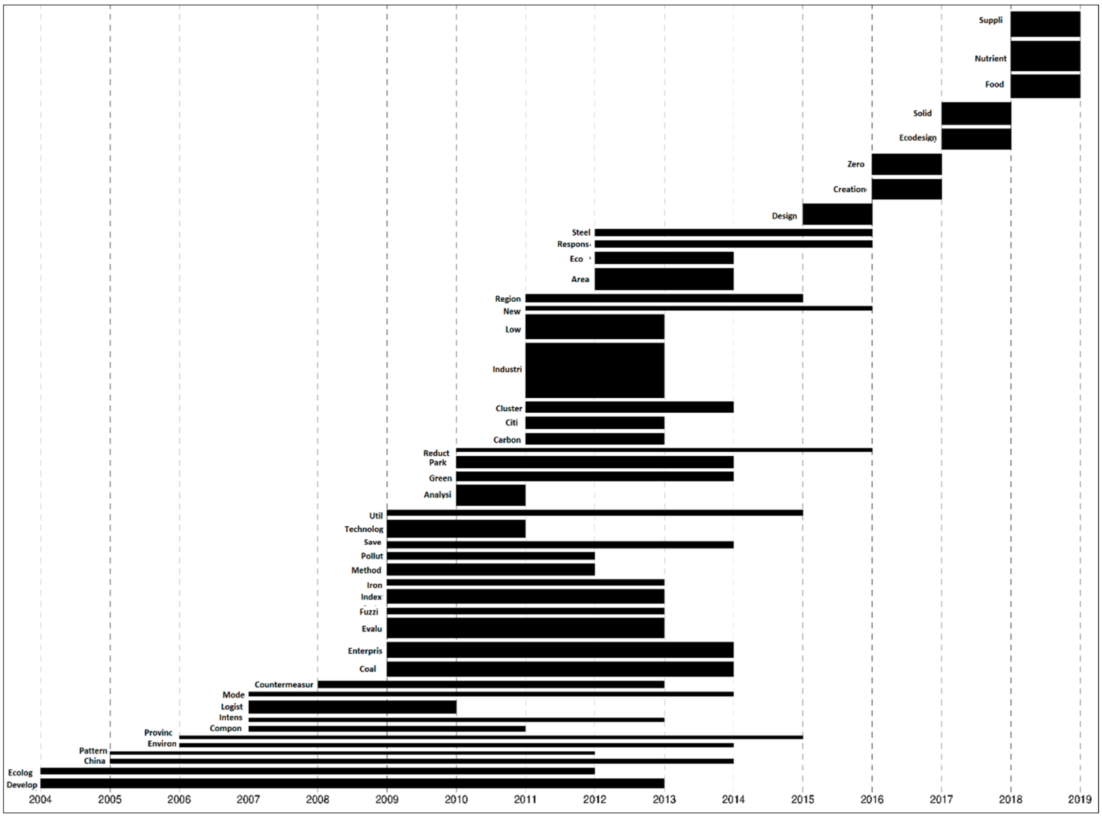


**Figure 4.** Detected Burst from Normalized Author Keywords (2004–2018).

The principal bursts point to CE as a *development strategy* (2004) and its relationship to *industrial ecolog*y (2004); *China* (2005); *patterns* (2005) such as development patterns of Industrial Symbiosis. The bursts *environment* (2006) and *province* (2006) reflect researchers' interest in investigating environment preservation and provinces' development under CE. The length of those bursts reflects the vivid interest of scholars in these topics over time.

Starting from 2009, bursts mainly become shorter in length but thicker. For instance, the bursts *coal* (2009), *enterprise* (2009), *evaluation* (2009), and *index* (2009) reflect a shift in academics' interest from macro to meso and micro levels, and, also, from a theoretical perspective to a practical one.

