

Development in the Circular Economy Concept: Systematic Review in Context of an Umbrella Framework

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Abstract: Even though the traction towards a circular economy (CE) is on the rise, and the benefits a CE has across ecological, economic, and social frontiers have been undeniable, still, CE-related developments and its adoption have not been appealing. This study conducts a systematic literature review of the CE-related literature in line with the ‘umbrella framework’ to find the current state of the diffusion and diversification of CE concepts both in the academic context as well as in application. Using a thematic and content analysis of the sampled literature, the study (i) develops a comprehensive and inclusive CE definition and (ii) examines the level of diffusion of CE in the economy. The study concludes that, even though CE-related developments are positive and promising, it is still in the validity phase of the umbrella framework and recommends focusing more on the application-based intervention of the CE.

Keywords: circular economy definition; circular economy development; umbrella framework; circular economy confusion



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1. Introduction

Irresponsible and unethical consumption has disharmonized the exchange of resources between the economy and the environment. It would not be wrong to say that our over-consumption of resources has pulled us into a state of resource deficit with an alarming ramification across the social, economic, cultural, and environmental frontiers. The circular economy (CE) has appeared as an innovative approach to resource utilization with an emphasis on the ethical and more rational use of these resources. Focusing on factors like extending the life of resources and maximizing the value of resources would help to keep resources within the loop of production and consumption (P&C) and could reduce the pressure on the existing stock of resources. A shift from this contemporary and prevalent linear economy (LE) mode of consumption, which focuses on take–make–dispose, to the circular concept of take–make–reuse methodology is a mandate to achieve sustainable development.

Even though the CE concept is gaining traction in the national as well as global arenas, the domain still has not diffused well; [1] conducted a comparative analysis of the perception and awareness regarding the CE between Nepal and the USA, which concluded that respondents across the sampled countries were unaware of the CE and its implications for their organization. Similarly, a survey by Liu et al. [2] in China concluded that the respondents thought of CE as a waste-management approach which defines their limited awareness of the CE philosophy; and in the Netherlands, only 9% of the respondents claimed to have exact knowledge of the CE [3].

1.1. Origin of the Circular Economy Concept

The literature has not precisely stated the origin of the CE concept; the circular domain was inspired with the manifesto of preserving natural resources and focuses on the concept of a cyclical closed-loop system [4]. Though the term circular economy was not precisely coined in early ages, enough literature could be found which focused on resource conservation, and these could have been the building blocks for the evolution of circular economy principles.

Winans et al. [5] writes that the U.S. professor John Lyle, William McDonough, German chemist Michael Braungart, and Walter Stahel were the originators of the concept. Luis and Celma [6] stated that Walter R. Stahel and Genevieve Ready were the first to establish the concept of CE in 1976. Pearce and Turner [7] formally introduced the CE concept in their economic model, where they stated the three economic functions of CE, those were, environment-resource supplier, waste assimilator, and source of utility [8]. The world expressed its concern for environmentalism when the Brundtland Report WCED (1987) stressed the sustainable development and emphasized the need to work globally on eliminating unsustainable practices so that we can take care of our future generations. Winans et al. [5]) noted that Silent Spring by Rachel Carson, the thesis of the Club of Rome entitled The limits to growth, and Barbara Ward and Kenneth Boulding's metaphor of spaceship earth had inspired the bringing of the concept of CE. Cautisanu et al. [9] wrote that whereas the concept of sustainability was initiated during the 1990s, the evolution of circular philosophy has been just a decade in discussion.

Murray et al. [4] claimed that in 1996 Kenneth Boulding was the first to shed light on circular ecology. In China, the concept of the CE was first proposed in 1998 and was formally accepted by the central government as a new development strategy in 2002 [10]. Mas-Tur et al. [11]) also echoed that the CE was first proposed in 1998 by Chinese academicians and adopted by the government in 2002. China has integrated the concept of the CE for the sustainability in their 11th and 12th "Five Year Plan" [4]. Homrich et al. [12] describes China to be dominating CE-related publications globally. China significantly used circular philosophy to reduce the pressure of its economic developmental policies on natural resources [13].

1.2. Academic and Non-Academic Developments in a Circular Economy

A paper by Homrich et al. [12] to assess the trends and gaps on integrating pathway of circular economy listed six journals that most published CE-related papers, to name some: *The Journal of Cleaner Production*, *Resources Conservation and Recycling*, *The Sustainability Journal*, and *Journal of Industrial Ecology*, and it was noted that the number of publications related to CE has increased since 2013. The count of research papers related to CE is on rise, in comparison to 30 in 2014, the published papers reached more than 100 in 2016 [14]. Mas-Tur et al. [11] adds that the annual publication related to CE increased from 4 in 2006 to 809 in 2018. A Scopus search on CE terminology shows a 50% increase in academic publication over past five years and significant growth was observed between 2015 and 2017 [15].

Though the concept of the CE was initially introduced by the Western scholars, later the Chinese scholars profoundly worked on the CE domain after gaining support from their government [16]. The Delft University of Technology (Delft, The Netherlands) and Chinese Academy of Sciences (Beijing, China), respectively, are the most productive and influential institutions in conducting CE-related publications; meanwhile, China tops the position of being the most productive and influential country in CE related publications followed by the UK, Italy, Spain, the Netherlands, and the USA [11]. The period of 2004–2015 was dominated by Chinese scholars [16].

Winans et al. [5] noted multiple incentives and models that would foster the inclusion of the CE, while countries like Japan and Singapore focused on the creation of the eco-city. Germany in the early 1990s aimed the management of resources and raw materials through CE principles, and China in the late 1990s promoted the concept of eco-industrial parks. In

the context of North America, the CE philosophy was used to perform reduce, reuse, and recycle programs and to conduct product lifecycle studies. In North America, corporate houses were found to be taking active approaches to incorporate the circular philosophy in their operations and strategy while the regulatory institutions have been inactive to the CE.

Though the circular concept came to existence before 1990, it was popularized by think-tanks like the Ellen MacArthur Foundation (EMF) [17]. The EMF (2013) [18] has played a crucial role in the development of the CE in the global platform. NGOs and INGOs across the globe like the World Economic Forum (WEF), United Nations, and business consulting firms like McKinsey & Company, Circular Economy, Accenture, KPMG, and Deloitte are also producing with numerous research works in the field of the CE to support the transition from the LE to the CE. In 2018, the EMF in collaboration with various government and non-governmental agencies initiated the platform for Accelerating the Circular Economy [19]; the sole purpose of the collaboration was to bring the governmental, non-governmental, and big business houses together for a commitment towards the implementation of the CE.

1.3. Conceptual Development in Circular Economy

Numerous scholars and practitioners were found using terminologies that infer a CE. Pauliuk [20] writes, over the last decade, the CE has gained significant traction to decouple economic development with natural resources. The CE has become a hot topic of discussion amongst the businesses, governments, academicians, and NGOs [21]. With the passage of time, the domain of the CE has proliferated, it started with the environmental concern, then incorporated economic domains and now has encapsulated the social aspects [4].

In fact, Kirchherr et al. [22] writes, the meaning and the use of the CE could be different to different people and this *circular economy babble* often creates confusion in materializing the precise definition of the CE. The CE has been evolving throughout time and is based on multiple domains and schools of thought [23]; with the passage of time, numerous scholars across different disciplines have written literature on the circular economy which has influenced our understanding of the CE [24]. Garces-Ayerbe et al. [25] stated that the CE concept is novel and is emerging.

The concept of the CE which started with waste management and the end of life cycle (EOL) has now incorporated a diverse field; numerous scholars have focused on managing the resources life cycle extension (RLES) and circular design strategies. A CE helps to bridge the gap between the waste and the resource management. Contrary to the LE, which focuses on cradle-to-grave, CE emphasizes on cradle-to-cradle [26]. Braungart and his team came up with the philosophy from “cradle-to-grave” to “cradle-to-cradle”, and Stahel put forth the concept of a closed-loop strategy [27]. The CE promotes cyclical thinking, instead of having an open-ended conception of value-added chain, CE focuses on the minimization of the use of the virgin materials [28]. Ghisellini et al. [29] asserts that the increasing attention the CE is gaining globally by promoting a closed-loop strategy can achieve resource efficiency.

Yuan et al. [10] wrote, CE is beyond ecological orientation and also precisely stresses economic opportunities that could be achieved from the CE. It is a transdisciplinary domain which has evolved through and envelopes numerous supporting ideas. The CE focuses on the restorative and regenerative cycle in contrary to an LE which is defined as a cowboy economy by Boulding [30] which emphasizes on the take–make–dispose. Waste is seen as a resource and no waste exists in a circular concept [31].

The CE is based on three principles: (a) design out waste and pollution, (b) keep products and materials in use, and (c) regenerate natural systems (EMF, 2013). [32] described the CE as a cyclic system where the goods after their end of life are turned into resources for others. Murray et al. [4] alerts us to the infancy of the CE domain and stresses the requirement of definitions which incorporate ecological and social benefits. Since the time of inception, the domain of the CE has been diversifying and cocooning numerous concepts from diverse domains, often creating confusion.

The circular economy is a multidisciplinary domain which is inspired by and evolving through incorporating numerous schools of thought [33,34]. Antikainen et al. [35] asserts ecological economics, environmental economics, and industrial economics have been antecedent to the development of the CE concept. Concepts like *The Natural Step* in 2020 by Karl-Henrik Robèrt, *Product-service systems in 2006* by Arnold Tukker and Ursula Tischner and *Cleaner Production* in 2004 by Richard S Stevenson and J. Warren Evans were cited in Borrello et al. [33] to highlight their importance in the development to the CE. Along with the passage of time, numerous scholars have provided CE definitions and it could be inferred that the dimension of the CE has been diversifying and inclusive since then.

1.4. Studies Related to the Concept and Taxonomies of the Circular Economy

With traction increasing in the CE field, the research related to CE is gaining momentum [33,36]. The number of publications related to the CE has increased significantly since 2017 [37]. An online search of the CE produced 20,570 results in 2008, which as of now extracted 5.74 million results [38]. Most of the academic research follows bibliometric analysis [6,16,37,39,40] whereas the researchers Alhawari et al. [41] and Friant et al. [38] carried systematic literature reviews with critical content analysis. Further, the number count of peer-reviewed paper in the databases (Scopus, WoS, Google Scholar, ScienceDirect) is also increasing significantly. A time-range categorization of CE concept development has been carried out along with the incorporation of the *umbrella concept* to assess the growth and proliferation of CE concepts across time ([6,16,37–40]).

1.4.1. Circular Economy

The CE is based on three distinct principles, [42]: (a) Preserve and enhance natural capital by controlling finite stocks and balancing renewal resource flows; (b) Optimize resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles; (c) Foster system effectiveness by revealing and designing out negative externalities. The CE is about restoring, renewing, and revitalizing through the integration of a natural process along with community and human actions. CE is the linking element between the economic growth and environmental issue Cautisanu et al. [9] which leads to sustainability. Peck [43] of Delft University stated the principle of the CE as waste is equivalent to food, building resilience through the diversity, energy from the natural resources, and thinking in systems. The features of CE include a low emission of pollutants, high efficiency, and low consumption of energy [44]. The CE is beyond waste management, it is about managing the resources with an aim to reduce waste [1]. It is practiced from the designing phase of a product and service rather than waiting until the end of the product (EOL) or service lifecycle.

Numerous frameworks have been defined and designed to explain the circularity and its business strategies. Centobelli et al. [45] stressed companies' capacity to design business models for sustainable development that reduce the consumption of natural resources and preserve the environment. Bianchini et al. [46] analyzed multiple circular business canvases on the basis of evaluation criteria like: (a) ease of understanding, (b) correspondence to real situations, (c) useful representation of circular initiatives, (d) quantification of the circularity grade of the initiatives and adaptation of the model to every product, and (e) industrial sectors. Amongst the circular canvases studied like the Accenture circularity model, moon fish model, Reike model, EIT, and Ellen MacArthur Foundation (EMF); the EMF ranked in the highest position.

The EMF model explicitly illustrates the core of the CE through a *butterfly diagram*. Figure 1 illustrates the CE procedure for technical, as well as biological, products. Whereas the technical cycle focuses on the reuse, remanufacture, refurbishment, and recycle of technical products, for example televisions, computers, automobiles, et cetera, the biological cycle emphasizes the regeneration of biological outputs like gas and compost, and the examples of biological products include vegetables, rice, meat, et cetera.

