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Is Business Research Shaping the Circle? Systematic and Bibliometric Review of Circular Economy Research

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Abstract: A circular economy (CE) transforms the linear system into a resource flow model based on reusing products and materials and increasing lifetime periods. This academic work aims to review the current CE research status from business, economic, and managerial (BEM) research perspectives. We carried out a systematic and bibliometric analysis to gather information on the current state of the art applications and learn about the leading research topics and sources. To reach these goals, we reviewed 962 research papers published in journals indexed on the Web of Science. After analysing the articles, three categories emerged worldwide: literature reviews, case studies, and frameworks and guidelines based on the current closed-loop system approach. Results evidence that BEM research in the CE is focused on the existing barriers to adopting a CE. More concretely, findings show that CEs are being slowed by the fact that citizens and companies do not know how to be circular. At the same time, the article showcases how the BEM areas and the recurring topics in CE research are increasingly being developed by collaborations between engineers and economists to design and create robust and measurable closed-loop models.

Keywords: circular economy; systematic review; sustainability; closed-loop system; bibliometric review

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1. Introduction

Capitalism, the most extended economic model nowadays, is based on the linear economy (LE). The main pillar of this concept is consumerism, in which every resource is obtained from nature itself, later transformed by industries to make it suitable for human use, and finally disposed of when its predetermined life cycle ends [1,2]. This system leads to a growing economy due to indiscriminate consumerism and the shortness of the artificial lifetime periods that industries set up [3]. However, the linear economy is not sustainable in the medium–long term [4,5]. Despite the improvement in production efficiency and the reduction in the use of non-renewable energies experienced recently, several limitations hinder linear economies' continuity [6,7]. Population growth greatly enlarges the number of natural resources needed [3,8]. Moreover, inefficient waste management degrades soil quality, complicating new biological resources' growth [9,10].

During the last few decades, some new economic models have emerged, aiming to cover the limitations of the linear model. The circular economy (CE) is becoming one of the most distinguished alternative business models, and it is widely expected to be standardised as the new global model. A CE modifies the previous linear system based on consumption and detaches and changes it to a resource flow model based on materials' reuse and longer life periods [11–13]. However, several interpretations and conceptions of a CE hinder its adoption as the primary economic model. Some researchers claim CE is less environmentally friendly than believed because it lacks a foundation, making it difficult to adapt to any kind of company (e.g., the availability of clean energy sources).

Circular economy research and publications are growing enormously, not only in number but also in typology. The multidisciplinary relevance and timeliness of the concept have attracted the interest of researchers from diverse fields of knowledge, who are now focused on developing the theoretical foundations and a wide range of resources aimed at widening the adoption of the circular economic model.

The study's main objective is to gain knowledge about how CE research is being structured in the field of BEM. Given that some researchers [14–21] are proposing CE as a business model, the article focuses on analysing the evolution and main findings of its state of the art applications. Aiming to reach these goals, this paper reviews the conceptions of CE provided by researchers and scholars [14,22,23] in several journals and universities worldwide. Then, a systematic and bibliometric analysis is performed to identify the main fields of CE research and better understand how they are being developed in written science. The study of keywords, publishing journals, research methods, and article results is used as a basis to gather knowledge of the fields that are being covered by CE research, as well as those that are still uncovered or with a lower level of development. Furthermore, this article looks for the links between the papers about CE and how society and companies are assuming the role that CE could have in the transition toward a cleaner economic system.

To reach the objectives, the analysis is performed in two aspects. On the one hand, to fulfil the bibliometric review, a set of the main aspects of journals is analysed to identify the main details of CE research in BEM areas. On the other hand, content analysis is conducted to identify the main findings and specific aspects covered by the science and classify papers into three categories based on their main contribution: literature reviews, case studies and frameworks.

The present study is structured as follows: After a brief introduction, Section 2 provides a theoretical background, context, and an overview of CE. Section 3 explains the method employed in the different analyses. Sections 4 and 5 present the results and discussion, and finally, Section 6 provides the main conclusions.

2. Literature Review

The linear economy has remained unchanged since its appearance, following a "take-make-dispose" pattern [24]. Production processes still require large amounts of raw materials to manufacture goods. The limited availability of natural resources has led to thinking of new models to decrease the amount of raw matter used in production chains and to creating a new economic model focused on reducing waste and optimising the product's lifetime. A CE can reduce waste and save remarkable amounts of raw materials [22,25]. Many practitioners defend the argument by claiming that CE principles are focused on leaving behind any possible harmful behaviour against the environment [26,27]. Moreover, CEs are expected to enhance nature's resilience and restore any previous damage thanks to its main principles of respect for nature and materials' recovery [28,29].

Some countries have already started to incorporate the closed-loop system (CLS) as a new production model, leading to an alternative greener than the existing one. The main goal of CLS is to reuse material waste generated during the production process and, at the same time, to use recycled products to create new ones [30–32].

Nonetheless, many limitations hinder its effective adoption [33,34]. Several pieces of research show that public and institutional support for CEs is still low [35,36] since no specific industry has adopted CLS as its main production model due to the technical and financial requirements [33].

2.1. Circular Economy Origins

According to some scholars [27,37], the term CE was born in the hands of the first president of the royal society of Chemistry, Hofman, in 1848 [27] when he stated: "In an ideal chemical factory, there is, strictly speaking, no waste but only products. The better the real factory makes use of its waste, the closer it gets to its ideal, the bigger is the profit". Therefore, by making an in-depth analysis of his words and the reference he made to a

closed-loop system (CLS) and, specifically, on how the waste is treated, it can be extracted that recycling and reusing every resulting product is a maximum principle of CE. Leontief, in 1928, also stated some of the main CE principles: "re-production point of view, flows' circularity, and scarcity point of view" [17,38–40]. Nonetheless, the CE concept took more importance in the middle of the 1960s and 1970s [23,41,42] when many different theories supported the idea of a closed-loop economy. Therefore, there is no agreement on choosing a unique CE definition. Many researchers [43,44] argue that it is essential to set a CE framework to foster and make the adoption of this economic system easier. Defining a specific model would support the dissemination of CE principles among companies and the population, supporting the exchange of information about technical and economic issues that would strengthen the development of a robust model [45,46]. For this reason, in this section, we take an approach to discuss the different scopes used by authors to talk about the concept of the circular economy and its development based on theories and premises designed by researchers and practitioners.

2.2. Circular Economy Definitions and Conceptions

The Ellen MacArthur Foundation (EMAF) determines in its circular economy digest how hard it is to trace the origins of the CE and its definition [28]. Nonetheless, the EMAF has been working on creating an approach to develop the CE concept. The foundation has taken some ideas from different streams of thought and concepts, which are explained below. Those streams include the Cradle-to-Cradle theory, permaculture approach, biomimicry, and natural capitalism.