By 2010, bursts reflect the high interest of scholars in *industrial parks* (2010) and *green* (2010), namely the green supply chain and the green economy. In 2011, a large set of bursts of different lengths and weights appear, reflecting researchers' interest mainly in *industrial clusters*, *low carbon economy*, and in implementing CE at the meso and the macro levels. In 2012, other new bursts of various lengths and weights emerge, highlighting new CE research tendencies focused on *steel* (i.e., steel by-products), *Extended Producer Responsibility (EPR)*, and *areas* of industrial development or pilot *areas* for CE implementation.

Interestingly, new, one-year long bursts with almost similar weights began to appear in 2015, which may reflect the intense development of CE research. In 2015, scholars focus on *design* (i.e., CE design strategies, design thinking under CE). In 2016, the tendency shifted toward *zero*-valued residues and *zero*-waste, and value *creation* in CE. In 2017, *eco-design* and *solid* waste represent the new emerging interests. Finally, by 2018, emerging trends include *food* in CE (i.e., food waste recovery into energy, LCA of wasted food); *nutrient* (i.e., closing nutrient loops); and *suppliers* (i.e., the impacts of CE strategies such as remanufacturing on Original Equipment Manufacturer (OEM) suppliers, the upstream re-design of the value chain).

In conclusion, the Burst Analysis results further consolidate the findings induced from the previously used bibliometric tools.

## 4. Discussion of Findings and Research Agenda

This section attempts to identify existing themes and emerging trends that characterize Circular Economy (CE) research, based on the consolidated results from Citation Network Analysis (CNA), Global Citation Score (GCS), Keywords Co-Occurrence Networks, and Burst Detection of Keywords.

### *4.1. Existing themes*

The CNA uncovers that 845 papers from among the 1558 papers of the dataset are not connected by citations. This is remarkable considering the recent exponential growth of CE research, i.e., 51% of papers in our dataset appeared in 2017 and 2018. Furthermore, the main path analysis reveals that CE is studied by researchers from various disciplines using different approaches. In other words, the topic has been analyzed through various theoretical perspectives and several research domains, without providing a holistic and broader view of CE that combines existing themes and emerging research trends. Accordingly, our results show that, despite its recent growth, current research about CE is scattered, overlaps with many other disciplines, and lacks a common approach to its development.

Moreover, the *Main Path* and *Burst Detection of Keywords* findings indicate that until 2015, CE literature was mainly focused on China. This could be due to the fact that it was mainly the Chinese government deploying national development strategies underpinned by CE as early as the year 2000. It was not until December 2015, when the EU commission introduced its first CE Package, that researchers started exploring CE in a wider context. Likewise, CE research is shifting from general to specific. As a matter of fact, researchers are moving from rhetoric about the general implementation of CE, outlining its barriers and opportunities, to studying the application of CE principles, so as to tackle issues of waste, for instance through the use of product design, Extended Producer Responsibility (EPR) and Circular Business Models (CBMs).

In addition, there is a growing focus on the conceptualization of CE and its relationship to sustainability. Indeed, although this pattern does not appear in the Burst Detection of Keywords, it is highly visible on the Main Path (Figure 3) where, starting from 2016, conceptual and review papers figure strongly. This is further confirmed by the GCS (Table 3), where the top 6 papers are reviews and conceptual papers; these data highlight that there is a growing interest from scholars of all disciplines to define the concept and set its boundaries, with the possible result of consolidating the knowledge regarding the subject.

### *4.2. Emerging Research Trends (RTs)*

Despite the proliferation of CE studies advancing CE theoretical perspectives and research domains, we believe that major research directions (RDs) remain to be explored.

Major research effort should focus on assessing the conceptualization of CE and its relationship to sustainability and limitations (RT 1). In addition to former research (e.g., [4,40]), further research may emphasize establishing a common CE definition that can take the viewpoints of various disciplines into consideration; and define CE's relationship to sustainability and its enablers and barriers to tackle sustainability issues (RD1).