OUTLINE OF A CIRCULAR ECONOMY

PRINCIPLE

1

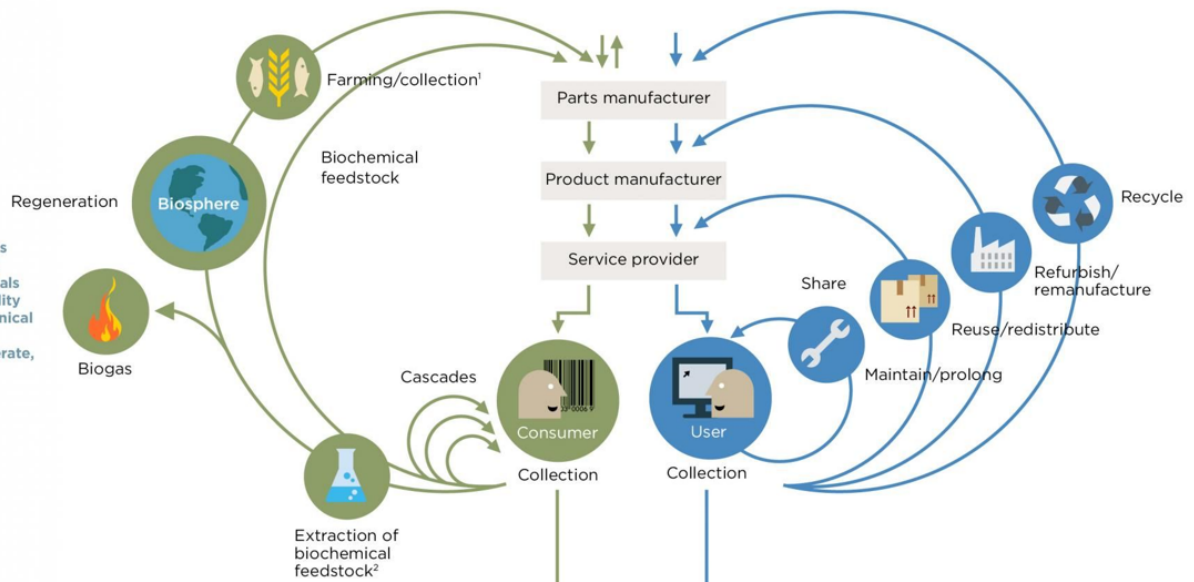
Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows
ReSOLVE levers: regenerate, virtualise, exchange



PRINCIPLE

2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles
ReSOLVE levers: regenerate, share, optimise, loop



PRINCIPLE

3

Foster system effectiveness by revealing and designing out negative externalities
All ReSOLVE levers

Minimise systematic leakage and negative externalities

1. Hunting and fishing
2. Can take both post-harvest and post-consumer waste as an input
Source: Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braungart & McDonough, Cradle to Cradle (C2C).

Figure 1. Butterfly diagram. Note. The butterfly diagram illustrates the importance of circular loop strategy, [47] EMF (2015).

In each of the cases (biological and technical), the maximum focus is given to the looping of the products back to the production and consumption cycle. The closed-loop cycle which is based on the cradle-to-cradle philosophy concentrates on product/material efficiency for maximum product utility and product life extension [48].

1.4.2. Importance of the Circular Economy

The CE focuses on the healthy and ethical use of natural stock and offers numerous advantages to individuals, businesses, and countries involved. Its modality can be implemented across the micro, meso, and macro level in an economy. The International Resource Panel (IRP) forecasts the raw material use to reach 170–180 billion tons by 2050 [49]. This is beyond the resource generation capacity of the Earth; it takes the Earth one and half years to regenerate what we use in a year [50]. Grdic et al. [51] asserts that the implementation of the CE not only brings economic gains but also preserves the environment and reduces the consumption of natural resources. Temesgen et al. [52] pointed to the CE as a common hub solution to curtail the global problems encountered from the over-exploitation of resources, climate change, and pollution of the environment. Ethirajan et al. [53] noted the CE to be the proven solution to tackle resource scarcity and the huge amount of waste created. The CE is driven by two fundamental goals; retaining the value of the materials by keeping them in circulating for a longer time and increasing the overall material efficiency [54].

The CE helps in creating a balance between the increasing demands of goods and services and their negative impact on the environment and society [55]. Velenturf and Purnell [56] noted the capacity of the CE to better use resources through the use of technology. The CE could bring numerous viable options in terms of social, economic, and ecological advantages to reduce the voracious consumption of these materials. The CE is not related to one specific domain or an industry; it is a transdisciplinary approach which can be practiced across multiple industries [34]. CE-based product design supports multifunctional goods, extends their life cycle, and emphasizes intelligent and smart manufacturing which could support the economic agenda in the post-COVID period [57]. Transition to a CE brings benefits through the minimization of pollution and climate emissions, preservation of natural systems, increased competitiveness and new markets for an organization, and social benefits like employment opportunities. The implementation of a circular model would bring millions of green jobs, alleviate pollution, lessen the risk of damages on the environment, and importantly reduce the dependence on raw materials. *Circular Economy* [49] stated the global economy is only 8.6% circular and the findings from the research vehemently emphasized that the global community must integrate circularity for the *common good*.

2. Methods and Design

This study is an extension of the umbrella framework by Blomsma and Brennan [39], which is further studied by scholars like Friant et al. [38], Hirsch and Levin [40], and Homrich et al. [12]) to assess the current state of the adoption of CE developments. The umbrella framework connects the previously unrelated concepts by drilling the commonalities that may prevail in those concepts [39]. The umbrella framework by Hirsch and Levin [40] as shown in Figure 2 splits the development of CE concepts into distinctive stages like a preamble followed by excitement and validity challenge. Any evolving theory in the market after a certain period of interaction could either be adopted, rejected, or end up maintaining the status quo [39,40].

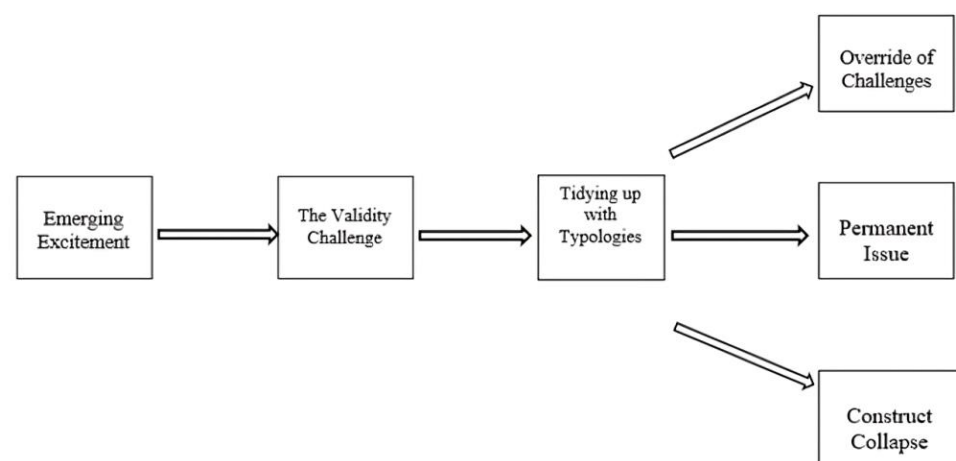


Figure 2. The umbrella framework for the assessment of CE development.

After defining an appropriate time frame to categorize and interpret the CE-related developments, this research design has emphasized examining how well the circular concepts have been adopted in the market in respect to the *umbrella framework*. The final conclusions are made to state the current position of CE development in regards to the *umbrella framework*. This study focuses more on the literature published from 2016 onwards until the middle of 2021.

Initially, a systemic literature review (SLR) technique based on the keywords was incorporated on the basis of the tag words like *circular economy*, *circular concept*, *taxonomy*, and *development* (see Figure 3). The snowball technique ([38–40,58]) on Google Scholar database was employed to select literature. The findings from Luis and Celma [6] which

identified the most significant authors, publications, and thematic structure output related to CE, were also considered. All of the extracted articles were manually screened and scanned for duplication and relevancy of information, and influential papers for achieving the objectives were kept in an Excel file.

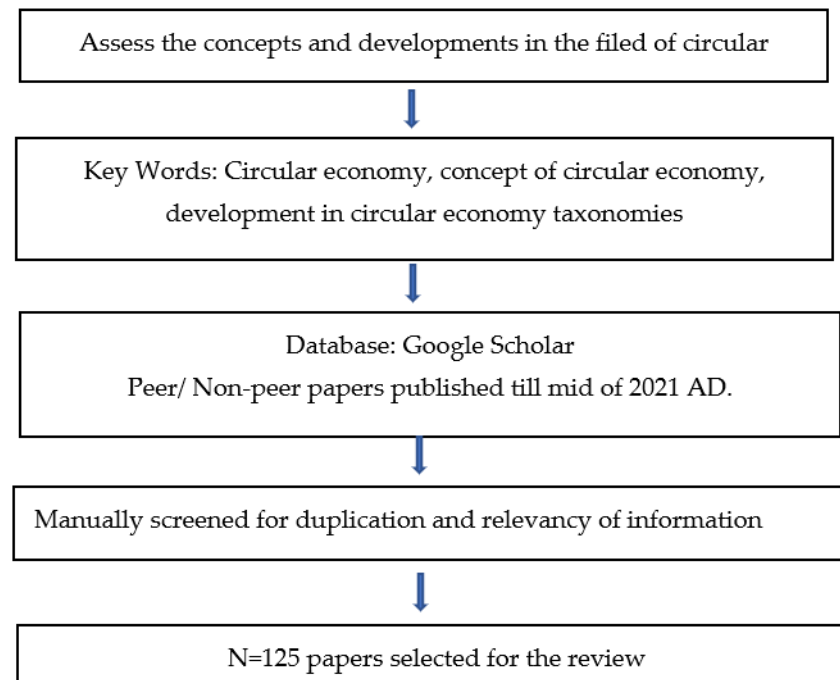


Figure 3. Steps involved in literature review.

Through the use of Nvivo12, important contents were noted in each sampled paper chosen for the study. For better clarification and classification, nodes were created with each unique theme. Depending upon the requirements, sub-nodes were also established. These nodes were compared across the time period to assess the development in the field of the CE. The cross-pollination of ideas across the sector favored filling the existing literature review gap [38]. The study is divided into two sections.

In the first section, the taxonomical development in the definitions of the CE was assessed and analyzed. After sorting the CE definitions for which the snowball sample collection technique was used, themes were generated. These themes and sub-themes were entered into Nvivo to carry out further thematic analysis. Qualitative assessments like a word cloud, the relation between the nodes, and the focus of sampled papers along the horizon of time were conducted in a chronological pattern. This provided a clear picture of the CE definitions' development across the period. And finally, a CE definition was proposed. In the second section, the development of the CE concepts and the applications of the CE was studied across the horizon of time. Finally, after the critical analysis and assimilation of the sampled papers, a decision in line with the umbrella framework was made on the development of the CE.

3. Discussion

The CE concept has become more popular since 2015 Alhawari et al. [41]; the number of scholarly papers related to the CE has significantly increased since 2015 [59]. Table 1 summarizes the number of publications in Google Scholar with the tag word "Circular Economy" and "Application of circular economy." From Table 1, it could be inferred that there has been a significant increase in the number of publications related to the concept of the CE. The count has increased to 21,800 by mid-July 2021 from just 493 in 2000 but the study associated with the application of CE has been minuscule; these could also have been a reason for the slower adoption of CE. After the establishment of the EMF, there

has been prominent and noteworthy advancement in the implementation of the CE [39]. Throughout the period, numerous scholars, think tanks, and consulting firms have offered definitions of the CE.

Table 1. Number of circular economy-related publications.

Year	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 July Mid
Circular Economy No of Publications	493	2140	3800	3700	3870	3510	3360	4720	6760	10,200	14,700	20,800	26,600	21,800
Application of Circular Economy No of Publications	7	58	57	59	42	26	21	26	19	51	94	125	201	103

3.1. Analysis of Development in CE Definition

To carry out content and thematic analysis, the sampled definitions of the CE were chosen through a snowball technique. The snowball technique continues the collection of samples until the researcher obtains a sufficient number of needed pieces (Goodman, 1961). The following section lists 27 CE definitions (chronological order) that were thought to be impactful by the researcher during this study and later processed in Nvivo12 for further assessment.

Wen et al. [60] wrote “Circular economy and eco-industry are effective ways to solve sustainable development problems on resources, the environment, and the economy” (p. 1).

The CE was defined by Yuan et al. (2008; as cited in Homrich et al. [12]) as follows:

The circular economy is a political strategy aiming to alleviate resource scarcity and reduce pollution, so it is essential to find effective ways to educate or train people so that they can implement the concept into their everyday work and life (p. 30).

The CE was defined by Geng et al. (2009, as cited in Grdic et al. [51]) as “An economy is based on a spiral loop, i.e., a system that minimizes matter, energy flow, and environmental deterioration without limiting economic growth or social and technical advancement” (p. 2).

The CE definition, as stated by the [61] EMF (2013), reads:

[CE] an industrial system that is restorative or regenerative by intention and design. It replaces the ‘end-of-life’ concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims to eliminate waste through the superior design of materials, products, systems, and, within this, business models (p. 7).

As cited in Homrich et al. [12], the CE is defined by Su et al. [62]. (as follows: “The circular economy can be defined as an economy type with a closed-loop of materials, which is opposite to the traditional open-ended economy” (p. 29)).

As stated by Nguyen et al. [63]:

The circular economy aims to eradicate waste—not just from manufacturing processes, as lean management aspires to do, but systematically, throughout the various life cycles and uses of products and their components. Indeed, tight component and product cycles of use and reuse, aided by product design, help to define the concept of a circular economy and distinguish it from recycling, which loses large amounts of embedded energy and labor (p. 5).

Ref. [64] define the CE as follows:

The CE is a crucial way to protect the environment and resources and to achieve sustainable development; it can transfer a traditional linear growing economy that depends on resource consumption into an economy that relies on the development of ecological resources circulation (p. 488).