2.2.1. Cradle-to-Cradle

Defined by B. McDonough and M. Braungart in 2002 [29], Cradle-to-Cradle is an approximation that cares about how every existing material used by manufacturers is transformed into nutrients. Nutrients are divided simultaneously into a lower classification of technical and biological nutrients useful for human beings. This interpretation changes the previous conception of the issues caused by the materials due to the limited amount of raw matter or the high pollution level produced by their transformation and focuses on their utility and the positive impact of the resource flow [47]. In this way, raw materials are similar to biological organisms, in that, after their use, they return to the biosphere. In a similar interpretation, non-biological resources could be recycled after disassembling to lead to brand new products [29].

2.2.2. Permaculture

In the mid-1970s, Mollison and Holmgren designed a process centred on mimicking the environment and developing behaviour based on ecological conduct. Their structure states how human beings interact with nature and how their negative impacts can be significantly reduced by adopting some of the CE theoretical principles in daily life. They contended the necessity of "working with, rather than against nature; of protracted & thoughtful observation rather than protracted & thoughtless labour; of looking at plants & animals in all their functions, rather than treating any area as a single-product system" [48]. Thus, permaculture aims for people to adopt a sustainable mindset in every aspect of their lives, taking into account the effect of each action and encouraging them to embrace a more sustainable attitude [49].

2.2.3. Biomimicry

Biomimicry allows human beings to imitate nature's functioning in its designs and economic processes. It argues that the adoption of biomimicry is essential to encourage and enact sustainability behaviours [28]. Moreover, innovation and development are postulated as something that emerged from the observation and understanding of nature. Therefore, analysing the environment, forests, land, and other natural resources will bring new ideas for people to care about the environment and its resources.

2.2.4. Natural Capitalism

Natural capitalism states the necessity of transforming the current manufacturing system into a system that cares about the biosphere and achieves better competitiveness and profits thanks to production improvements and efficiency progression [50].

3. Methods

3.1. Content Analysis and Bibliometric Analysis

Content analysis was defined by Krippendorf in 2013 [51] as "a research technique for making replicable and valid inferences from texts to the context of their use". Similarly, Berelson in 1952 [52] stated that content analysis allows any qualitative data to be transformed into quantitative information, facilitating its evaluation and comparison, thanks to the application of a systematic model. In a similar definition, Gerbner in 1985 [53] said that content must be analysed to then be described more specifically because mass-media audiences are affected by hidden messages that are not explicitly communicated. Therefore, the authors agree on various aspects of content analysis, such as the necessity of extracting information not expressly defined and the absolute requirement of making the research replicable, aiming to make objective something that could be primarily considered subjective. Therefore, content analysis is used to define and understand the studied text from a scientific perspective, which checks out every part of a written document to give it a detailed and empiric interpretation. Thanks to the proper use of this kind of methodology, this paper gathers information from research articles using systematic, objective, and replicable methods [51].

In the words of Merigó and Yang [54], bibliometric analysis is "the quantitative study of bibliographic material. It provides a general picture of a research field that can be classified by papers, authors, and journals". Therefore, this analysis allows a study to gather information from different articles and quantify them. It is important to mention that this type of analysis helps measure the impacts of research studies as it makes the information quantifiable and easily manageable. Broadus (1987) defined bibliometrics as a statistical approach to literature, and Glänzel et al. [55] said that bibliometrics can be defined as the study of books, articles, and other media applying different kinds of mathematics. Specifically, some of the characteristics of the literature that could be analysed and covered by this kind of analysis are the subject, document, language, country of publication, and date [56].

3.2. Sample to Perform the Analysis

The bibliometric analysis method was applied to a sample of papers related to circular economy to identify different kinds of articles [42,57]. To select the sample, the following criteria were used: We looked for the terms "Circular Economy", "Closed-Loop system", "Circular production system", and "Circular Model" and refined the search filtering by articles from BEM categories indexed in the Web of Science Index. The final sample, gathered at the beginning of 2021, comprised 1109 articles that matched the search criteria. The methodology PRISMA 2020 [54] was used to process these articles and refine the sample, allowing filtering of the results thanks to a multiple-phase identification of the papers. Firstly, papers were obtained using the terms previously mentioned. Papers were then screened to remove those that were not related to the research area of interest or that were duplicated. Then articles were downloaded from the different origins.

Nonetheless, as can be observed in Figure 1, some articles could not be retrieved, or the information disclosed was insufficient to be included in the analysis. Finally, a refinement was conducted by removing those entries related to wrong keywords, incomplete information, or articles showing inconsistencies such as not disclosing the complete information and the bibliometric data. This refining process resulted in a sample of 962 articles. Then, papers with the same research questions or overlapping assessments were removed in the eligibility process, leaving a final sample of 296 articles for the content analysis.