Further investigation of CE as sustainable development paradigm and its implementation (RT 2). Building on former research (e.g., [6,91]), scholars might consider the contextual issues; evaluation of CE initiatives at the environmental and social levels; based on non-traditional tools from various disciplines (i.e., system design; CBMs) to reach CE goals (RD 2).

Further research is also required for investigating the transition to CE at the Macro and the Meso levels (RT 3). New research avenues should consider a wider regional and institutional context (i.e., EU) as highlighted in the GCS with the papers [2,63], and incorporating new tools (i.e., eco-design (2017)) as highlighted in the Keywords Burst. Other avenues include investigating the transition of industrial clusters, polluting industries, and the role of industry incumbents in the transition to CE (RD 3).

An important body of research explores the implementation of CE at the micro level (RT 4). This appears in the Bursts (i.e., *circular design (2017))* and the GCS analysis where [13,25,46] emphasize the role of Product-Service Systems, circular design and CBMs strategies, and sustainable supply chains in the transition to CE, respectively. We believe that further theoretical and empirical effort is required to understand the role of customers in the success of CE initiatives in companies; the impact of CE transition on the internal level of organizations; and the impact of new forms of governance on the success of CE transition (RD 4).

Previous studies (e.g., [30,79]), explore resources and materials efficiency underpinned by CE principles, which goes in line with EU legislations targeting resource efficiency (RT 5). It represents the third biggest research trend in the CNA (Table 2) and still entices the curiosity of scholars, which for instance appears in the GCS analysis (i.e., [13]) and the Burst (i.e., *Nutrient (2018)*). Further insights should investigate the role of innovation and policy in enabling resource efficiency, development of urban mining, and WEEE and e-waste (RD 5).

Existing research has also examined the shift from waste management to resource management, based on existing and new technologies (RT 6) (e.g., [30,80]). However, literature in this stream, i.e., Cluster 8 and Cluster 11 of the CNA, represents just 7% of the biggest connected component, despite the increased interest in the topic appearing in Bursts *solid (2017)* and *food (2018)* wastes as *nutrients (2018)*. Further effort should capitalize waste as a source of additional value through upcycling or downcycling; engaging the supply chains actors for that purpose; and development of Circular Supply Chains beyond the local context (RD 6).

Additionally, literature emphasizes CE measurements and indexes (RT 7) (e.g., [75,87]). New insights should target new contexts (i.e., the impact of CE packages issued by the EU commission); narrower levels, such as the meso level as it appears in the GCS analysis; and the micro level for instance measuring the degree of circularity of companies' business models (RD 7).

Finally, researchers have addressed the role of digital technologies for enabling CE transition (RT 8) (e.g., [44,89]). This trend represents only 4% of the biggest connected component, despite the forecasted role of smart industries and smart cities in promoting economic development, ecosystem equilibrium, and social fairness [98]; the role of virtual platforms in promoting CE (i.e., sharing economy); and the potential of Industry 4.0 to reach CE targets. Thus, academics and funding bodies should catalyze their efforts to its further development (RD 8).

Table 5 summarizes the emerging research trends and promising directions for future research.

**Table 5.** The Eight CE Research Trends and Future Directions.

| Research Trends (RT) | Topics Based on CNA | Topics Based on Keywords Co-Occurrence Networks | Future Research Directions (RD) |
|---|---|---|---|
| RT 1: Conceptualization of Circular Economy (CE) and its relation to sustainability | Conceptualization of CE, its relationship to sustainability and limitations (Topic 7) | Sustainability, Industrial Symbiosis and the principles of Industrial Ecology (Topic 1) | • How could CE be defined under various subject areas/ disciplines?<br>• How does CE overlap with sustainability?<br>• What are CE enablers and barriers for tackling social and environmental issues? |
| RT 2: CE as a development paradigm | Implementation of CE, performance indicators, enablers and barriers (Topic 5) & Transition from linear economy to CE and its benefits for the environment (Topic 10) | Achieving sustainable development through CE (Topic 9) & Creating a low-carbon economy, and the needed instruments (Topic 12) | • How could CE be adapted to the contextual needs (i.e., Africa versus Europe) to reach sustainable development?<br>• How could CE outcomes be evaluated at the environmental and social levels?<br>• How could tools from various disciplines (i.e. system design; Circular Business Models (CBMs)) be fostered to reach CE goals? |