The CE, as defined by Haas et al. [65], reads “The circular economy is a simple but convincing strategy, which aims to reduce both input of virgin materials and the output of wastes by closing economic and ecological loops of resource flows” (p. 765).

Ref. [66] defined the CE as “A concept associated with the idea of closed-loop systems and economies, where wastes are put back into the system to become resource inputs for production processes” (p. 220).

The CE definition by Franklin-Johnson et al. [67]: “The center of CE is the circular flow of raw materials and energy consumption in multiple phases”.

The CE, as defined by Geissdoerfer et al. [14]: “CE is a regenerative system in which resource input, waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” (p. 759).

The CE definition by Murray et al. [4] states it is “An economic model wherein planning, resourcing, procurement, production, and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being” (p. 369).

The CE definition by Kirchherr et al. [22] states the following:

A circular economy describes an economic system that is based on business models which replace the ‘end-of-life’ concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso station (eco-industrial parks), and macro level (city, region, nation and beyond), to accomplish sustainable development, which implies creating environment quality, economic prosperity and social equity, to the benefit of current and future generations (p. 229).

The CE definition by Hollander et al. [31] is as follows:

In a circular economy, the economic and environmental value of materials is preserved for as long as possible by keeping them in the financial system, either by lengthening the life of the products formed from them or looping them back into the system to be reused (p. 517).

The CE definition by Ionescu et al. [68] is as follows:

The CE supports the harmonization of human needs for sustainable long-term development by optimizing resource usage so that you consume as little and re-use as much as possible. Optimizing natural resource use reaches a balance threshold where the number of natural resources consumed net does not endanger their rhythm of natural restoration for future generation needs (p. 101).

Winans et al. [5] defined the CE as “A central theme of the CE concept is the valuation of materials within a closed-looped system to allow for natural resource use while reducing pollution or avoiding resource constraints and sustaining economic growth” (p. 825).

The CE definition by Homrich et al. [12] states that “CE is a strategy that opposes the traditional open-ended system, aiming to face the challenges of resources and waste disposal in a win-win approach with an economic and value perspective” (p. 19).

The CE definition by Prieto-Sandoval et al. [69]. is as follows:

The CE is an economic system that represents a change in paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated into symbiosis), and macro (city, regions, and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in how society legislates, produces, and consumes (p. 610).

The CE as per Korhonen et al. [70] is as follows:

The CE is a sustainable development initiative to reduce the societal production-consumption systems’ linear material and energy throughput flows by applying materials cycles, and renewable and cascade-type energy flows to the linear system. The CE promotes high-value material cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers, and other societal actors in sustainable development work (p. 547).

Figure 4 shows terminologies like resources, system, energy, material, consumption, economic, et cetera, which were frequently referred to in CE definitions. At the same time, terminologies like micro, meso, macro, social, and innovations were also referred to but in a lesser frequency. From this word cloud, we can report that the definition of CE is diversifying and diffusing; numerous newer terminologies are evolving. While multiple authors refer to the languages like economic and environmental, the social factor of CE has not been incorporated in the definitions. Out of the 27 samples, only 2 definitions by Kirchherr et al. [22] and Korhonen et al. [77] have included the impact of the CE on the social frontier.

Further nodal analysis was conducted in Nvivo to explore the themes generated across the sampled CE definitions; authors were found quoting the CE's environmental and economic dimensions more frequently than the social dimensions. Likewise, the CE was referred to as the strategy and approach for achieving sustainable development. A few authors referred to terminologies like business model, reverse logistic, and a moderate use of language like waste management, design focus, value enhancement, and geography.

Table 2 lists 14 main themes (nodes) and subsequent sub-themes, along with the number of papers that have referred to those themes. It was observed that the CE was mostly defined as a closed-loop strategy and a strategy to balance people, profit, and the planet. It was noted as a strategy by 14 authors out of 27. In the same way, the CE was described as an approach that included terminologies like responsible, decoupling, and system approach. Nine of the papers highlighted the CE to help save resources and materials. Five scholarly papers were found stressing life cycle management and the life extension strategy to enhance the value of resources through the CE. The same number of documents pointed to the CE as a cleaner production and waste-management medium. Eight papers defined the CE as a modality to achieve sustainable development. Moreover, eight, four, and two scholarly articles represented the CE as a modality to manifest environmental, economic, and social gains. Further, four definitions were design-focused and attributed the CE as a restorative and regenerative approach. A territorial system to the CE was incorporated for four purposes where the papers talked about micro, meso, and macro-level CE activities and inclusions. Finally, terminologies like business model, reverse logistic, and political strategy have also evolved around the CE definitions.

Table 2. Taxonomical analysis of CE definitions.

S. No	Terminology (Node)	Associated Words (Themes)	References
1	Strategy	Closed-loop, three P's	14
2	Approach	Decoupling, responsible approach, system approach	9
3	Resources		9
4	Environmental dimension	Environment, environmental innovation, GHG, renewal energy	8
5	Sustainable development		8
6	Geography	Significant level scope, macro, meso, and micro level	5
7	Value enhancement	Life cycle management, life extension strategy	5
8	Waste management	Clean production, waste minimization	5
9	Designed focused	Design, restorative, and regenerative	4
10	Economic dimension		4
11	Social dimension		2
12	Business model		1
13	Political strategy		1
14	Reverse logistic		1

Each node was further introspected along the horizon of time and respective literature. Table 3 lists the names of papers that used specific themes to define the CE. We can see that throughout the time duration, the definition has enhanced its scope. Some authors have seen it as an approach to obtain resource efficiency, some as a method to achieve sustainable development, some have focused on the environmental dimension, some on the economic, and some on the social implication of the CE.

Table 3. Exploring each theme of CE definition.

Nodes	Referred Papers
Approach	Murray et al. (2017) [4]; Moraga et al. (2019) [36]; Nguyen et al. (2014) [63]; Corona et al. (2019) [72]; Seroka-Stolka and Ociepa-Kubicka (2019) [73]; Korhonen et al. (2018) [77]; EMF (2013) [18]; Prieto-Sandoval et al. (2018) [69]
Business Model	Kirchherr et al. (2017) [22]
Design Focused	Geissdoerfer et al. (2017) [14]; Prieto-Sandoval et al. (2018) [69]; Suárez-Eiroa et al. (2019) [74]; EMF (2013) [18];
Economic Dimension	Winans et al. (2017) [5]; Homrich et al. (2018) [12]; Kirchherr et al. (2017) [22]; Hollander et al. (2017) [31]
Environmental Dimension	Kirchherr et al. (2017) [22]; Hollander et al. (2017) [31]; Wen et al. (2007) [60]; Wang et al. (2014) [64]; EMF (2013) [18]; Sandoval et al. (2018) [69]; Seroka-Stolka and Ociepa-Kubicka (2019) [73];
Geography	Yuan et al. (2008) [10]; Kirchherr et al. (2017) [22]; Wen et al. (2007) [60]; Prieto-Sandoval et al. (2018) [69]; Suárez-Eiroa et al. (2019) [74]
Political Strategy	Yuan et al. (2008) [10]
Resources	Winans et al. (2017) [5]; Yuan et al. (2008); [10]; Homrich et al. (2018) [12]; Alhawari et al. (2021) [41]; Wen et al. (2007) [60]; Ionescu et al. (2017) [68]; Velenturf et al. (2019) [71]; Kristensen and Mosgaard (2020) [76]; Geng et al. (2009) [78]
Reverse Logistics	Kazancoglu et al. (2020)
Social Dimension	Kirchherr et al. (2017) [22]; Korhonen et al. (2018) [70]
Strategy	Winans et al. (2017) [5]; Kirchherr et al. (2017) [22]; Hollander et al. (2017) [31]; Moraga et al. (2019) [36]; Alhawari et al. (2021) [41]; Su et al. (2013) [62]; Haas et al., (2015) [65]; Balanay and Hlog (2016) [66]; Franklin-Johnson et al. (2016) [67]; Korhonen et al. (2018) [70]; Corona et al. (2019) [72]; Kristensen and Mosgaard (2020) [76]; Geng et al. (2009) [78]; Kazancoglu et al. (2020) [79];
Sustainable Development	Kirchherr et al. (2017) [22]; Wen et al. (2007) [60]; Wang et al. (2014) [64]; Ionescu et al. (2017) [68]; Korhonen et al. (2018) [70]; Velenturf et al. (2019) [71]; Corona et al. (2019) [72]; Suárez-Eiroa et al. (2019) [74]
Value Enhancement	Geissdoerfer et al. (2017) [14]; Hollander et al. (2017) [31]; Nguyen et al. (2014) [63]; EMF (2013) [18]; Kazancoglu et al. (2020) [79]
Waste Management	Homrich et al. (2018) [12]; Haas et al., (2015) [65]; Seroka-Stolka and Ociepa-Kubicka (2019) [73]; Kazancoglu et al. (2020) [75]; Kristensen and Mosgaard (2020) [76]

It could be seen that some of the concepts like a closed-loop strategy, sustainable development, and environmental and economic implications, along with resource-saving have been present throughout the sampled period. Interestingly, the CE's research and development has increased after the Ellen MacArthur Foundation's establishment. Further, it could be observed that from 2016 onwards, new terminologies like CBM, regeneration, restoration, social impact, organization aspects, and system thinking of the CE have come into existence.

Observation and Analysis: CE Definition Evolvement

The definition of the CE across the literature has varied, as summarized by Alhawari et al. [41]: Yap [80] emphasized recycling, Liu et al. [2] focused on the reduction in material used, Bocken et al. [17] stressed sustainable development, and the EMF (2013) and [81] focused on restorative and regenerative designs. Mahanty et al. [59] used lexical,

as well as semantic, analysis to understand the evolution of CE and while the early dataset prioritized terminologies like resource, materials, recycling, China, environmental, economic, and industrial; the recent dataset highlighted language like innovations, business models, social, strategies, companies, supply chain, and sustainable development. Though the definitions have varied, most of them share common premises like closed-loop strategy, resource efficiency, and economic and ecological benefits.

Tapia et al. [54] listed the core attributes shared by CE definitions found across the literature; they were: aspirational components (aspiring to achieve sustainable development, economic decoupling), strategic dimensions (instrumental concept to achieve business goals with innovative circular strategies), restorative and regenerative aspects (focuses on avoiding waste by closing the loop), efficiency principles (focuses on strategies to achieve material efficiencies through socio-technical innovations), design elements (restorative by intention and design, design of product for durability and repairability), the cooperation mechanism between societal actors (requirement of cooperation across the supply chain), and system perspective (CE requires holistic and system approach).

In a bibliometric analysis conducted by Alhawari et al. [41], terminologies like circular economy, sustainability, recycling, sustainable development, waste management, industrial ecology, resource efficiency, life cycle assessment, waste, China, industry 4.0, and remanufacturing were often repeated. Further, the definition of CE depends on the premises of the study undertaken; its definitions have varied across the industry. Along the same line, Saidani et al. [82] stated, to date, there is no standard definition of the CE. Moreover, there is still a lack of societal context in CE definitions which could have demotivated communities to incorporate the CE. The definition has been diversifying and contains newer domains but still lacks a precise standard of CE definitions.

3.2. Missing Attributes in Existing CE Definitions

Though the CE definitions have been developing and diversifying, the researcher found some factors missing after assessing the above-sampled definitions. The presence of those factors could help in the better acceptance and implementation of the CE. Some of the missing attributes are listed:

- Any theory in society would not be accepted until the community feels it to be responsible towards them, so an attribute of ethics and an ethical circular approach should be in place. William [83] inferred that a lack of moral credibility would demotivate a consumer to purchase the products. Moreover, Jacobs and Hultgren [84] also noted the requirement of ethical commitment on the value-sensitive designs.
- For the better adoption of the theory, it should envision a promising future for a more significant population segment, such as the common good for multiple stakeholders. Holding a utilitarian perspective where a maximum number of people receive benefits, as per Udoudom [85]. Greater acceptance would help in the diffusion of the theory to a greater extent.
- Further, the CE requires cooperation and coordination across the value chain, and the CE needs change in our production and consumption patterns. Hence, the definition should ensure that there would be a positive impact on the culture and their way of living. Canh et al. [86] noted the importance of innovation in bringing positive change to an enormous scope of stakeholders.

3.3. Proposed Definition of CE

Based on the previous analysis of sampled definitions and their missing attributes, a definition for CE is proposed as follows:

The circular economy is a transdisciplinary realm based on an ethical and responsible regeneration and restoration of resources for the attainment of the common good through an integrated approach across the micro, meso, and macro levels with the promises and possibilities of environmental, economic, cultural, and social gains for existing and future generations.

The proposed definition has added the taxonomies where the CE is emphasized as an ethical approach and additionally focused on bringing positive social and cultural changes to more significant segments in the short and long run.

3.3.1. Chronological Studies and Conceptual Development in the CE

As shown in Table 1, studies related to the CE have increased significantly over the last decade and have diffused aggressively. Numerous concepts are evolving across multiple spectrums along and across the circular image.