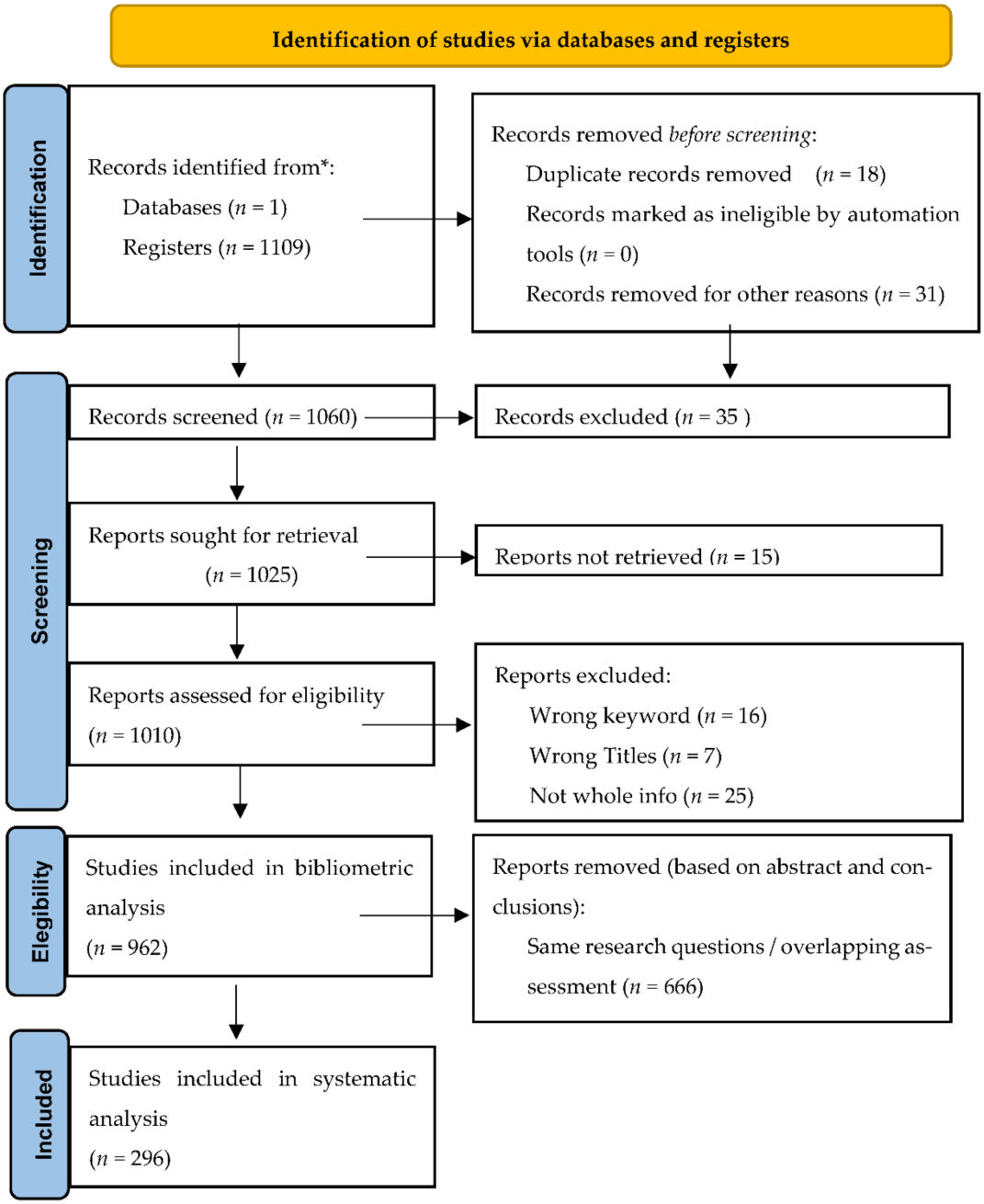

Figure 1. PRISMA graph. Source: self-made based on [58,59]. * Data was gathered from the database after performing the specific search defined in the text.

3.3. A Systematic Review of Articles and Their Publishers

Using a sample of 962 pieces, we gathered information from different journals and countries. We counted the times a keyword was used in the CE research field as well as the different areas of research in the journals. We gathered every aspect of the bibliometric review from the same database, WOS, to keep the consistency of the information.

To perform the content analysis, we departed from the 962 articles. The abstracts, titles, keywords, and conclusions were used to identify those articles with the more interesting incipient and relevant topics, choosing those articles with more findings. Once the sample was refined, we removed those papers with repeated findings or a lower significance level from the systematic analysis sample according to the authors' criteria or overlapping assessment. Information was classified by manual inspection of the study's researchers,

who specialise in the topic. In case of disagreement with the classification of the articles, and as we were three researchers, the articles were classified by the majority of the authors' criteria. Keywords were checked to obtain a central idea of the document content. By reading the papers, the primary purpose and topics were extracted. Then, articles were classified into three categories based on the most incipient and predominant article types. This classification offered an overview of CE research's most trending topics and the articles' main typology. Furthermore, by delimiting the previously mentioned information, we could assess the current state of the art research and how practitioners approach the research and its scope.

At the same time, we classified the different typologies into subcategories based on the more common types of analysis and methods. There is a profound degree of information in empirical and framework studies. In contrast, the literature reviews exposed more general information, so it was not possible to define criteria-specific categories for that kind of article.

This methodology was applied with some assumptions that must be considered to understand the results better. The restrictions on the area of research and the main keywords selected can create an important bias as several types of CE research are multidisciplinary or are mainly from other areas. In this regard, we decided not to use the keywords and highlights automatically generated by WOS, mainly because of two reasons. The first one was based on the authors' decision to choose the specific keywords for their articles, so analysing words not chosen by them could distort the analysis. Secondly, there was a low number of matches among the articles' keywords and the "database keywords". Therefore, article information highlighted by the authors in the form of keywords could not be included in our analysis if we decided to analyse those defining words instead of the author's ones.

The application of the methodology also has some limitations. Access to articles was limited depending on the license of the institutions, so some articles were left outside the sample. Finally, it is important to remark that the authors' criteria and experience, together with the previous literature, were the criteria for classifying the articles by typology. This criterion can change depending on the researcher's knowledge and experience in the CE field.

4. Results

4.1. Bibliometrics

After analysing the primary statistical data extracted from WOS, we identified the journals and keywords with more spheres of influence in the CE research field. Specifically, we analysed the leading BME journals with active CE research selected from the WOS Social Science Citation Index (SSCI) categories up to the momentum when the study began.

4.1.1. Journals' Analysis

According to the journals identified in the sample, Table 1 reveals a very high concentration of articles in a small set of journals.

It is worth noting that more than 68% of the published articles are concentrated in 16 journals, while the other 32% are distributed among 72 journals. Sustainability (172) and The Journal of Cleaner Production have the most substantial number of articles (165 articles), followed by Resource Conservation and Recycling (93) and Business Strategy and the Environment (38). Therefore, the main topics and terms of the articles are directly linked with CE terms explicitly such as green, sustainable science, and environmental science/studies that are included in several of the reviewed articles. Two results deserve special attention. As shown in Figure 2, the first finding is related to the importance of science and technology journals in the progress of CE research. The number of topics related to technology, engineering, or any other term used to label technical science research is considerably larger than those linked to the BEM.

Table 1. The number of articles in the different journals.

Journals	Numbers
Sustainability	172
Journal of Cleaner Production	165
Resource Conservation and Recycling	93
Business Strategy and The Environment	38
Science of the Total Environment	32
Waste Management	31
Journal of Industrial Ecology	28
Ecological Economics	14
Journal of Environmental Management	13
Environmental Science and Pollution Research	13
Development of Circular Economy in China	11
Waste and Biomass Valorization	10
Quality-Access to Success	10
Environmental Engineering and Management Journal	10
International Journal of Environmental Research and Public Health	10
Amfiteatru Economic	10
Journals with 5 or more publications and less than 10 (12 journals)	83
Journals with less than 5 publications (154 journals)	219

Source: self-made based on information extracted from WOS.

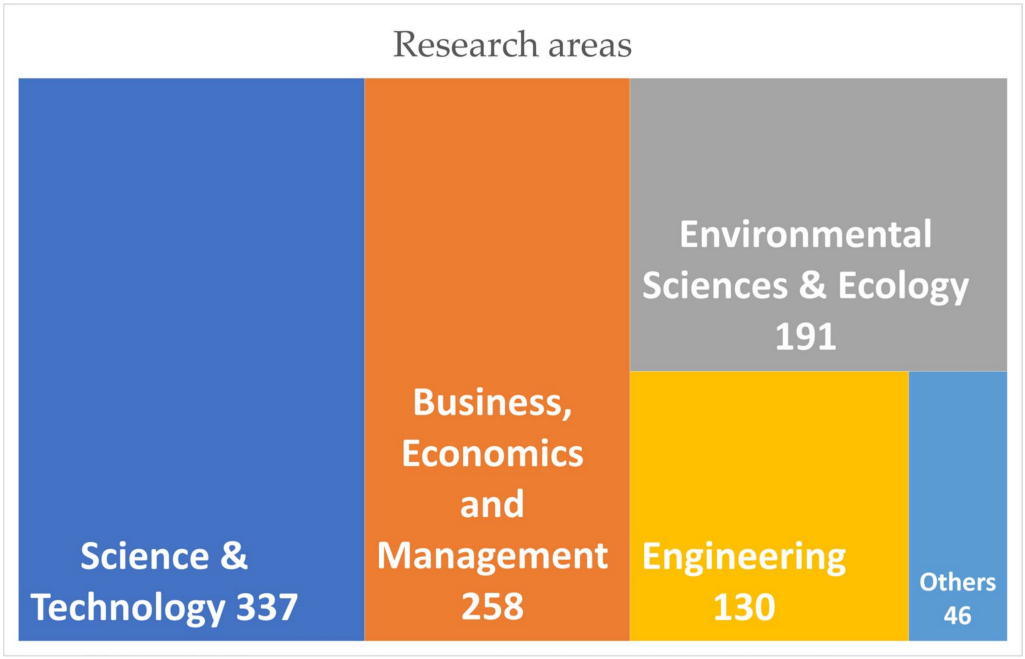

Figure 2. Areas of CE research. Source: self-made based on information extracted from WOS (Table S1).