| | | | |
|---|---|---|---|
| RT 3: The transition to CE on the meso and macro levels | Implementation of CE, with a focus on China's case (Topic 1) & Development of Industrial symbiosis and eco-industrial parks (Topic 4) | Instruments for CE implementation, with a focus on China (Topic 4) | • How could current industrial clusters transit to CE?<br>• How to foster the transition to CE in the most polluting industries (i.e., the construction industry)? How do SMEs and big corporations contribute to fostering the transition to CE in a given industry? |
| RT 4: The transition to CE at the micro level | Circular product design and CBMs (Topic 2) | CBMs and Circular Supply Chains (Topic 5) | • How do customers perceive circular initiatives in diverse sectors and how to engage them?<br>• How could organizations leverage change management tools to catalyze their transition to CE at the internal level?<br>• How could new forms of governance (i.e., B-Corporations) enable CE implementation in organizations? |
| RT 5: Reaching resources and materials' efficiency under CE principles | Resource efficiency, design and process engineering underpinned by CE (Topic 3) | Reaching resource efficiency through reuse and recycling, with a focus on waste electrical and electronic equipment (WEEE) and e-waste (Topic 2) & Tools for Resource Productivity and Eco-Efficiency (Topic 10) | • How could innovation and policy allow resource efficiency?<br>• How could governments and organizations foster urban mining?<br>• How could WEEE and e-waste be fostered as nutrient of industrial processes? |
| RT 6: Transformation of wastes into valuable resources | Transforming wastes into valuable resources, technologies and barriers (Topic 8) & Enabling CE through new technologies (Topic 11) | Waste management using environmentally friendly processes and new technologies with a focus on food wastes and municipal solid wastes (Topic 3) & Waste management involving producers and specific indexes (Topic 6) & Closing the loop through cleaner production, green supply chain, product design, and sustainable manufacturing (Topic 11) | • How to foster upcycling and downcycling in diverse industries?<br>• How to engage the supply chain actors in the in a common strategy for closing the loop?<br>• How to develop Circular Supply Chains in global scale industries (i.e., textile)? |
| RT 7: Measuring CE at micro, meso and macro levels | CE indexes and measurements (Topic 6) | Life Cycle Assessment (LCA) and Cradle-to-cradle as tools for waste prevention and valorization (Topic 7) | • How could other institutional contexts besides those in China be reflected into CE indexes (i.e., the impact of the EU Commission's CE packages in the medium and long run)?<br>• How to design CE metrics adapted to industries (i.e., Green Chemistry)?<br>• How to measure the degree of circularity of companies' business models? |

| | | | |
|---|---|---|---|
| RT 8: Enabling CE throughout internet technologies | How sustainable are current CE strategies, measurements and alternatives (Topic 9) | Big data and internet of things as enablers of collaborative economy, resource recovery and remanufacturing (Topic 8) | • How do smart (digital) technologies enable the transition towards CE?<br>• To what extent do collaborative and sharing economies enable CE in a given industry (i.e., fashion)?<br>• To what extent do networked organizations better succeed in CE transition? |

## 5. Conclusions

This research is an introductory initiative to rationalize and systematize the body of scientific literature centered on "Circular Economy (CE)" since its early appearance. For that purpose, we applied various quantitative bibliometric tools, algorithms and software, which resulted in a dynamic depiction of the progress of CE research over time. Thereby, we present the big picture of CE theoretical and practical understanding, identify its major research trends, and propose a future research agenda underpinned by the dynamic advancement of the topic.