This section is focused on studying the extant literature, after 2016, to analyze the development in the field of the CE and to get an idea of how well circular concepts are amalgamated in society as per the concept of the umbrella framework (see Figure 2). In totality, for this section, 125 peer and non-peer reviewed articles were selected, which were classified based on the date of publication, name of authors, and focus of the study. Further, based on the similarity of the objective of the papers (Themes), the focus of this study was categorized into groups (nodes), and 125 articles were classified into 22 groups (nodes), as shown in the second table of Section The Year 2021.

3.3.2. Analysis of Circular Development across the Time The Year 2016

A close link between the CE and sustainability has been advocated since the inception of the CE concepts, and the extant research was observed to be continuing the same concept. Banaité [87] further examined the CE indicators across micro, meso, and macro levels to achieve sustainable development and concluded a lack of social component indicators. Jawahir and Bradley [88] stressed the importance of sustainable manufacturing and laid down the framework for reducing, reusing, recycling, recovering, redesigning, and remanufacturing based on closed-loop sustainable manufacturing. Similarly, Hernández et al. [89] added six sustainable elements of a manufacturing process: environment impact, energy utilization, waste management, manufacturing cost, resource utilization, and society/consumer.

Ruggieri et al. [90] presented a meta-model of inter-organizational cooperation for the transition to CE. They pointed out factors like regulations, stimuli, and consumer behavior to facilitate symbiosis across the organizations. The circular principles were tested and tried at local and regional levels, ref. [91] did the same in Wafangdian city in China to define circular principles for eco-cities. With the focus on enhancing material and product life, Bradley et al. [92] put forth the framework to support design decisions by selecting the material that would optimize the value; the study emphasized the importance of effective product and process design before the manufacturing of the product.

Franklin-Johnson et al. [67] prioritized resource longevity as a core in the CE. They stated three generic components: initial lifetime earned, refurbished lifetime, and made recycled lifetime as an indicator of the CE. CE principles have been adopted and tested across industries; Sheridan [93] studied biobased industries for a circular bioeconomy, Chen and Sun [94] evaluated the CE in agriculture in the Hebei province in China, and Mylan et al. [95] studied sociotechnical analysis in regards to the CE in domestic food provisioning. Balanay and Halog [66] incorporated life cycle thinking and system thinking to manage mining waste. Gama et al. [96] adopted and studied a holistic perspective for implementing the CE in the electronics sector. The CE concept was also incorporated in the electricity sector in India. Varma et al. [97] studied 20 companies. They mentioned the financial gains for those companies on account of adopting the CE through energy-efficiency practices. Table 4 lists the sampled papers for 2016 based on their focus area (subgroup) and respective categorization (group).

Table 4. CE-related studies in 2016.

Author	Subgroup (Themes)	Group (Nodes)
Niero and Olsen (2016) [98]	Product-oriented circular analysis through the life cycle assessment (LCA) of aluminum	CE Assessment/Indicators/Measurement
Verberne (2016) [99]	Circularity indicators for the buildings termed as building circularity indicators (BCI)	CE Assessment/Indicators/Measurement
Lewandowski (2016) [100]	Business model canvas (BMC)	CE Business Support/Implementation
Achterberg et al. (2016) [101]	Mastering circular business with value hill	CE Business Support/Implementation
Fischer and Achterberg (2016) [102]	Creating a financeable circular business in 10 steps	CE Business Support/Implementation
Achterberg and Tilburg (2016) [103]	6 guidelines to empower financial decision-making in the CE	CE Business Support/Implementation
Mylan et al. (2016) [95]	Consumption focus	Consumption
Du (2016) [91]	Eco-cities	Regional
Jawahir and Bradley (2016) [89]	6R Approach	RLES
Bradley et al. (2016) [88]	Product focused CE strategies	RLES
Franklin-Johnson et al. (2016) [67]	Resources utility and life cycle extensions	RLES
Bocken et al. (2016) [17]	Slowing, closing, and narrowing resources loops	RLES
Chen and Sun (2016) [94]	CE and agriculture	Sectoral
Balanay and Halog (2016) [66]	Mining industry	Sectoral
van Buren et al. (2016) [104]	The social ramification from the CE which is stated as Circularity 3.0 by Reike et al. (2018)	Social Dimension
Banaitè (2016) [87]	CE and sustainability	Sustainability
Ruggieri et al. (2016) [90]	Inter-organization	Symbiosis

The Year 2017

Liu et al. [105] performed a study in China prioritizing waste management through the 3R principles of the CE. Most of the circular initiatives are focused on waste and the management of secondary raw materials. Only a few countries take holistic, innovative approaches throughout the global supply chain [106]. Jones and Comfort [107] stressed the ability of the CE to achieve a sustainable future and laid out the characteristic features of the CE along with their applications. Moreau et al. [108] highlighted the importance of social and intuitional dimensions in the CE and studied the underlying biophysical aspects to explain the limits of the CE. Neumeyer and Santos [108], in a study carried in southeast US states noted the importance of a well-developed entrepreneurial ecosystem for the development of a sustainable business model. The researchers Pomponi and Moncaster [109] contributed to the study of *circular buildings* since the built environment puts significant pressure on the natural environment. Toop et al. [110] studied the project entitled *AgroCycle* for implementing CE principles in agriculture to reduce agricultural waste and enable the best economically feasible management of those wastes. Nadeem et al. [111] studied circular prospects in logistics.

Elia et al. [112] looked to overcome the lack of indicators of the CE at a micro level and proposed a framework for monitoring CE strategies, and Masi et al. (2017) [113] carried out a systematic literature review at a meso level to study the configuration of the supply chain for a practical CE; the authors summarized three supply chain configurations: eco-industrial parks; environmental, sustainable, and green supply chains; and a closed-loop supply chain. The CE not only focuses on the end-of-life of the product but rather throughout the life cycle management approach; proper planning for the design of the product plays a crucial role in saving resources; in the same line, Pigosso and McAloone [114] carried out research to highlight the vital relationship between design science and the CE, and Mestre and Cooper [115] proposed four loop strategies for circular product design: design to slow the loops, design to close the loops, design for bio-inspire loops, and design for bio-based loops.

Saidani et al. [82] proposed a framework to assess the performance of a product in CE. The author listed existing CE indicators and toolkits like the circular economy toolkit, material circular indicator, and circular economy indicator prototype. Table 5 lists the sampled papers for the year 2017 based on their focus area (subgroup) and respective categorization (group).

Table 5. CE-related studies in 2017.

Author	Subgroup (Themes)	Group (Nodes)
Saidani et al. (2017) [82]	CE measurement for the product	CE Assessment/Indicators/Measurement
Mendoza et al. (2017) [34]	Applied back casting and eco-design for the implementation of the CE in an organization	CE Business Support/Implementation
Jones and Comfort (2017) [107]	Concept of the CE	Concept Development
Blomsma and Brennan (2017) [39]	The emergence of the CE, 1960–2016 data collection, umbrella concept	Concept Development
Kirchherr et al. (2017) [22]	Transparency provides the coherence of the CE concept, else a concept may either collapse or remain in a deadlock due to permanent conceptual contention	Concept Development
Kirchherr et al. (2017) [22]	After 2012, the use of a system-perspective business model is on the rise, with responsible production, whereas less light was shed on responsible consumption	Concept Development
Mestre and Cooper (2017) [115]	Design science and CE	Design
Hollander et al. (2017) [31]	Product integrity in product design/resisting, postponing, and reversing the obsolescence of the product	Design
Masi et al. (2017) [113]	Confusion	Lack of Clarity/Confusion
Saidani et al. (2017) [116]	Definition confusion	Lack of Clarity/Confusion
Kirchherr et al. (2017) [22]	Circular concepts to be operated at the micro (product, companies, consumers), meso (eco-industry parks) and macro level (city, region, nation, and beyond).	Regional
Toop et al. (2017) [110]	CE and agriculture	Sectoral
Pomponi and Moncaster (2017) [109]	Built environment	Sectoral
Nadeem et al. (2017) [111]	CE and logistics	Sectoral
Moreau et al. (2017) [117]	Social and institutional dimension	Social Dimension
Kirchherr et al. (2017) [22]	Much less focus on the social impact of the CE in comparison to the ecological and economic domains, and lack of time horizon.	Social Dimension
Geissdoerfer et al. (2017) [14]	Differences between sustainability and the CE	Sustainability
Kirchherr et al. (2017) [22]	System framework highlighted rather than R framework, EMF [61]	System/Holistic Approach
Murray et al. (2017) [4]	System perspective and holistic approach across the value chain to achieve the CE	System/Holistic Approach
Kirchherr et al. (2017) [22]	More focus on system perspectives rather than 3R and 4R: EMF pivotal role	System/Holistic Approach
Masi et al. (2017) [113]	CE and supply chain	Transdisciplinary Domain
Liu et al. (2017) [105]	Waste management	Waste Management

The Year 2018

Korhonen et al. [77] provided a deeper introspection on the CE and recommended an approach to bring a paradigm shift in the implementation of the CE. The author highlighted that extant CE studies are more focused on identifying the tools, metrics, instruments, indicators, and measures (parameters of practice stage) and inferred that lesser focus is placed on seeing worldwide perspectives and concepts of the CE. Multiple CE approaches were developed across a continuum (organizational width on the x-axis and complexity on the y-axis) to bring integration among the practice stage of CE activities to the paradigm stage. Val'ko [118] conducted a theoretical study on the CE and highlighted the CE's effectiveness in reducing economic growth's dependence on the production of primary resources and their imports. Ref. [119] and Vargas-Sánchez [120] conducted a study of the impact of the CE on tourism and the hospitality industry. Jones and Comfort [121] studied the effects of CE principles on the construction industry and stressed the advantages the CE could provide.

Implementation of the CE in business organizations for sustainable development was referred to often during this research period; Gupta and Jain [122] and Skawińska and Zalewski [123] studied the circular business operation models for a sustainable business where the latter highlighted the critical innovations for the sustainable circular models. Kalmykova et al. [124] reviewed the existing literature offerings and developed multiple circular strategies across the value chain. Studies for the implementation of the CE at business levels were emphasized; Jørgensen and Remmen [125] described the concept of a *circular economy journey* and provided three circular options for business: (a) redesign of existing services by changing the role of products, users, service and so forth; (b) re-design of the value chain, up-stream as well as down-stream; and (c) redesign of internal business operations. Table 6 lists the sampled papers for 2018 based on their focus area (subgroup) and respective categorization (group).

Table 6. CE-related studies in 2018.

Author	Subgroup (Themes)	Group (Nodes)
Kalmykova et al. (2018) [124]; Jørgensen and Remmen (2018) [125]	CE strategies and value chain	CE Business Support/Implementation
Pauliuk (2018) [20]	The British Standard Institute (BSI) in 2017 developed practical framework for the implementation of circular economy in the organization- standard BS 8001:2017	CE Business Support/Implementation
Korhonen et al. (2018) [77]; Gupta and Jain (2018) [122];	CE as an emerging concept	Concept Development
Reike et al. (2018) [15]	Data 1970–2016/CE concept as CE 1.0, CE 2.0, and CE 3.0	Concept Development
Homrich et al. (2018) [12]	WoS and Scopus and included data until 2016/the two clusters of research: one focused on symbiosis, eco parks, and supply chain, while another cluster highlighted the implementation of CE principles in business model literature; lack of empirical research	Concept Development
Camacho-Otero et al. (2018) [126]	Consumption side analysis for the CE rather than supply side only	Consumption
Korhonen et al. (2018) [70]; Korhonen et al. (2018) [77]; Gupta and Jain (2018) [122];	Confusion in the CE	Lack of Clarity/Confusion
Korhonen et al. (2018) [77]	CE as contested and important concept	Lack of Clarity/Confusion

Table 6. Cont.

Author	Subgroup (Themes)	Group (Nodes)
Gupta and Jain (2018) [122]; Korhonen et al. (2018) [77]; Skawińska and Zalewski (2018) [123]	Unexplored: still much left to explore in the CE	Lack of Clarity/Confusion
Kallis et al. (2018) [127]	Skepticism for the achievement of the CE in the capitalist economy by stressing on degrowth.	Lack of Clarity/Confusion
Homrich et al. (2018) [12]	Lack of confirmatory approach and empirical validation in the CE, lacks homogeneity	Lack of Clarity/Confusion
Velis (2018) [128]	Lack of effective economic model	Lack of Clarity/Confusion
Reike et al. (2018) [15]	Rather being a fresh concept is a refurbished concept of preexisting notions and adds circularity has been a notion in EU since ages	Lack of Clarity/Confusion
Babbitt et al. (2018) [129]	The circular theories should be tested in the real-world scenarios to measure their effectiveness	Lack of Clarity/Confusion
Girard and Nocca (2019) [130]	As per the literature review, the CE can be categorized into three references—micro, meso, and macro.	Regional
Jones and Confort (2018) [121]	CE and construction industry	Sectoral
Vargas-Sánchez (2018) [120]	CE and tourism	Sectoral
Korhonen et al. (2018) [70]; Skawinska and Zalewski (2018) [123]	CE and sustainability	Sustainability
Figge (2018) [131]	Performed two-dimensional study by incorporating the longevity and circularity of the resources needed for sustainability	Sustainability
Korhonen et al. (2018) [77]	Global integration	System/Holistic Approach
Korhonen et al. (2018) [77]; Skawinska and Zalewski (2018) [123]	Holistic approach	System/Holistic Approach
Korhonen et al. (2018) [77]	Sub concepts	Transdisciplinary Domain

The Year 2019

Jones and Wynn [132] prepared a study tourism and the hospitality industry to assess the relation and impact of the CE, natural capital, and resilience. They pointed to key sustainable management areas: energy monitoring, water management, resilience monitoring, waste management, and natural capital management. Corona et al. [72] studied the existing circularity metrics which would play an essential role in the adoption of CE. Circularity indices: material circularity indicators (MCI), global indicator prototype, circular economic value (CEV); CE assessment frameworks: input–output analysis, material flow analysis (MFA), life cycle assessment (LCA), and CE assessment indicators: circularity degree, circular performance indicator (CPI), eco-efficiency index, global resource indicator (GRI), longevity indicators were assessed. The study concluded that none of the extant circularity indices were developed enough to incorporate all circular factors (reducing the input of resources, especially scarce ones, reducing emission levels, reducing material losses/waste, increasing intake of renewable and recycled resources, maximizing the utility and durability of products, creating local jobs at all skill levels, value-added creation and distribution, and increased social wellbeing).