The second finding is related to the presence of specialised business journals. As Figure 2 shows, the most common research topic in the CE field is "Science and Technology" (37%). This research field is essential for CE evaluation, and introducing a CLS requires total new material management and production processes and much specialisation to transform operations from linear to circular production. In second place, business, economics, and

management areas are found. This aspect is interesting since the search terms were related to those areas. The economic research field is not the predominant one. In the third position, environmental sciences and ecology (21%) are linked to the study of the effects of a CE on the environment, and, finally, in fourth place was engineering (15%), where most of the articles are related to technification processes and the development of new technologies to transition to a CE. Finally, there are 5% from other areas linked to different topics, which, in some cases, are related to the inclusion of CE in several fields such as ecology, geography, computing, etc. Therefore, this study highlights two different findings from the keyword analysis.

On the one hand, science and technology research and engineering research are taking a relevant part in the CE's diffusion and disclosure. On the other hand, articles on business only represent about a quarter of the total (258 from 962), even when filtering in the database by the research areas of business, economics, and management. For this reason, we will take a more in-depth analysis of why this is happening in the Discussion Section of the present work.

In Figure 3, it is remarkable to see how CE articles from economic study fields have been concentrated in the last five years, during which almost 90% of research papers have been published. Therefore, the economic studies of the CE emerged late compared to other knowledge areas such as technology, environmental studies, and science (CE articles have been published since early 2002). This fact relates to the public partners' policies supporting CEs and the CLS among different countries. Research in China is remarkable compared with other countries because of the strong backing for a CE made by its government since the early stages of this knowledge stream, thanks to many laws that have increased its adoption. As the sample was gathered from the beginning of 2021, we include a polynomial forecast of the expected number of publications for the whole of 2021 in discontinued lines.

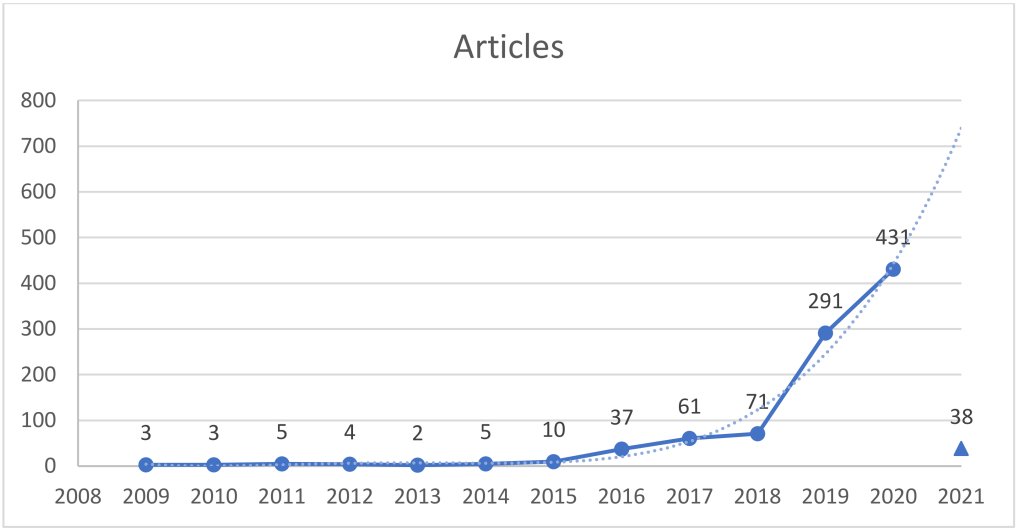

Figure 3. CE research by years (number of articles). Source: self-made based on information extracted from WOS.

In Table 2, we find the number of publications by country. It is notable how the three countries with the highest level of CE research are China (79), which is as expected as they have a specific agreement to focus on sustainability and sustainable development and have developed concrete regulations to promote CE (China's CE promotion act), Spain (71), and Italy (67), which have no specific remarkable CE research streams except for those that come from being European countries where some CE stimulus starts from the EU. France (63), UK (63), and The Netherlands (55) have a remarkable level of CE research. Finally, it is important to highlight how European countries such as Germany, Denmark, Sweden, Finland, Romania, Portugal, and Poland are showing a high number of CE princi-

ples' publications, which may be related to the European stimulus towards an alternative production model and the diverse programs launched to research in the CE field.

Table 2. The number of articles by country.

Country	Iterations
China	79
Spain	71
Italy	67
France	63
UK	63
The Netherlands	55
Germany	46
USA	45
Denmark	42
Sweden	37
Finland	34
Romania	32
Australia	25
Brazil	21
Portugal	20
Poland	20
India	18
Austria	17
Belgium	16
Greece	15
Mexico	15
Singapore	10
Canada	10

Source: self-made based on information extracted from WOS.

4.1.2. Keywords Analysis

Some other collected information is related to the main words that authors used to categorise and expose the topics treated in the articles, helping readers to a fast understanding of their content. Table 3 shows the most used keywords by the authors and the number of times those words have been used. However, it is important to say that keywords not present in at least seven articles were omitted. Focusing on the data in Table 3, two main findings of CE research are identified, as well as the way authors classify their articles. The first keyword of CE is circularity (214), which could be expected due to the high link to CE. The second keyword of CE is sustainability, with 135 iterations. Sustainability may be considered a global topic, so we cannot use it to extract information or take a more in-depth approach or research. Recycling (47) is another term that is too general but gives us specific information about the main techniques fostered by CE research and ways of incorporating a CE. The next most common words are sustainable development and waste management, which gives us an emerging field of study that could be interesting to analyse in detail. Specifically, waste management is a common word in articles, and it makes sense because the circular economy model is highly connected to how materials are handled,

Table 3. CE research, keywords chosen by the authors.

Keyword	Number
Circularity	214
Sustainability	135
Recycling	69
Sustainable development	57
Waste management	47
Life Cycle Assessment	42
Industrial Ecology	37
Circular Business Model	34
Eco-innovation	34
China	29
Resource efficiency	26
Remanufacturing	23
Industrial symbiosis	20
Reuse	17
Waste	15
Resource Recovery	14
Reverse logistics	14

Source: self-made based on information extracted from WOS.