While several literature reviews have appeared, to the best of our knowledge, none of them provides a comprehensive assessment of the dynamics of CE knowledge. Thus, the paper contributes to the theoretical implications by tracing the evolution of CE research, its scholarly trends, and emergent themes, with a call for further scholars' attention to promising themes. We found that CE is an emerging topic, which is increasingly developing through the contributions and collaborations of scholars from all disciplines and geographical areas. Though Western scholars were the first to raise attention to the concept of CE, Chinese scholars set its foundations, for they were backed by their country's progressive CE development strategy and were supported in their roles as researchers. However, since 2015, research about CE has mainly been led by European scholars. Moreover, to date, CE research is still dominated by Environment and Engineering scholars.

Our results indicate that there is an atmosphere of ongoing uncertainty and disagreement regarding the focus of CE research. Moreover, although research is in its primary development stage, the emerging research trends reflect the existence of academic communities dedicated to well-defined CE topics. Accordingly, we believe that there is a need to further encourage the community of scholars to examine phenomena in CE using a well-defined set of theoretical perspectives while, at the same time, encouraging its diversity and knowledge sharing among fields, thus avoiding the trap of academic silos [99].

In addition, our review shows that 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. Therefore, there is a need to encourage a larger contribution of scholars from the Business and Economics area to explore the viability and profitability of CE strategies, and related managerial practices to overcome related issues (i.e., rebound effect, hyper consumerism).

Regarding the methodology, our research highlights a rising interest in developing conceptual models and frameworks. Yet, these seldom result from exploratory research. Consequently, there is great potential in investigating the extent of their implementation using qualitative and quantitative research (i.e., surveys and case studies). In particular, research should become more exploratory considering longitudinal studies and causality analysis.

Moreover, our results show that the existing empirical research tackles the levels of analysis of CE (i.e., micro, meso, macro) as separate, while studies that are focused on the intersection between levels are completely absent. Accordingly, we see future opportunities in developing a holistic approach that considers systemic interdependencies between levels.

As for the micro-level, our assessment indicates that organizational aspects of implementing CE tools and strategies are rather neglected (i.e., responses to internal changing requirements). Hence, it would be interesting to investigate the impacts of CE transition at the organizational level and change management. Furthermore, there is a need to consider new units of analysis that span beyond the boundaries of the focal company (i.e., customers, entrepreneurs, designers, institutions) to explore their engagement in CBMs.

Lastly, our analysis indicates that funding institutions are acting as relevant players in the diffusion of CE; thus, it would be interesting to further explore their role in the progress of CE research.

This research presents some practical implications since it is the first study focused on the cutting-edge evolution of the concept "Circular Economy". It updates both business and policy communities about the current standing of CE knowledge and highlights promising trajectories of its progress. This dynamic investigation unearths a set of key areas of CE topics, and supplies companies, organizations, and policymakers with acute information to enable a real large-scale transition towards CE. In other words, this paper draws politicians' attention to every scholars' community work, and its potential contribution to an effective transition to CE, whereby special attention to each research trend is necessary (e.g., funding). Additionally, the eight identified research trends may serve as the building foundations of a future political agenda, whereby every research trend should be entitled to further political attention.

Moreover, the eight identified research communities are developing, each on its own; therefore, this research offers scholars from diverse disciplines a roadmap of plausible multidisciplinary collaborations by identifying peers from other disciplines and their work. Thus, this paper opens the gates for new opportunities of interdisciplinary collaboration by introducing communities of scholars to each other's work. An additional, very significant, contribution of this work resides in the methodology used for conducting the research. The Systematic Literature Network Analysis (SLNA) proved to be a research approach that allows for discovering the dynamics of research about a specific topic, CE in our case, and inferring its research agendas to further contribute to research development. Nevertheless, the applied methodology has its limitations. First, the dataset is retrieved from Scopus, which, although large enough for reviewing the literature [10], represents only a fraction of the scientific literature. Second, due to the "Matthew effect", scholars tend to cite prominent papers (i.e., already highly cited), and possibly overlook the value of other scientific contributions.

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