Many papers were found studying the relationship between the CE and sustainable development. Bocken et al. [133] developed a novel framework to enable a systematic form of sustainable business model experimentation incorporating three key issues—construct clarity, boundary setting, and uncertainty about the outcome. Suárez-Eiroa et al. [74]

clarified the operational principles of the CE for achieving sustainable development. They ended up laying down seven principles: adjusting inputs to the system of regeneration rate, adjusting outputs from the system to absorption rates, closing the system, maintaining the value of resources within the system, reducing the system size, designing for the CE, educating for the CE. Circular concepts were tested in newer industries; Keijer et al. [134] studied the implementation of the CE in the lifecycle of chemical products to increase the efficiency of resources and create a waste-free chemical industry. Seroka-Stolka and Ociepa-Kubicka [73] described the context of green logistics as an essential tool for the development of the CE.

Quantification of CE performance provides an influential gauge in the measurement of CE activities, but comparatively fewer studies have been conducted to define CE indicators explicitly. Avdiushchenko and Zajac [135] carried out a literature review to examine existing CE indicators and consequently proposed indicators for CE monitoring at the regional level; this included areas like economic prosperity, zero waste, innovation, energy efficiency and renewable energy, low carbon, smart connection through the IoT (Internet of Things), and spatial effectiveness. Ref. [136] conducted a systematic literature review to assess the effectiveness of CE performance measurement methods. The implication of CE innovation in generating economic and social impact was studied in Germany [137]. Table 7 lists the sampled papers for the year 2019 based on their focus area (subgroup) and respective categorization (group).

Table 7. CE-related studies in 2019.

Author	Subgroup (Themes)	Group (Nodes)
Corona et al. (2019) [72]	Circularity matrices	CE Assessment/Indicators/Measurement
Niero and Kalbar (2019) [98]	Multi-criteria decision analysis (MCDA) by bringing two sets of indicators: material circularity-based indicators and life cycle-based indicators.	CE Assessment/Indicators/Measurement
Suárez-Eiroa et al. (2019) [74]	Operational principle of CE	CE Business Support/Implementation
Bianchini et al. (2019) [46]	Circular business model (CBM) visualization tool	CE Business Support/Implementation
Suárez-Eiroa et al. (2019) [74]	CE evolution study	Concept Development
	Emerging concept	Concept Development
Saidani et al. (2019) [82]	SLR on the taxonomies of circular economy indicators, the paper categorized the taxonomies in 10 different segments: levels, loops, performance, perspective, usages, transversality, dimension, units, format, sources	Concept Development
Kirchherr and Santen (2019) [138]	Lack of empirical studies	Lack of Clarity/Confusion
Saidani et al. (2019) [82]	Sta [46] tes circular indicators are at the infancy and much more generalized	Lack of Clarity/Confusion
Sassaneli et al. (2019) [82]	Lack of common practice in companies to measure and assess the circular performance	Lack of Clarity/Confusion
Bianchini et al. (2019) [46]	Highlighted the importance of data for analysis	Lack of Clarity/Confusion
Inigo and Block (2019) [139]	Responsible research and innovation (RRI) and CE	Responsible Development
Keijer et al. (2019) [134]	CE and chemical industry	Sectoral
Jones and Wynn (2019) [132]	Hospitality and Tourism	Sectoral
Kirchherr and Santen (2019) [138]	Sectoral analysis	Sectoral
Horbach and Rammer [137]	Social and economic study	Social Dimension
Serika-Stolka and Ociepa_Kubicka (2019) [73]	Green logistics	Transdisciplinary Domain

The Year 2020

CE concepts were found to be implemented across developing and emerging countries; Fiksel et al. [140] studied the approaches toward achieving the CE in India. Geissdoefer et al. [141] studied the circular business model (CBM) and circular business model innovation (CBMI) to bring clarity to the implementation of the CE in organizations; a detailed study of its history, definition, and conceptual framework was carried out. Ferasso et al. [37] studied bibliometric analysis to study the relationship between the CE and business models in the extant body of literature. The study put the CE, CBM, value, supply chain, transition, resource, waste, and reuse as the most-studied terminologies and highlighted emerging topics like managerial, supply-side, demand-side, networking, performance, and contextual consideration of circular business models.

More studies were found across the literature where scholars were profoundly formulating circular business models; Centobelli et al. [45], through a systematic literature review of extant literature, developed business models to align with circular strategies in organizations. Likewise, Angelis [142] studied the CE's management dimension and focused on achieving competitiveness and profit from the application of the CE.

Kristoffersen et al. [143] studied the impact and importance of digital technologies (IoT, big data, and data analytics) and business analytics in enabling CE; the study provided a more robust integration of technology in creating competent CE. Primc et al. [144] studied the factors to make CE implementation more robust across various evolution stages of an organization; the study developed thirteen circular economy configuration indicators, ten for the innovative and three for the conservative stage of the organizational life cycle. Upadhayay and Alqassimi (2020) [145] borrowed the pre-existing concept of a business model canvas of Osterwalder and Pigneur (2010 [146]) and the value hill diagram Achterberg et al. [103] to define a good point for transition (GPT) from a LE to a CE for a business.

Yadav et al. [58] developed a framework for adopting the CE in Indian manufacturing sectors through a hybrid best worst method and decision-making trial and evaluation laboratory approach. The incorporated five indicators were (a) organizational, (b) supply chain, (c) informational and technological, (d) strategy and policy, and (e) managerial. The study concluded that strategy and managerial indicators could influence other remaining indicators to adopt the CE. Investigation and research continued throughout the period. Abdul et al. [147] specifically studied CE practices using generic decision support systems in the leather industry. They concluded that the lack of financial support from authorities was the primary barrier to implementing the CE. Table 8 lists the sampled papers for 2020 based on their focus area (subgroup) and respective categorization (group).

Table 8. CE-related studies in 2020.

Author	Subgroup (Themes)	Group (Nodes)
Feraso et al. (2020) [37]; Centobelli et al. (2020) [45]; Angelis (2020) [142]	Business model and CE	Business Support/Implementation
Geissdoefer et al. (2020) [141]	CE, CBM, CBMI	Business Support/Implementation
Primc et al. (2020) [144]	Organizational implementation	Business Support/Implementation
Upadhayay & Alqassimi (2020) [145]	Determine the good point for transition (GPT) from a LE to a CE	Business Support/Implementation
Luis and Celma (2020) [6]	Concluded the double evolution in the field of CE: the focus of CE on the productive sector and next in the implementation of CE principles in business organizations	Business Support/Implementation

Table 8. Cont.

Author	Subgroup (Themes)	Group (Nodes)
Ferasso et al. (2020) [37]	A link of CBM with terms like product, technology, industry, strategy and sustainability was highly revered	Business Support/Implementation
Vinante et al. (Press) [148]	SLR on CE assessment at a firm's level where the Porter's value chain was used to come with new circular value chain framework.	Business Support/Implementation
Friant et al. (2020) [38]	Data 1945–2020/CE concept (CE1,2,3. a/3. b); listed 4 CE discourse	Concept Development
Khitous et al. (2020) [16]	A citation network analysis (CNA), diversification in CE literature,	Concept Development
Khitous et al. (2020) [16]	Movement from rhetoric to the general implementation of CE principles to tackle problems related with the waste through EPR and CBM	Concept Development
Morseletto (2020) [149]	Further clarify the terminologies- restorative and regenerative which was highlighted in the definition by EMF [61]	Concept Development
Borrello et al. (2020) [33]	Multilevel perspective (MLP) as stated by Frank W Geels in 2019	Concept Development
Borrello et al. (2020) [33]	Niche-innovation builds internal momentum as noted by Frank W Geels in 2019	Concept Development
Goyal et al. (2020) [150]	CE study area divergence throughout the time period	Concept Development
Centobelli et al. (2020) [45]	Confusions in CE concepts	Lack of Clarity/Confusion
Primc et al. (2020) [144]	Lack of organization specifics	Lack of Clarity/Confusion
Friant et al. (2020) [38]	CE implementation is a challenge in the developing countries by limiting the consumption	Lack of Clarity/Confusion
Friant et al. (2020) [38]	Definition, objectives, and form of implementation of the CE are unclear, inconsistent, and contested	Lack of Clarity/Confusion
Khitous et al. (2020) [16]	Definition, objectives, and form of implementation of the CE are unclear, inconsistent, and contested	Lack of Clarity/Confusion
Luis and Celma (2020) [6]	Passivity of countries like the USA and Canada to express their commitment towards the CE would have global implications	Passivity
Moktadir et al. (2020) [151]	CE in the leather industry	Sectoral
Çetin et al. (2021) [152]	Study of built environment where authors used the Delphi method to assess the implementation of CE principles in asset management	Sectoral
Schröder et al. (2020) [153]	Studied the socio-economic dimension of the transformation from the LE to the CE, integrated framework on the CE and human development	Social Dimension
Ferasso et al. (2020) [37]	Raphaëlle Stewart and Monia Niero in 2018; Antonella Zucchella and Pietro Previtali in 2019; as cited in Ferasso et al. [37] explored the relation of sustainability with CE for organizations	Sustainability
Konietzko et al. (2020) [154]	System approach	System/Holistic Approach
Kristoffersen et al. (2020) [143]	CE and technology	Transdisciplinary Domain
Christensen and Hauggaard-Nielsen (2020) [155]	Inter-related domain	Transdisciplinary Domain

The Year 2021

Ref. [156] examined and concluded the importance of CE for the clean energy transition in China and mentioned the CE approach as a new opportunity during the COVID-19 pandemic. The study assessed the cruciality of CE across three segments: a built environment comprised of households and non-residential stays, transport which comprised passenger and freight transport, and finally, industries which included the dyeing, gas production, textile, and steel industries.

Ref. [157] conducted a comprehensive bibliometric analysis to examine the relationship between the CE and the sharing economy (SE). The study attempted to define sustainable business options and premises within the fundamentals and principles of the CE. The intensity and complexity of the studies were enhanced for further validation during this period. Konietzko et al. [154] presented a study on circular ecosystem innovation and asserted circularity to be a property of a system rather than being limited solely to a single product. His findings are asserted in line with the previous scholars Christensen and Hauggaard-Nielsen [155] and Konietzko et al. [154], who stated that the CE is a transdisciplinary approach. The interdependence between the CE and sustainability was further explored. Velenturf and Purnell [56] concluded and put forth several points of similarities and contradictions between sustainable development and the CE. The study proposed a circular value framework and a set of ten principles for designing, implementing, and evaluating a sustainable CE. Peña et al. [158] undertook a life cycle assessment (LCA) to assess the sustainability impacts of CE strategies to foster the development, adoption, and implementation of the CE.

Tapia et al. [54] studied the territorial dimension that would impact the closed-loop systems and stated six territorial factors for fostering the CE. The study concluded that territorial factors like land-based factors and agglomeration supported defining the framework of the CE, the more challenging territorial factors like accessibility and technologies enabled the CE in practice, and softer factors like knowledge, awareness, governance, and milieus contributed to catalyzing circular transition.

de Oliveria et al. [159] carried out nano (product level) and micro (company level) analyses to support decision-makers in the assessment of circularity. More practical approaches for the implementation of the CE were explored, Taleb and Farooque [160] in Egypt studied the application of a total cost account (FCA) to municipal waste recyclables and concluded that providing prepaid bags under the volume-based pay-as-you-throw method has the lowest waste costs and created more incentives for households in terms of economic, social, and environmental benefits. Donner et al. [161] listed critical success factors in the valorization of agriculture waste; and highlighted the importance of innovative technologies, flexible logistics, R&D investment, and the availability of space. The CE concept was found to be tested and practiced across the globe. Patwa et al. [55] conducted a survey in emerging economics to determine the factors that support the CE; Upadhyay and Alqassimi [1] conducted a comparative study between the USA and Nepal to access the level of awareness and perception towards the CE, the study concluded that the level of awareness people have about the CE is still minimalistic. Hossain and Khatun [162] conducted a qualitative study in Bangladesh to find the barriers to the CE.