Finally, it is important to talk about other words that have been issued several times and are interrelated. These words are lifecycle assessment (42), industrial ecology (37), eco-innovation (34), resource efficiency (26), remanufacturing (23), resource recovery (14), and reverse logistics (14). They are linked to materials' management and recovery, showing the high relation between the CE research and the materials' and waste management.

Definitively, at the base of the keyword's analysis, the CE research focuses on sharing a new approach to the new economic model for industry transformation, and aspects such as logistics, innovation, recycling, and waste management are the focus of research works and the main base on which to transition to the new business model brought by a closed-loop system.

4.2. Content Analysis

After reviewing the articles, we gathered information about the different focuses of CE research, the main terms related to them, and a complete description of the relevant information found. Concretely, we identified three main kinds of research papers, namely literature reviews, frameworks, and case studies, and we highlighted the main kinds of findings based on the information identified in those types of papers.

4.2.1. Literature Review Articles

In Table 4, we present three main groups from the analysis of the literature review articles. More concretely, we find articles of:

Circular Economy Enablers: As the circular economy is still in an initial phase [60–62] and is being expanded in several countries around the world [63,64], there is not an official model in any country, and it is necessary to gather information from different sources to incorporate this new system in business and public organisations. Through this kind of literature review, researchers analyse the different firms where a CE has been adopted to make public several ideas and suggestions to incorporate it. These papers expose how useful the different measures have been for some organisations [65,66] and how they have supported the incorporation of a CE and a CLS. These articles are still highly limited

because of the difficulty of finding a CLS applicable to different levels of organisations and companies [66,67]. One of the main obstacles is making a universal model incorporate a CLS in any kind of business and public structure. However, as is stated, some initiatives have started to develop specific models to foster the diffusion of CEs and to try to include some basic pillars to make the adoption easier in several industries, specifically in the manufacturing industries. Concretely, it is important to remark upon the models from the Ellen MacArthur Foundation and the European Union, which are significantly investing and researching in CE and CLS topics, and promoting their adoption.

Table 4. Literature review articles analysed.

Groups	Keywords	Findings
Circular Economy Enablers	– CE Indicators – Environmental advantages	– Green economy and industrial ecology, as models, contain all CE principles. Therefore, some CE theories compiled provide a framework to extend the resource's life and stimulate CE adoption. – CE adoption will be increased if there is a high diffusion of best practice among industries. – It is crucial to promote a system of CE indicators to avoid green-washing and provide tools to measure the actual degree of CE adoption and effectivity.
Circular Economy Limitations/ Limiters	– Linear economy predominance – Limited citizen and community collaboration	– Retrieval and reprocessing are hard to design, and there is still an important lack of community collaboration to recover materials. – There is no private initiative to encourage innovation in reverse logistics, and complete recycling is impossible as there is always an amount of energy spent. – Programmed obsolescence is a significant barrier caused by the industry and the citizens (fashions). – Biomimicry, Cradle-to-Cradle, and natural capitalism are not highly developed to be adopted by industries. – CE frameworks require attention because they are not being analysed from a technological point of view.
Public Policies	– Soft public CSR policies – Low level of public and private support	– BS 8001:2017 standards provide a comprehensive list of frameworks for implementing CE. – Enterprises are not incrementing measure tools (LCA) or the product lifecycle because they are neither stimulated by public sources nor private entities. – European and Chinese legislation is vital to defeating the main adoption challenges and changes. – Many big countries, e.g., Russia and Brazil, do not have CE programs.

Source: self-made view. See Tables S1 and S2 for more details about articles analysed.

Circular Economy Limitations/Limiters: As the CE is a new economic model, several conditions hinder its adoption [68,69]. The transition from a universally recognised model to a new one must be supported by the main economic agents (public powers, firms), but there is still limited public or private support for the CLS [70]. Therefore, this article is based on analysing the main failures of the different kinds of strategies to adopt a CLS. Many articles [27,71] have focused on these studies because, nowadays, there are more significant failures in the total adoption of a CE than successes [72]. The main reason is not the model's utility but the difficulties in changing the different enterprises' cultures, values, and production systems.

Public Policies: These articles require special attention when they are defined because they could be considered as part of the enablers and limitations. However, after analysing all the literature review papers, public policies are taken as the main approach and as a principal agent in the development of the circular economy so that they are not just boosters or a way to hinder its adoption [73,74] but, on the contrary, they offer the main factors that could change the model by itself, thereby developing a new one [75,76].

After reviewing several literature review articles, we found many kinds of analysis and article structures. We next analyse and categorise more deeply the different main groups of research types in terms of frameworks and empirical studies.

4.2.2. Frameworks

In Table 5, we see the four different groups from the analysis of the framework papers. More concretely, we find articles focused on:

Table 5. Frameworks analysed.

Groups	Methods	Theoretical Frames
Production models	Mixed-integer linear programming (MILP), dynamic numerical optimisation modelling, related matrices framework, backcasting and eco-design, Ramsey model, PDRI rating index	CLS synergies, non-renewable resources and optimisation, SDGs and sustainability dimensions, eco-design, Pigouvian taxation, optimal recycling, supply chain management
Business models	Business model canvas, Hirsch and Levin's notion, grounded theory, input–output matrixes	Industrial ecology, ecosystem services and eco-industrial parks, eco-design, value creation, circular economy business model, servitisation and inverse logistics
Life cycle assessment	CVORR; LCA, LCSA, CBA	LCA and material Flow, waste management; resource recovery, durability and CE measurement, the sustainability of products and pollution
Circularity measures	Index evaluation, longevity indicator, social objective, waste accumulation equation, environmental value propositions table, input–output matrixes	Eco-city, environmental assessment performance, agent-based model and consumer behaviour, stakeholder and financial perspective of CE, MFA; DEA, resource efficiency and tech advancement, free market assessment, latecomer

Source: self-made view. See Tables S1 and S2 for more details about articles analysed.

Closed-loop system models: Based on different current theoretical frameworks, this kind of article looks for the development of an alternative production method [77,78]. Furthermore, researchers try to transition from current production models to a resource flow model [79,80]. Due to this specificity, there is not currently an active project based on a generic transition, but there are industry-specific ones. For this reason, we have tried to conceptualise different studies regarding goals and achievements.

- Developing CLS networks for managing generic products (inverse logistics, real-time forecasting of product returns) [16,80,81].
- Inclusion of sustainable practices in business to develop CE and sustainability from different perspectives and obtain information on the environmental and financial terms of the advantages [82,83].
- To improve the measurement of the expected outputs in terms of pollutants, their management, and how emissions and their impacts could be ameliorated by transitioning through new energy sources [84,85].

Business models: The circular economy is not just based on the closed-loop system but many other concepts [17,86] such as the servitisation of products. For this reason, several different CE models are shown and designed to foster this new business concept:

- Define a different business model to support components in the adoption of eco-design, but at the same time transition to a whole new conception of property, which is nowadays industry- or even firm-specific [25]
- The incorporation of ecosystem services into CE supports the inclusion of a better balance between economic growth and environmental concerns [86].
- Foster the inclusion of resource-efficient and clean energy sources [87]

Life Cycle Assessment: It is essential to obtain a reliable system to measure the advantages of CE. The main objective of these new measurement tools is to look for an

improved instrument to assess the value creation, destruction, and distribution of the leading new models, especially on inverse logistics but eventually in every kind of task derived from the new product designs and the improvement of a product's lifecycle [88]. Nonetheless, after reviewing the articles, it is important to mention that one specific aspect of using life cycle assessment is the setting where it is being applied. As companies are adopting CE more gradually and the adoption rate is still low, most of this research is being undertaken under specific conditions that are not easily replicable, and that could vary depending on the sample.

Circularity measures: There are several tools to measure the degree of sustainability. Nevertheless, there is still a low development of indicators to measure the performance degree of the new business models [89,90]:

- To determine the leading transformation, the main entities, public firms, and cities must engage in the process to migrate through to a CE. Several investigations bring to light the changes and processes firms must undertake [91].
- To identify the current leading sustainable indicators in order to transform them and obtain new sets of metrics that allow them to evaluate and assess the environmental value of the leading CE models proposed by researchers and practitioners [92].To define the different CE dimensions more deeply. It is essential to focus on the fact that the economic and environmental point of view is highly developed, but there is still a lack of research on the social perspective [34,72].

4.2.3. Empirical Studies

Finally, Table 6 reviews the different kinds of empirical studies, classifying them by the methodologies taken to perform the analysis. Concretely, we found four main groups:

Table 6. Empirical Studies analysed.

Methods	Theoretical Framework	Source
Case study	Institutional analysis, material flow accounting, industrial ecology, business ecosystem, durability, 3R targets, stakeholder theory, eco-efficiency of industrial parks, industrial symbiosis, sustainability-driven innovation.	Case studies, SIAPA, Eurostat, FAO, SEPA, firms' and enterprises' reports
Input/Output Matrix/ MRIO	Sharing economy, industrial symbiosis, urban industrial, green supply chain management, product–service systems, institutional theory.	ISTAT, questionnaires, Eurostat
Interviews	Renewability, education for achieving CE, wastewater treatment, industrial ecology, Cradle-to-Cradle, eco-innovation, secondary raw materials and lean value chain, EU and green marketing systems, CE public awareness, consumer behaviour, awareness, internationalisation and EOL practices, dynamics of consumption.	Questionnaire and structured interviewing
Material Flow Analysis	The flexible design of remanufacturing systems, eco-efficiency, substance flow analysis, green innovation and resource efficiency, EVR benchmarking and circular transition, landfill management and reuse, developed and applied social metabolism, city GHG emissions.	National Statistical Offices, GreenEcoNet, Eurobarometer Questionnaires

Source: self-made view. See Tables S1 and S2 for more details about articles analysed.

Case study: Their main goals are based on previous investigations made by researchers or companies. These articles look to analyse the successes and failures at the moment of incorporating a CE into the firms, aiming to improve the models and determine if the unsuccessful situations could be fixed or if the models applied to other industries [93,94]. It is notable how there is an increasing number of case studies based

on the main adopting industries such as automotive, agri-food, and logistics, among others, which analyse the successes or the failures of some models and the main practices undertaken by companies to incorporate a CE.

Input/Output: This study focuses on obtaining and evaluating models in different enterprises. To do this, they usually look for an enterprise interested in incorporating CE and CLS in their production system, and then they make a model and evaluate the performance degree [95,96]. This kind of research is limited as companies are hindering the adoption of new models due to the changes they require in terms of technologies and structural and organisational changes.

Interviews: The main objective of reviewed questionnaires and structured interviews is to determine the main barriers to CE adoption in terms of psychological barriers, e.g., the adoption of a flow service system instead of property transmission and waste management in the most basic terms. The interviewing techniques allow information to be gathered from several different collectives and used to take measures that promote the evolution of a CE among the main public and companies. Some specifically structured interviews are being used, and the most common method is the use of open questions, especially when the interviewing is used to identify aspects incorporated by companies to foster the adoption of CE business models. Furthermore, at the same time, it helps to measure the degree of accomplishment felt by firms that publicly affirm to have actively embraced a CLS [97–100].

Material Flow Analysis: This looks to develop and grant the accuracy of a more structured, objective tool to measure the circularity effects at the micro, meso, and macro levels [101–103]. Current indicators are supported and based on the previous sustainability models. However, there is not really a specific and generally applicable tool to measure the efficiency of CLS in the triple bottom line [104–106]. For this reason, through these research papers, practitioners and scholars look to test every proposal introduced by worldwide researchers to consider them as a proper measurement tool. These papers are still subject to research limitations due to the unavailability of an official model of CEs. This limitation hinders the possibility of developing a detailed and universalizable model to measure circularity efficiency.

5. Discussion

Results evidence that the CE is still a research topic under development, and several issues deserve the attention of academics and practitioners.

Developing a CE model based on current knowledge is still an important research challenge that can only be addressed with the collaboration of experts from the world of science, technology, and engineering. For this reason, several researchers' works in BEM journals are directly linked to case studies aimed at measuring the degree of incorporation of different principles or practices of the circular economy, but which are not always clearly integrated with the business strategy or the business model, and which do not follow a standard framework.

Many of the papers analysed in this study could be considered general or low-specific since they rarely focus on concrete research questions. Instead, their main contributions are generally linked to literature reviews that are complemented with theoretical proposals that are not empirically validated, or case studies that are fuzzily linked to the CE. Moreover, most of the papers try to propose a self-standardized definition for the circular economy or CLS, definitions that are not governed by a different criterion than other existing definitions. Far from contributing to improving or standardising a single definition, the several definitions may be considered a threat to the development of the concept.

Research on CE primarily focuses on developing circular business models for the production or manufacturing industries, and there are few efforts aimed at conceptualizing or developing the concept within the service sector. In this context, the sharing economy arises as a way of developing the CE due to its harmonizing nature since it focuses on sharing those resources that users underuse and reincorporating them into the economy.

The sharing economy may therefore facilitate the incorporation of the CE because it may lead to the adoption of business models that are more circular than existing linear ones and that maximize the use of resources.

There are, therefore, several issues related to the CE's current and future development and its adoption by business and society. The rest of this section discusses those issues more widely agreed.

5.1. Circular Economy Challenges and Limitations

The literature review highlights some important limitations that should be considered in order to redefine and improve the current conception of a circular economy. Every statement analysed proposes an overall remake of every productive process from the extraction of raw materials to the end of the product's life. In this section, these topics are exhibited to show the main limitations of a closed-loop production system.