Pre-existing concepts were further tested and analyzed from broader perspectives; Kardung et al. [163] conducted an extensive EU study on the bioeconomy and asserted relations among bioeconomy, green economy, and circular economy. The CE was further tested and established as a cross-disciplinary domain. Newer concepts were put forth based on existing gaps; Adami and Schiavon [164] proposed the concept of circular ecology, which defined the CE to focus on environmental benefits rather than economic sustainability alone explicitly. Table 9 lists the sampled papers for the year 2021 based on their focus area (subgroup) and respective categorization (group).

Table 9. CE Related Studies in 2021.

Author	Subgroup (Themes)	Group (Nodes)
Patwa et al. (2021) [55]	Awareness analysis	Awareness
Hossain and Khatun (2021) [162]	Barriers to the CE	Barriers
Taleb and Farooque (2021) [160]	CE accounting practice	CE Business Support/Implementation
de Oliveira et al. (2021) [159]; Kardung et al. (2021) [163]; Peña et al. (2021) [158]	CE metrics	CE Assessment/Indicators/Measurement
Su and Urban (2021) [156]	COVID-19	COVID-19
Tapia et al. (2021) [54]	CE and territorial factors	Geographical Factors
Tapia et al. (2021) [54]; de Oliveira et al. (2021) [159]; Hosseinian et al. (2021) [165]	Confusion in CE concepts	Lack of Clarity/Confusion
Velenturf and Purnell (2021) [56]	CE and sustainability	Sustainability
Fiksel et al. (2021) [140]	System approach	System/Holistic Approach
Kardung et al. (2021) [163]	CE and bioeconomy	Transdisciplinary Domain
Adami and Schiavon (2021) [164]	Circular ecology	Transdisciplinary Domain
Su and Urban (2021) [156]	CE concepts in the energy sector	Transdisciplinary Domain
Henry et al. (2021) [157]	CE and technology importance	Transdisciplinary Domain
Korhonen et al. (2018) [77]; Su and Urban (2021) [156]; Henry et al. (2021) [157];	Interdisciplinary	Transdisciplinary Domain
Alhawari et al. (2021) [41]; Velenturf and Purnell (2021) [56]; Henry et al. (2021) [157]; de Oliveira et al. (2021) [159]	Limited study in CE	Unexplored
Tapia et al. (2021) [54]	Unexplored	Unexplored

After completing the assessment of sampled literature for circular development through the years 2016 to 2021, the researcher produced 22 significant themes, which are listed in Table 10. These themes have evolved throughout the period; Tables 4–9 state the major work accomplished in that year and its subsequent generated themes. From Table 10, we can infer that the circular domain is diversifying, and the complexity of the analysis is on the rise.

Table 10. Themes generated in the assessment of CE development.

S.No.	Groups (Nodes)
1	Awareness
2	Barriers
3	CE Assessment/Indicators/Measurement
4	CE Business Support/Implementation
5	Concept Development
6	Consumption
7	COVID-19
8	Design
9	Geographical Factors
10	Lack of Clarity/Confusion
11	Passivity
12	Regional
13	Responsible Development
14	Resource Lifecycle Extension Strategy (RLES)
15	Sectoral
16	Social Dimension
17	Sustainability
18	Symbiosis
19	System/Holistic Approach
20	Transdisciplinary Domain
21	Unexplored
22	Waste Management

Table 10 classifies the nodes generated during the content and thematic analysis; these 22 nodes are classified in the chronological analysis of CE-related literature across the years 2016 and 2021. Finally, Table 11 represents the consolidation of all of the themes generated in the study arranged in descending order. A total of 123 out of 125 papers were generated, classified into 22 nodes.

Table 11. Consolidation of all of the themes generated.

S.No	Year	2016	2017	2018	2019	2020	2021	Total
1	Lack of Clarity/Confusion		3	9	4	5	1	22
2	CE Business Support/Implementation	4	1	2	2	7	2	18
3	Concept Development		4	3	3	7		17
4	Sectoral	2	3	2	3	2		12
5	Transdisciplinary Domain		1	1	1	2	5	10
6	System/Holistic Approach		3	2		1	1	7
7	Sustainability	1	1	2		1	1	6
8	CE Assessment/Indicators/Measurement	2	1		2			5
9	Social Dimensions	1	2		1	1		5
10	RLES	4						4
11	Regional	1	1	1				3
12	Consumption	1		1				2
13	Design	2						2
14	Unexplored						2	2
15	Symbiosis	1						1
16	Waste Management		1					1
17	Responsible Development				1			1
18	Passivity					1		1
19	Awareness						1	1
20	Barriers						1	1
21	COVID-19						1	1
22	Geographical Factors						1	1
Total		19	21	23	17	27	16	123

In Table 11, we can observe that the highest number of themes was generated in the “Lack of Clarity/Confusion” about the CE, which is followed by the papers that studied the approaches needed to make the CE more inclusive for businesses; similarly, the third highest node was related to papers related to the concept development of the CE. From Table 11, we can infer that although CE studies are diffused and diversifying, there is still confusion in the circular domain, which could have hindered the acceptance of the CE. Still, studies are being made on developing and understanding CE concepts and philosophies. Newer dimensions are also being studied, and the more sector-wide impact of the CE is being assessed, like the impact of the CE on tourism, the chemical industry, and the aluminum industry. Further, more systematic and value chain approaches are being referred to; numerous CE strategies are being crafted across multiple regions.

3.4. Confusions and Contradictions in the Development of the Circular Economy

The CE is not limited to a single domain or any isolated discipline; it is evolving and complex; the CE still requires in-depth grounded studies. Saidani et al. [82] asserted that the CE, rather than being an entirely new concept, is a combination of fundamental and founding concepts. Korhonen et al. [77] (Table 12), applying [166] framework, put forth the CE as an “essentially contested concept” (ECC) and mentioned a lack of CE-related studies to examine its impact on social values, societal structures, and cultures. Korhonen et al. [77] further added that ECC ideas have internal complexities and involve different schools of thought, actors, and interest groups, which often makes the theory easy to adopt. Over the last decade, the circular domain has rapidly grown, but the study is limited to material

science and new CE business models. Korhonen et al. [70] studied the CE's concepts and limitations and inferred that the field is still in its infancy. The CE performance assessment methods still lack a standard approach [136].

Kirchherr and van Santen [138] noted the lack of empirical evidence to support the circular transition. They stressed limited research in the service sector to support CE transition in the service industry. Most of the research was limited to manufacturing sectors. The circular domain lacks consistency and uniformity, Muradin and Foltynowicz [167] stated a lack of agreed global vision on circularity. Inigo and Block [139] studied the impact and principle of responsible research and innovation (RRI) in fostering the CE concept along with the socio-ethical consideration of the CE on the community; the same was studied by Kalioujny and Ermuskho [168] to determine the ways to make the integration of CE easier in society. Some scholars have stated the circular concept to be unclear, confusing, and hard to realize; Millar et al. [169] noted the existence of inconsistency across the literature on the ability of CE to achieve sustainable development.

The transition to CE is still blurred; the global enterprise with high public coverage has still not been an agent to foster CE [170]. Sectoral research was tremendously carried out to see the inclusion and implication of CE, and still, a plethora of research is being carried out to clarify its concepts; Istudor and Negrel [171] produced a paper to bring clarity between the concept of the CE and its relation to the economic system and systemic ecology. Christensen and Hauggaard-Nielsen [155] noted that the concept of the CE being a paradigm approach has been derived from preexisting concepts like cleaner production, industrial ecology, and cradle-to-cradle.

Velenturf and Purnell [56] asserted the CE as an emerging practical ideology lacking enough of an evidence-based theoretical framework to guide its implementation. Centobelli et al. [45] pointed to the lack of adequate studies to support a company to transition from the LE to the CE model of P&C. In the same line, Hosseinian et al. [165] added that there is increasing interest in the CE across multiple domains. Still, CE is more focused on the end-of-life strategy like recycling which has overshadowed important circular activities like designing circular products, dematerializing society, and developing service-based business models.

A study by de Oliveria et al. [159] concluded the existence of nano-level (product-level) circularity indicators driven by environmental and economical objectives and noted the lack of social dimension; in the same line, Murray [4]) and Velenturf and Purnell [56] also asserted the same; CE lacks social dimensions. The academic and empirical test related to the CE is still in progress, but no common ground has been established. Scholars are investigating the development of the concept of the CE [59]. Upadhyay et al. [172] write that scholars are still trying to find practical solutions to curb the pressure on resources through their effective reutilization, and Grafström and Aasma [173] noted that despite the estimated gain of the CE, the progress across the micro, meso, and macro level has been sluggish.

Table 12. List of papers stating the confusions around the CE.

Authors	Focus
Freire-Gonzalez and Puig-Ventosa (2015) [174]	Rebound effect
Bocken et al. (2016) [27]	Stressed a need for more coherent terminologies and taxonomies to facilitate a transition from a linear to a circular economy
Kirchherr et al. (2017) [22]	Transparency provides coherence to the CE concept, or else a concept may either collapse or remain in a deadlock due to permanent conceptual contention
Murray et al. (2017) [4]	Lack of study in the field of business and sustainability
Kirchherr et al. (2017) [22]	Lack of social dimension and time horizon perspectives
Zink and Geyer (2017) [175]	Rebound effect

Table 12. Cont.

Authors	Focus
Kallis et al. (2018) [127]	Expressed the skepticism for the achievement of the CE in the capitalist economy by stressing degrowth
Homrich et al. (2018) [12]	Still, the study is exploratory, lacking a confirmatory approach and empirical validation, and further needs homogeneity in the nomenclature
Velis (2018) [128]	Lack of an effective economic model and precise indicators have made the CE tougher to be followed and bring common points at large, which may ultimately lead to the collapse of the CE construct
Reike et al. (2018) [15]	Argues the CE rather than being a fresh concept is a refurbished concept of preexisting notions and adding circularity has been a notion in EU for years
Homrich et al. (2018) [12]	Described the CE as in the stage of inception; it still lacks structured definition
Babbitt et al. (2018) [129]	The circular theories should be tested in the real-world scenarios to measure its effectiveness
Reike et al. (2018) [15]	Lack of coherence, standardization, and uniformity in terminologies and semantics has also generated delusions
Garcia-Barragan et al. (2019) [176]	CE still lacks unambiguous definitions
Friant et al. (2020) [38]	45% of the global population is under poverty and it could be challenging to restrain the consumption of resources
Friant et al. (2020) [38]	The definition, objectives, and form of implementation of the CE are unclear, inconsistent, and contested
Luis and Celma (2020) [6]	The passivity of countries like the USA and Canada to express their commitment towards CE could have a global implication
Korhonen et al. (2018) [77]	Mentioned the lack of CE-related studies to examine its impact on social values, societal structures, and cultures
Sassaneli et al. (2019) [136]	The CE performance assessment methods still lacks a common approach
Kirchherr and van Santen (2019) [138]	Lack of empirical evidence to support circular transition and stressed limited research carried in service sector to support CE transition in the service industry
Muradin and Foltynowicz (2019) [167]	Lack of agreed global vision on circularity
Inigo and Block (2019) [139]	Responsible research and innovation (RRI)
Millar et al. (2019) [169]	The existence of inconsistency across the literature on the ability of CE to achieve sustainable development
Geipele et al. (2018) [170]	The transition to CE is still blurred; the global enterprise with high public coverage has still not been an agent to foster the CE
Christensen & Hauggaard-Nielsen, (2020) [155]	Derived from pre-existing concepts
Velenturf and Purnell (2021) [56]	The CE is an emerging practical ideology which lacks enough evidence-based theoretical framework to guide its implementation
Centobelli et al. (2020) [45]	Lack of effective studies to support company to transition from the LE to the CE model of P&C
Hosseinian et al. (2021) [165]	Though there is an increasing interest in the CE across multiple domains, the CE is still more focused on the end-of-life strategy like recycling which has overshadowed important circular activities like designing circular products, dematerializing society, and developing service-based business models
de Oliveria et al. (2021) [159]	Existence of nano-level (product-level) circularity indicators driven by environmentally and economically objectives and noted the lack of social dimension

3.4.1. Critical Assimilation and Impressions

After conducting a systematic literature review of the topic, the following developments in the field of the circular economy were pointed out.