Firstly, there are several concepts based on enterprise modelling that consider production processing and after-sales support. However, there is not a focus on how society in general, including citizens, must perform to change from a linear economy to a closed-loop system. Under the same premise, there is a big barrier in terms of how the CE is conceptualised and conceived by people [107]. Remanufactured and refurbished products are negatively perceived [108] because customers consider them used without considering the durability or the increase in the lifetime cycle that takes place due to reprocessed products. This issue happens because of an educational lack of what the CE is and sustainability. As many different studies disclose [26,74,92], there is no specific knowledge on how to improve the efficiency and use of resources. Therefore, many pieces of research [109,110] explicitly state the necessity of educating people about the CLS and its advantages for both nature and human beings. People need to take a new approach concerning how beneficial refurbished products could be in their daily economy, as well as the essential reduction in harmful emissions implicit in their use. Therefore, it is fundamental for CE adoption and transmission to share the main principles and basis to overcome the current bias on the CE's definition. Following this path, some higher education institutions have started incorporating specific programs to overcome limitations. However, as other studies mention explicitly [34,111], there is no overall program to introduce alternative production and business models to the main public, which hinders the CE and CLS approaches to a really limited part of the population that looks for that knowledge by themselves.

5.2. Remanufacturing/Reprocessing

Recycling and remanufacturing materials and exclusive products require significant and high technology investments [112,113] to make it work properly. Many enterprises or organisations have not yet adopted the several machines and technologies required to process waste and recycled materials. There are no universalizable machines in many cases due to the specificities of each industry and developing those technologies could have a significantly high cost [114]. The lack of adoption is caused by the high investment in research and development required to design machines to process the products properly. Moreover, as the circular economy requires new processes and machinery, it is necessary to teach and train employees to ensure appropriate performance. Otherwise, those processes could be harmful to the environment instead of beneficial. These troubles would cause the wrong application of remanufacturing and incorrect material processing. If materials and energy are not adequately used, the environmental impact of reprocessing could be higher than that derived from the consumption of the inputs required to produce a new product.

Furthermore, a remarkable difference between the processes in the manufacturing and service industries hinders the adoption and generalisation of remanufacturing processes. More concretely, there is not a high development of reprocessing in the service industry due to the lower level of development of the CE in this kind of sector and a lower level of research too. A major part of the design of CEs for industry is based on the adaptations of models that are mainly designed for manufacturing.

5.3. Product and Material Retrieval

Linked to the previous information about remanufacturing and reprocessing, it is necessary to be able to retrieve and recover products and materials from being reused or reprocessed. CE models and their new economic approach provide an edge compared to the linear model. Several advantages come from its dissemination, especially the lengthening of the life cycle and citizenship awareness-raising of this while maintaining the expected performance. More concretely, consumers, customers, and end users must take care of the waste they produce and its correct processing (using the proper places to remove it). Aiming to ensure the correct processing, understood as the recycling and refurbishment of every material, people must return used products to the correct recycling bins, but, at the same time, and most important, it is necessary to share with the users of products the idea of zero waste. If people adopt the main principles of zero waste, they will start not just to act respectfully toward nature and use products properly but also increase their lifecycles and reduce the raw materials' use.

Nevertheless, there is not enough information concerning the importance of product retrieval; without it, there is no way of dealing with resources. As different authors state [23,34,45], many citizens and, in general terms, communities define themselves as high defenders of the CE. However, studies [43] highlight that citizens do not take an active role in CE diffusion or adoption, even though, in some cases, interviewed people do not even know what the CE is. Many practitioners from China and the EU, where some CLS policies have been extended as an alternative model to replace the linear economy, affirm that CE-based models have not been widely adopted. This lack of adoption is related to the fact that people are unaware of how important this transition is, generally because there is no compensation or retribution for recycling or retrieving products whose lifecycles have ended. Therefore, it is necessary to solve this problem through closed-loop systems' education and diffusion.

Nevertheless, it is important to mention that not every country has the same issues when retrieving some materials. Cases such as in the north of Europe, where aluminium cans and crystal bottles have a special tax that everyone must pay when purchasing a product, have been translated into a much higher recycling rate than those countries with no specific tax. Therefore, the introduction of fiscal and specific actions can help incentivise people to learn about how to recycle, and at the same time enforce them to do it, as in Sweden or Finland, where the cans must be returned to recover the specific tax.

5.4. Natural Materials or Highly Efficient Materials

Another critical focus of CE research is the development of more durable and efficient materials, which inevitably requires R&D investment. Many manufacturers and retailers are designing high-quality and technologically sophisticated products to be significantly more efficient. Remarkably, European Union countries and China are extending several research fundings to promote investigation in this field and to test new materials that can be better and more conscious of the environment in terms of the resources' use. However, some studies state that several technologically advanced products are sometimes less efficient than natural ones, which require much less energy and raw materials for their production. Therefore, manufacturing linear products may be more environmentally friendly in the short term as they can be collected from nature, extracted, and processed without difficulties with the existing technology, at least in the short term. Many new materials, which have a growing adoption among different industries, are more harmful in terms of their environmental impact than the existing ones. This is happening because some of these materials have been designed thinking about the maximum durability but it has not been considered as to how harmful their production could be compared to natural resources, which require much less specialisation. Definitively, as the CE is still emerging, it is necessary to carefully design and think about specific issues, such as the "materials that are going to be used in the future", as some studies disclose, in several different cases, that it was cheaper, faster, and more environmentally friendly to use natural resources

even if the amount of them was higher or the lifetime was shorter because these were not so harmful.

5.5. Community Knowledge and Responsible Behaviour

Another limitation of the CE concept is closely linked to one of the main strengths of a CLS. Concretely, two main problems are derived from longer product lifetimes. The first one is related to human behaviours and manners, inherently adopted from the current LE, that promote the purchase of different kinds of goods following a persistent pattern, also named fashion, and is currently one of the economic bases of the economic system. Under this premise, people purchase different items in short periods, even if previous products are still handy for them and can be used by them or other people in the form of second-hand or refurbished products. Nevertheless, citizens do not want to use them if they do not follow the social pattern. They discard them, aiming to buy another product with similar characteristics that companies promote as being accurate in terms of what is currently supported by different trademarks. However, the new product will follow the current fashion styles. The other trouble is not related to consumers but manufacturers, producers, and companies. LE assumes that the higher the sales are, the higher the profit.

Moreover, many researchers [23,43,115] have demonstrated that many businesses reduce the lifetime of their products deliberately, looking for growing sales. Therefore, since the CE and CLS increase a product's lifetime, introducing this system in the economy would reduce the number of products produced and sold, which may considerably reduce the sales and profits of companies. As can be seen, there are not only materials or technological process limits, but there are also some limitations in terms of the culture and the way ideologies and consumerism patterns are diffused. Therefore, as stated previously in this article, it is necessary to start diffusing this alternative production model to reduce waste and raw materials used.

5.6. Circular Economy Enablers

The results of this research indicate several papers related to the limitations of facing a CE [116–118]. Moreover, many researchers are publishing papers about real case studies accepting or rejecting CE conceptions. As the companies analysed by researchers exposed the good and bad ideas regarding barriers and enablers of CE, practitioners can argue which of the theoretically valid facilitators works. The first enabler identified is a valid and robust public policy to promote the CE adoption. This fact has been demonstrated in different case studies that analyse Chinese CE policies whose degree of adoption is still low but whose importance globally is becoming more significant [34,78,119]. At the same time, it is necessary to highlight the effort made by different European countries thanks to the different policies and research institutions that foster the inclusion of alternative business models. For example, the program to facilitate the inclusion of the CE fostered by the European Union focused on changing the production and consumption patterns of citizens and companies. Nevertheless, there is still a big lack of standardised frameworks to develop the CE in different companies and industries. Moreover, there is no guidelines as to the best practices in the sector, which would create a framework on which different businesses could base their actions to start applying a sustainable strategy.

Secondly, some practitioners have adopted a position of highlighting industrial ecology collaboration to help CE adoption. Many practitioners state that this definition is not only more complete than the CE concept but itself contains the CE and sharing economy. Therefore, following the ideas of different researchers, it would be necessary to develop this term through the community and educate them to facilitate the diffusion.

Finally, developing a system of indicators is necessary because it may allow us to measure the degree of performance in the sustainable field and benchmark them among different businesses or countries. Then, it is important to encourage enterprises and public entities to perform appropriately to be on an acceptable level.

5.7. Public Policies: The Chinese CE Stimulation Policy

Another approach is the dissemination and expansion of the circular economy in China. This kind of research is becoming one of the most highly trending research topics in the CE field. Nevertheless, this is not just happening because of the growing importance of China's economy but because of the big effort that this country is making to transition from a linear model to a circular one.

Many researchers have pointed out that the Chinese latecomer [120,121] is one of the most influential characteristics and advantages of Chinese policies' because it allows the development of new economic systems without committing any of the mistakes of previous economies. As China's industry is one of the most powerful in the world, thanks to other countries' outsourcing, they have the opportunity to invest their benefits in developing technologies and new systems to face the currently established LE. Moreover, the government is highly promoting the CE in its industries. Concretely, and looking at the different laws and recommendations made by the Chinese government, there have been several propositions to encourage a CLS adoption. For example, we can look at the law approved in 2009 by the Chinese government to promote sustainability in the industry. China's Circular Economy Promotion Law has been valid since January 2009 and looks for more sustainable behaviour in businesses and throughout the entire Chinese society. As China's population is increasingly growing and its industries are very active, it has been necessary to plan alternatives that allow for reducing GHG emissions and increasing energy use. As has been argued, a circular economy is the sustainable development model that China is trying to adopt.

Nevertheless, some studies [41,120,121] determine that Chinese policies are not as effective as they are trying to promulgate among the rest of the world. Those policies have been designed by the government but have not been adopted by any industry. Furthermore, different researchers have taken some Chinese enterprises and some eco-designed clusters to analyse them and determine the degree of adoption. As a result, many of those enterprises have adopted a CE. However, there are some notable limitations, as shown previously, that slow down its implementation.

6. Conclusions

The present article aims to analyse the current state of CE research in the BEM areas of knowledge. To reach this goal, a bibliometric review with a sample of 962 articles and a content analysis of 296 of the total 962 articles was performed.

The bibliometric analysis shows the main active investigations being addressed in CE research within the BME areas of knowledge, as well as those that remain uncovered or with a lesser degree of investigation. After analysing the articles, findings show that the main participation occurs in the science and technology area of knowledge, whereas business, economics, and management occupy the second position. As CE business models are still developing, joint research among disciplines is necessary to support CE growth and create a tool to measure its effects. Following the results, this research, which has mainly been developed from 2009 to now, but specifically since 2018, is being developed mainly in European countries, China, and the USA. Countries with several policies, funds, and regulations foster the development of alternative business models to reduce pollution and better manage materials and production waste. Those aspects have also been confirmed by the bibliometric analysis of keywords, highlighting the main topics of CE research: recycling, sustainable development, waste management, life cycle assessment, and the industrial ecology.

From those results, the analysis takes a deeper level of detail, focusing on the systematic review to obtain knowledge of the specific topics covered by CE research and the main constructions and pillars of the BME areas. From this perspective, researchers are currently trying to cover the main lack of the CE in BME areas.

One of the most important research gaps comes from a managerial perspective and is the absence of generally applicable guidelines or instructions to adopt a circular business

model or a CLS in manufacturing industries. As the CLS is innovative and there is neither enough technology nor processes developed, it is difficult to spread such an innovative system. Therefore, articles reveal that the inexistence of a universal model or path to follow is not allowing for the further development of the CE from a managerial perspective, explaining the existent delay in CE adoption.

Another important research gap is related to the official definition and conceptualization of the CE, despite several statements and theories based on different streams of knowledge. The current state of the art applications bring to light that there is no agreement to settle on a universal and official definition. This aspect also determines why businesses and companies are not embracing the CE so easily. Companies and citizens cannot apply their principles to daily life and activity because the general public does not know what the CE is. Translated into the business world, companies are hindering the adoption of a CE not just for the lack of an official model but because of the absence of a specific definition that limits managers' ability to make decisions due to a lack of knowledge.

Finally, it is important to remark on the fact that several different findings have been found derived from the analysis that brings information about the current interest and perspectives of CE research: the failure at the moment to retrieve materials from citizens and businesses to be recycled and refurbished, and the use of energy and the processes followed to recycle materials. Other problems are related to the fact that many products are linked to fashions and tendencies, making it challenging to promote the CE in these industries, as it is difficult to change the mass interest in these products to those previously used and restored to have a higher life cycle. Additionally, some cannibalisation problems are derived from the higher number of lengthened life cycles thanks to the increased quality of the materials and to the new design of products to make them more durable and efficient. Finally, related to the CE's diffusion, there is a substantial limitation on sustainability in education and specifically on circular economy models, which must be rectified to promulgate the CE's principles among the population.

These findings may, however, be conditioned by some of the limitations of this study. On the one hand, only 962 articles have been analysed, so that some studies could be left out of the study. On the other hand, the employed methodology is based on the authors' information analysis, and biases may arise due to the subjective interpretation of the information, search terms chosen, and the specific criterion detailed in the Methods Section.

Although many researchers from science and technology fields are highly engaged, there is still limited economic research on the circular economy as a future business model and its impacts. This fact opens a knowledge gap that could be interesting to analyse in detail: why is there such a low level of economic researchers publishing about the actual economic effects of the CE? Other future research opportunities are related to widening the sample by using a less restrictive query in WOS or by incorporating other sources. It could also be possible to use other methods for content analysis that would complement those employed in this work to enhance the validity and detail of the results.

Related to the contributions of this work, this paper contributes to the goal of gathering information about the state of the art applications of the circular economy; its main purpose being to classify the current CE BEM research based on the main themes and findings, and to expose, as well as identify, in the form of the highlights and main topics, the main research aspects of the CE in BEM fields. Another remarkable aspect of the research is related to the findings that reveal how the BEM state of research on the CE is still at a low level, but it can be supported by several different areas to be a part of CE research in a multidisciplinary investigation.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14148306/s1, Table S1: Highlighted main findings sources from the Literature Systematic Review; Table S2: Systematic review table with some examples.

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