- Nature of study
- Throughout the study period, the studies related to the CE were exploratory. Most of the works focused on understanding the taxonomies and developing the concepts. The studies still lack enough empirical and quantitative data-driven results. Throughout the sampled period from 2016 to 2021, authors have frequently studied the conceptual development in the CE through bibliometric analysis.
- Progressive growth, evolving, and testing: Repetition with complexity
- The growth in the field of the CE has been progressive. The same research topics were often repeated during the sampled period, but studies have become more complex. The CE matrixes, indices, and indicators have become inclusive and have been proposed and examined in diverse industries.
- Research orientation
- The exploratory research has a subjective orientation which could create a bias at the time of deriving inferences and conclusions. The literature review during the study period was subject to the researcher's understanding, and objective orientations in studies were not found in significant numbers.
- Availability of data
- The primary reason for the absence of quantitative research in the field of the CE in the USA and Asia regions was the lack of the availability of CE-related data. The lack of archival data on the CE from recognized institutions has made it challenging to run empirical tests and has missed the objective orientation of CE-related research.
- Ambiguity and lack of homogeneity
- There has been no precise and standard definition related to the CE, the domain has been diversifying, and multiple concepts have appeared. Though it has provided multiple domains for analysis, it has also created confusion among practitioners.
- CE and Fourth Industrial Revolution (4IR)
- With an increasing interest in the CE, the impact of technology is also being studied. The 4IR, signified by AI, blockchain, and 3D printing, can enhance resource productivity. It would not be wrong to say the CE is diverging and diffusing.
- Disproportionate studies across industries
- Throughout the study period, the CE-related studies were focused more on the manufacturing industry. Though the service industry significantly contributes to the economy's GDP, there is still a lack of exploratory and empirical research related to the CE in the service industry.
- Presence of confusion and clarity
- Though study related to the CE has increased drastically, confusion about the CE still exists. Throughout the study period, authors were found working to clarify and define the CE.
- CE indicators, matrices, and indices
- With time, tests and studies related to the CE are rising, but there is still a lack of adequate and holistic indicators, matrices, and indices to measure the CE. Business entities have been unable to implement the CE due to the lack of circular toolkits and measurement instruments.
- Fragmented versus integrated approach
- While the CE was seen and studied as a fragmented and isolated subject before, now it is seen as a transdisciplinary domain. It incorporates multiple domains and cross-industry knowledge.
- Concentrated approach on end-of-life strategy
- Studies have listed a multiple CE approach related to closed-loop strategies and RLES; this includes a management strategy throughout the product life cycle for efficient utilization of resources. Still, in a practical word, businesses are found to be more focused on end-of-life strategies like recycling. Less focus has been placed on circular design and innovations.

3.4.2. Reconciling with the Umbrella Framework

The umbrella framework, which highlights the development of the theories across the time horizon, helps in understanding the diffusion and adoption of the concepts. In line with the previous studies by Hirsch and Levin [40] and Blomsma and Brennan [39], tremendous and significant diffusion in CE-related subject matters has been observed. Authors have incorporated multiple sectors in their studies; the CE has become a transdisciplinary domain that involves cross-industry knowledge. Studies of circular principles in fields like the environment, sustainability, built environment, metallurgy, waste management, and tourism have been conducted and are further evolving.

The CE and its impact on sustainability and sustainable development were studied from 2016 to 2021. Most authors before 2016 and the aftermath of 2016 have pointed to the CE as a medium to achieve sustainable development. In the same way, exploratory studies related to the CE were prevalent in each sampled year. Most of these studies were focused on citation and bibliometric analysis through the systematic review of literature whose focus was to understand the definitions and development in the concept of CE across the period. Still, at the same time, scientific studies related to the practical application of the CE are lacking.

Likewise, an attempt to quantify CE performance through CE-related indices, matrices, and indicators has been studied and proposed. Moreover, studies have stressed the positive impact of the CE beyond the environmental frontier, and many studies have highlighted the importance of the CE for the economic good of involved stakeholders. Still, the social and cultural implication of the CE has not been dealt with in detail [4]. As Blomsma and Brennan [39] concluded, the same topics have been revised and studied multiple times across the timeline but with higher complexity. The same pattern was observed in this study too.

Regarding the development in the CE concept and taxonomies, the authors [39], Friant et al. [38], and [15] all echoed the same version, CE is developing and diversifying, and the CE concept is in validity phase (as per the umbrella framework). For the assessment of circular development, a more holistic approach is taken in this study, as stated in Figure 5; for any theory to be successfully implemented/diffused in society, it has to have a solid theoretical background along with practical industry-level CE tools and kits.

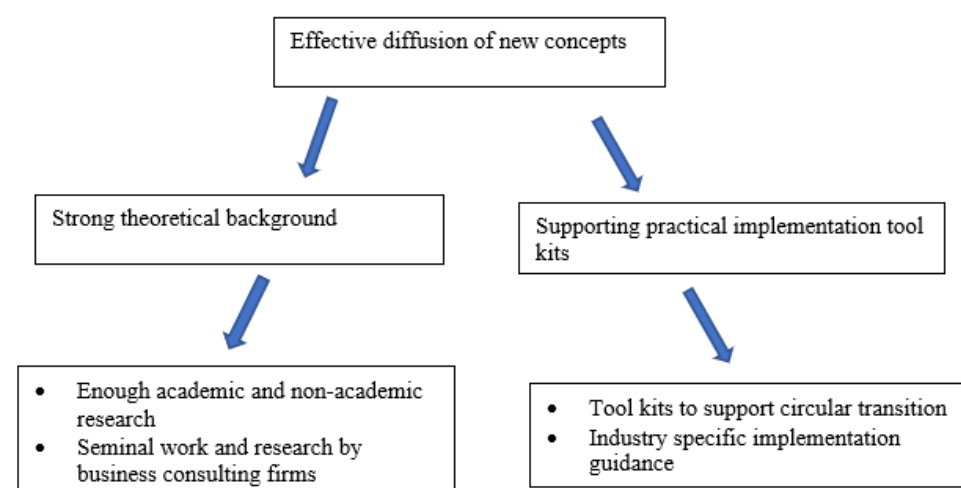


Figure 5. Requirement for effective diffusion of theory (author's work).

As stated in Figure 5, a solid theoretical base is created by the pool of academic sources related to the CE. Regarding a theoretical base related to the CE, as illustrated in Table 1, significant research about CE concepts and topology has been recorded. But, during the same period, the studies related to the application of the CE have not been promising. For any theory to be quickly diffused and adopted, research and findings on its application are necessary and should be backed by evidence-based science [177].

Further, this assessment incorporated the parameters listed in the diffusion of innovation model by Moore and Benbasat [178] to test the level of the adoption of CE in the economy; Jebeile and Reeve [179] implemented the same model in their study to assess the diffusion of e-learning innovations in an Australian secondary college. Moore and Benbasat [178] model specifically provided seven factors that could support adopting a new theory and the same was tested in this study by making a case for the CE. Per Moore and Benbasat [178], listed factors are relative advantage, compatibility, ease of use, visibility, image, result demonstrability, and voluntarism. Table 13 lists the elements, their assessment, and their explanation regarding the adoption of the CE.

Table 13. Assessment of the adoption of the CE.

Factors	Description	Result	Explanation
Relative advantage	Is it better than the LE model of P&C?	Yes	The CE enhances RP, positive impact on economy, ecology, and society
Compatibility	Fits well with existing mechanism, operations, way of life	No	Could be difficult and costly to replace existing the LE-based P&C mechanism
Image	Enhances the image and prestige	Yes	Adoption of the CE enhances company image in the market
Visibility	Is easily seen	Moderate	The CE focuses on long run hence often short-run benefits may not be observed
Ease of use	Ease to understand, use, control, learn	No	The CE still lacks clarity in its concept, definitions, and use
Results demonstrability	Easy to share, communicate, explaining the results	No	Lack of regulatory involvement to guide CE implementation, low awareness about the CE
Voluntarism	Participating by self-desire	No	Still reluctant to adopt the CE due to lack of expertise, knowledge, and high-risk perception

From Table 13, we observed that the CE lacks compatibility, has moderate visibility, is not easy to implement, and lacks the awareness to demonstrate and communicate its impact. Still, there is the presence of skepticism about adopting CE principles voluntarily. All these factors would hinder the diffusion and adoption of the CE in daily operations across the micro, meso, and macro levels.

3.4.3. CE Concept and CE Development: Progressive but Still in the Validity Phase

Compared to the last decades, there has been a significant increase in the literature related to the concepts and topologies of the CE (see Table 1). At the same time, scholars have studied the implication of circular principles across industries (see Table 10). From the previous research by authors Blomsma and Brennan [39]; Friant et al. [38]; and Reike et al. [15], this study confirms that CE is still going through rigorous tests and experimentation and the same time, its usefulness and positive impacts are being widely accepted and acknowledged in the global platform. This acceptance and diffusion have been geographically different; the circular approach and understanding across the global south and north are different [180].

While countries in the EU, Japan, and China have firmly accepted and adopted the CE, countries in the least developed countries (LDC) and developing countries are still unaware of the CE and its consequences. Contemporarily, most of the development in the CE has been in developed and advanced economies. Based on the previous literature studies and findings, we can infer that the CE is in the validity phase of umbrella framework. But also, at the same time, the theory is not widely accepted due to the lack of system-wide holistic studies.

Through the sample period (2016 to mid-2021), there have been a lot of concepts and application-based development in the CE. But still, the CE has not become homogeneously accepted in the global arena. As depicted, it is received and acknowledged in developed countries, but still, its adoption has been minuscule in the other half of the globe.

Figure 6 illustrates the final inference for this study, the current status of CE development, and its adoption globally. Until now, Blomsma and Brennan [39] stated the CE still to be in the validity test stage; Reike et al. [15] further classified the CE as CE 1.0, CE 2.0, and CE 3.0, where CE 1.0 signifies the period when waste production was seen as a negative to CE 3.0 where the focus was placed on long-term consumption and sustainability, and Friant et al. [38] laid down multiple topologies for the CE based on the adoption modalities of the CE in societies.

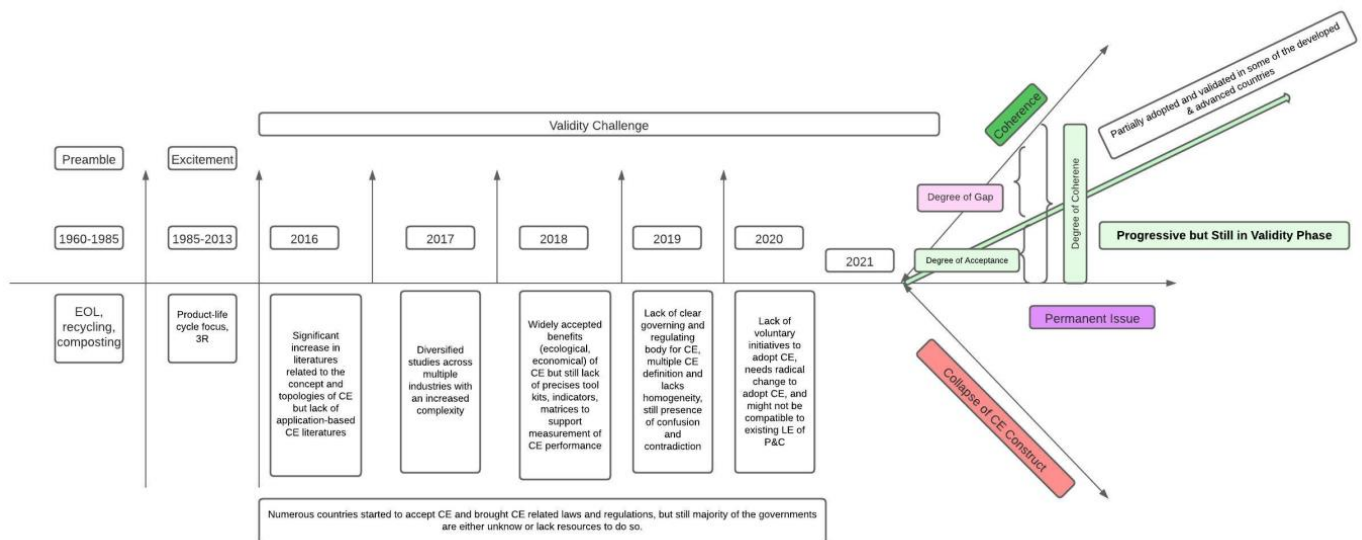


Figure 6. Umbrella framework: contemporary assessment.

Throughout the assessment of developments of CE concepts, CE typologies, and the CE for the business world, most scholars have inferred that there still exists confusion in CE concepts and definitions; at the same time, there is no denying that CE philosophies are being experimented with across the industries, there still lacks a common ground and standard reports for the CE. This heterogeneity in the implementation of the CE has created confusion. Figure 6 portrays that, starting in 2016, the CE is still in the validity challenge phase. In the last decade, much more has been achieved theoretically and practically. It could be concluded that the development of CE concepts is progressive but has not been fully implemented. Hence, the researcher has concluded CE developments to be *“Progressive but in Validity Challenge Phase”*.

The green arrow in Figure 6, which is at an angle between the horizontal axis: permanent issue and line of coherence, is the present state of CE adoption. The degree of coherence, which is the sum of the degree of acceptance and degree of gap ($\text{Degree of Coherence} = \text{Degree of Acceptance} + \text{Degree of Gap}$), has illustrated that there still is a gap in the implementation of the CE. But there is also a degree of acceptance fueled by the circular developments and practices in advanced and developed countries. In the global context, after the inception of the EMF and the publication of its seminal papers, the EU and countries like China and Japan are aggressively trying to implement CE philosophies by bringing policy-level reforms, but the other hand, a vast majority of the countries and civilization are still either unaware or lack enough resources to transition from LE to CE.

Figure 6 states the development and achievements made in CE since 2016. Compared to the preamble and excitement phase, tremendous analytical and technical introspection related to CE has been carried out. CE is diffusing and diversifying, but still, there exist numerous challenges in the implementation of CE. Hence, this study concludes by highlighting CE to be in the validity challenge phase and, at the same time, notes that the development has been positive and progressive. However, most global communities are still unaware of the concept, importance, and implication of CE at the micro, meso, and macro levels of the economy.

Though CE has a positive and promising impact on ecological, economic, and social frontiers in society, there is still an absence of studies related to the practical implementation of CE that would support company, market, or the government to transition from the existing LE to the paradigm modality of the CE (see Table 1).

After analyzing 27 sampled CE definitions, the researcher proposed a CE definition incorporating the philosophy of responsible and ethical consumption, encapsulating cultural dimension and promising future for upcoming generations. The researcher noted the divergence in the definitions of the CE which justifies the diffusion of the CE across the industries. Still, at the same time, this heterogeneity and lack of homogenous nomenclature could have created confusion in the understanding and adoption of the CE [12]. A plethora of authors: Centobelli et al. [45], de Oliveira et al. [159], Hosseinian et al. [165], Masi et al. [113], Saidani et al. [116], Sassaneli et al. [136], Tapia et al. [54], and have mentioned the prevalence of a lack of clarity in CE concepts and definitions throughout the study.

The second section concluded that business communities' and governments' traction toward the CE is rising [33,36,76]. Table 1 portrays the increase in the number of CE-related papers in Google Scholar; it was 500 in 2000, which increased to 21,903 in the middle of July 2021. The CE is rapidly diversifying and diffusing across industries. The chronological study carried out through the sampled period from 2016 to 2021 has listed multiple themes generated across the sectors (see Table 4 to Table 10) and finally categorized 22 themes to which the sampled papers were related. While a significant number of articles were still referring to the lack of clarity of the CE, a sizable number of documents were also working to understand the CE concept (see Table 10).

Upon reconciliation of the extant literature related to CE with the umbrella framework as previously studied by Blomsma and Brennan [39] and Friant et al. [38], this study concluded that the development of CE concepts in theory as well as in the practical dimension is still in the validity challenge phase but is in the progressive and positive direction. As listed in Table 11, though there is still the presence of confusion related to the CE, it should not be neglected that there are also studies related to newer premises like circular design, the CE as a transdisciplinary field, CE matrices and indices, and sectoral studies related to the CE (see Table 11) which provides ample reasons for us to believe that the CE is being experimented with and tested rigorously. Figure 6 depicts that though there is a degree of acceptance, the degree of the gap must be eliminated for the CE to be fully diffused in the social spectrum. To minimize this gap, enablers for the CE should be implemented.

4. Conclusions

The study concluded that there is rapid development in concepts and taxonomies related to the CE. During the study, it was observed that the CE concepts were being employed across multiple industries; for example, the researcher found CE-related studies in the construction industry [121,181,182]; service industry [34,183]; tourism industry [120,184], agriculture industry Chen & Sun [94], chemical industry ([134]; green logistics Seroka-Stolka & Ociepa-Kubicka [73] and many more. However, at the same time, this diversification of CE has brought some confusion which numerous researchers in their papers have noted. Homrich et al. [12] stated that CE is still in the explanatory phase and lacks a confirmatory approach and empirical validation; likewise, Korhonen et al. [77] asserted that CE still seems to be a collection of vague and separate ideas from several fields and semi-scientific concepts. Sassaneli et al. [136] pointed out that there is still a lack of standard CE performance assessment methodologies.

As recently as 2021, authors are still claiming that CE lacks an evidence-based framework Velenturf & Purnell [56]; the focus is more on end-of-life (EOL) rather than overall product life cycle management Hosseinian et al. [165]; CE stills lacks social impact and assessment indicators de Oliveria et al. [159]. Further, during the research, it was evident that studies are still being conducted to understand the concepts of CE [16,38]. These facts may compel us to infer that CE is still in its infancy, as noted by Murray et al. [4] and Saidani et al. [82].

The conclusions made by the researcher in this research are that CE is still in the validity challenge phase, and the development in a progressive and positive direction is promising. The environmental, economic, and social benefits that the CE could provide are undeniable [51,53]. The focus on CE and its strategies through numerous resource life cycle extension strategies (RLES) would help to enhance the productivity of the resources and reduce the burden on the environment Tapia et al. [54]; further 3R approaches would generate new jobs in the economy, and that would bring social change in the life of the communities. The researcher in this study pointed to significant development in the studies related to the CE; the same studies are being carried out with higher complexity over time. The integration in the global value chain and a systemwide holistic approach is needed for the diffusion of CE worldwide. Kirchherr et al. [4,22]; and in the same line, Konietzko et al. [154] asserted that CE is not related to a single product but rather is the outcome of the overall system.

However, the diffusion of the CE has not been homogeneous across the globe; ref. [180] pointed out that the CE approaches and understandings have been different across the global north and global south; likewise, the rate and intensity of the CE diffusion in the developed and underdeveloped countries have been different. Most CE-related research was carried out in EU countries and China, representing emerging economies. In contrast, advanced countries like the USA, Canada, and Australia were not so profoundly involved in CE policies and practices.

Thus, it would be wrong to say that the CE has not made progress, but it would not be correct to say that CE is fully diffused and accepted in the market. That is why the researcher in this study concluded that CE is in the validity challenge phase, which is positive and promising. And still, much work is needed to make the CE fully adopted in the local, regional, and global arena.

4.1. Results Comparison with Other Previous Findings

The researcher concluded an exponential increase in the number of studies related to CE concepts which was also noted by Alhawari et al. [41], and Mahanty et al. [59]; but at the same time, during the study, it was tougher to find literature which was related to the practical implementation of the CE in the real corporate world; data-wise, as of the middle of July 2021, there were 21,800 CE related publications, out of which only 108 papers were related to the applications of the CE (see Table 1); in the same line, Centobelli et al. [45] had highlighted a lack of studies to support the business transition from the LE to the CE which could have hindered the implementation of the CE in the business world. While most previous studies related to assessing the CE concepts have used bibliometric analysis and citation [6,12,16,39,41,82] this study has focused on the thematic and content analysis.

Throughout the study, it was inferred that the diffusion of CE in the social dimension has been reluctant; out of 27 papers sampled for the assessment of CE definitions, only 2 of the CE-related definitions had mentioned the term “social”, and the same was concluded by de Oliveria et al. [159], [4], and Velenturf and Purnell [56]. Moreover, due to the lack of a governing and regulating body, CE lacks a proper and standard definition; during the study, CE definitions were industry specific which has created confusion and a lack of clarity in the implementation of CE; Friant et al. [38]; Garcia-Barragan et al. [176]; and Homrich et al. [12] have also stressed the requirement of homogeneity, clarity, and unambiguous CE definitions.

One of the primary objectives of this study was to develop a holistic CE definition and assess the development of the CE concepts through an umbrella framework; in contrast to the previous research, this study brought up the concept of ethics, culture, and reassurance in CE definitions. The researcher continued and supported the findings of [39] and Friant et al. [38] and stated that the CE is still in the validity challenge phase but inferred that CE-related developments are positive and progressive.

4.2. Policy Level Recommendations and Interventions

Focus on Policies and Programs to Increase Awareness

It was observed that companies, markets, and governments are not fully aware of the CE's concept, strategies, and impact when it comes to the CE. Hence it should be made a priority to make all of the involved stakeholders aware of the CE.

- Education plays a prominent role in making people aware of the CE and its impact on economic, ecological, and social frontiers. A positive relationship between the education of the CE and its implementation has been concluded [9,74,138,185]. Hence, initiating and introducing CE and sustainability-related academic curricula in schools, colleges, and universities, along with higher degree specialization in the CE and sustainability, would help to make students and practitioners aware of the CE.
- There still exists a misconception about refurbished and recycled products being of lower quality [186] the market should be aware of the financial and ecological benefits it brings to the ecosystem. Likewise, the companies involved in CE activities should assure the market about the quality. Various certifications and labeling on the product and process could be conducted [187,188]. The labeling and certification assure the quality of the circular products.
- A receptive organizational culture that would be ready to accept the changes should be developed. The CE often requires paradigm changes, and resistance against it might be developed in the organization and the communities. The principle of responsible research and innovation (RRI) should not be forgotten [189]; the stakeholders should perceive the CE innovations or changes as desired. The organization could organize workshops, training, and seminars on the CE to enhance awareness about the CE.

4.3. Prioritization of CE Activities

The CE is a system-wise holistic approach that focuses on the product life cycle rather than the end-of-life of the product alone. The same rule of thumb might not be applicable for all; it has to be custom tailored.

- When it comes to the transition from the LE to the CE, the assessment of the available circular resources should be carried out, and circular strategies should be crafted depending on the circular expertise, resources, knowledge, and skills. Companies could focus on circular design (uphill strategies), resource life cycle extension strategies (top hill), or value retention (downhill), or all of them depending on the expertise they have [101,145]. For example, a company focusing on uphill strategies are more into circular product designs, modular product design, ethical extraction, and the procurement of resources; a company emphasizing top hill strategies focuses on RLES like performance economy, servitization, sharing economy, digitalization, and bringing products/components back into P&C cycle, and a company prioritizing downhill strategies focuses on EOL strategies like refurbishing, remanufacturing, and recycling.
- Likewise, the country may also have its stock of circular resources. Collaboration and cooperation are essential in developing CE across the global arena [77,190]. Since the developed and advanced countries are technically superior, they often could prioritize R&D and develop innovative CE products; they could focus on upcycling, whereas the poor and LDC are the recipients of circular innovations and would often focus on EOL strategies like recycling.

4.4. Creation of Regional Block, Special Interest Committee for the CE

The regional blocks are the groups that share the common objective for the betterment of the group members.

- The initiation of the unique regional block should be a priority with the focus on mitigating excessive resource consumption, uncontrolled extraction of virgin resources, and sharing of technical and non-technical resources across the block for

CE-related integration and cooperation. The CE is not only limited to enhancing resource productivity but is also a transdisciplinary approach with a cross-domain impact. The CE's application and implementation help to achieve SDGs and mitigate climate-related problems.

- The concept should be further discussed, prioritized, and practiced. Forums like the World Economic Forum (WEF), World Bank, and IMF Annual Summits, G7, G20, and OECD should focus on the CE and sustainability.

4.5. CE Resource Hub: A Common Point

There is a lack of enough technical, as well as non-technical, resources related to the implementation of CE. Compared to the EU countries, the USA lags far behind when it comes to implementing the CE at the corporate and policy levels. Some of the steps to make CE-related resources available:

- Making the data related to the CE and its indicators available at ease. This would promote theoretical as well as empirical studies related to the CE. These data are available on their websites for the EU and most OECD countries.
- Providing CE-related toolkits to guide and support the implementation and transition. These should be specifically designed for businesses based on their nature: service, manufacturing, and agriculture, since the CE strategies could be different depending on the nature of the industry.
- Likewise, the toolkits, techniques, matrices, and measurement KPIs related to the CE for the overall management to the CE transition should be made available.
- While collecting archival data for this study, the researcher had to refer to multiple sources. It was time-consuming. The USA should put effort into supporting CE-related studies at a regulatory level.

4.6. Coordination and Cooperation across the Value Chain

The CE is a supply chain-wide transdisciplinary approach [34] and is an umbrella concept covering multiple domains and philosophies [39,40]. Coordination and cooperation for the cross-pollination of ideas are essential.

- For example, waste created while manufacturing a product could be used as input for manufacturing another product. Similarly, cooperation should not only be limited to the flow and sharing of resources and by-products. There should be cooperation among government, non-government agencies, and universities to share their expertise in CE and sustainability.
- Here, agencies and institutions, such as the World Bank, National Science Foundation (USA), U.S. Energy Information Agency, U.S. Environment Protection Agency, and International Resource Panel (IRP), should come jointly to share their CE and sustainability-related knowledge and skills.

4.7. CE-Related Policies and Regulations

The CE and its principles are being incorporated by EU countries and emerging nations like China; these countries have made the CE and sustainability the mainstream national agenda and formulated multiple laws and regulations to transition from the LE to the CE of P&C. But at the same time [6] noted that countries like Canada and the USA have been reluctant to align with CE policies and procedure. The same was observed in this research; too, the researcher found hardly any papers related to the CE regarding the USA. Policy-level interventions are the most common; some of the factors that should be considered while doing so are:

- Bring a policy that focuses on managing the resources throughout its life rather than having a policy to only manage the product after the end of its life (EOL). Most of the policies in the USA are focused on managing waste, like sorting and recycling waste.

- A policy should be in place which focuses on the minimal extraction of resources from the Earth and prioritizes the re-looping of the existing resources through RLES (for example, 3R).
- The policy should support the ethical, responsible, and green procurement and logistics of resources; likewise, modular and standardization principles in product design should be facilitated and promoted. Modular design supports easy repair and maintenance, and standardization supports the cross-utilization of product components and the product itself. For example, if the laptop companies are required to have the same type of charger, then the consumer could use the same kind of charger throughout the range of products.
- Depending upon the urgency and requirement, the CE-related policies could be made mandatory or voluntary.
- Imposing taxes on polluting items and activities supports circularity. Likewise, a recycling tax and environment tax helps to foster the treatment of the products after their EOL.
- Policies and interventions should change the energy production and consumption model. Projections to 2035 show that as much as two-thirds of energy efficiency potential will remain untapped unless policies change International Energy Agency [191].
- Financial and non-financial benefits to businesses should be in place that would intend to focus on CE and sustainability.
- Policy should be formulated aggressively to support reverse logistics, extend producer responsibilities, and product take-back schemes.

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