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Mapping Research Trends in Responsible Consumption and Production: A Bibliometric Analysis of SDG 12 and Circular Economy Practices

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Abstract

Sustainable development has become a critical global priority, focusing on balancing environmental protection, economic growth, and social well-being to ensure a thriving future for generations to come. This study examines the evolution of research on responsible consumption and production, particularly within the framework of Sustainable Development Goal 12 (SDG 12) and circular economy practices. The findings reveal a significant increase in scholarly interest from 2010 to 2024, with notable growth in publications post-2018. Key aspects, such as access types, document classifications, geographic distribution, keyword co-occurrence, collaborative networks, and citation trends, are analyzed. The results show a strong preference for open access publishing, with "Gold" and "Hybrid Gold" dominating, while journal articles represent the primary document type. Geographic analysis highlights Europe, particularly the United Kingdom and Italy, as leading contributors to the research. Keyword co-occurrence analysis identifies circular economy and sustainable development as central themes, interconnected with subtopics like waste management and policy frameworks. Collaborative networks underscore the role of influential authors like Serenella Sala and countries such as the UK and Germany in fostering global research. Citation trends demonstrate exponential growth, especially from 2015 onward, reflecting the rising relevance of sustainability research. A comparison of key journals reveals variations in CiteScores, with Resources, Conservation and Recycling achieving the highest impact. The study emphasizes the interdisciplinary and global nature of research in advancing SDG 12 and circular economy practices, underscoring the importance of collaboration, accessibility, and impactful dissemination. This study provides valuable insights and data-driven analysis that can guide researchers, policymakers, and governments in formulating evidence-based strategies, fostering collaborations, and implementing effective policies to advance sustainable consumption and production practices, thereby contributing to the achievement of global sustainability goals.

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1. Introduction

The UN Sustainable Development Goals (SDGs) are designed as global objectives, applicable to both developed and developing nations. They integrate the economic, social, and environmental aspects of development (UN, 2015). The global shift towards sustainability has heightened the significance of responsible consumption and production patterns, as emphasized by the United Nations' Sustainable Development Goal 12 (Gasper et al., 2019; Guevara & Julián, 2019). With environmental challenges such as resource depletion, waste accumulation, and climate change escalating, integrating principles of responsible production, resource efficiency, and circular economy into sustainable development strategies is paramount (Islam & Zheng, 2024; Kandpal et al., 2024; Sagar et al., 2023).

Responsible Consumption and Production (RCP) is a cornerstone of sustainable development, as articulated in the United Nations Sustainable Development Goal 12 (Chan et al., 2019; Huck, 2022; Shah & Shah, 2023). This goal emphasizes the need to ensure sustainable consumption and production patterns to address pressing global challenges, such as resource depletion, environmental degradation, and social inequality (Bengtsson et al., 2018; Monaco, 2024). RCP is crucial for balancing economic growth with ecological sustainability and social well-being, fostering a more equitable and resilient future (Lin et al., 2024; Shukla et al., 2024). The concept of RCP aligns with the principles of the circular economy, emphasizing resource efficiency, waste minimization, and the transition from linear production models to regenerative systems.

Research in this area often explores innovative approaches to sustainable supply chain management, consumer behaviour, policy frameworks, and technological advancements. These studies aim to identify strategies to reduce environmental footprints, promote ethical production practices, and encourage pro-environmental consumer behaviour.

In recent years, there has been a surge in scholarly interest in RCP, as researchers seek to address gaps in knowledge and provide actionable insights for policymakers, businesses, and communities. By analyzing research trends in this domain, we can better understand the evolution of the field, identify key areas of focus, and uncover opportunities for future exploration. Mapping these trends is vital for fostering interdisciplinary collaborations, enhancing the impact of academic research, and advancing

the global agenda for sustainability. Despite growing research interest, a comprehensive understanding of the interconnections between these areas remains fragmented. Keywords such as "Responsible Consumption," "Sustainable Consumption," "Consumption Patterns," "Responsible Production," "Sustainable Production," "Resource Efficiency," "Circular Economy," "Waste Management," and "Environmental Impact" frequently appear in academic literature but lack a cohesive analytical framework to explore their relationships systematically.

Although the adoption of sustainable practices is crucial for addressing global environmental challenges, the literature lacks a structured synthesis of research efforts related to responsible consumption and production within the context of SDG 12. The diversity of terminologies and approaches has led to a scattered body of knowledge, making it difficult for stakeholders to identify actionable strategies for achieving sustainability goals. This fragmentation hinders the ability to assess research trends, collaborative networks, and thematic clusters that can inform policy-making and industrial practices.

Existing studies on responsible consumption and production often focus on isolated aspects such as waste management, circular economy practices, or sustainable consumption. However, there is limited bibliometric analysis that integrates these dimensions within the broader scope of SDG 12. Moreover, gaps persist in identifying high-impact keywords, collaborative research networks, and emerging trends that bridge the nexus of consumption, production, and circular economy with global sustainability goals. This study aims to map research trends in responsible consumption and production by conducting a bibliometric analysis of Sustainable Development Goal 12 (SDG 12) and circular economy practices. It seeks to identify key themes, emerging trends, influential works, and knowledge gaps within the scholarly discourse, providing insights into how these practices contribute to achieving sustainability goals globally. To address this aim, the following research questions have been formulated:

1. What are the dominant themes and trends in the literature concerning responsible consumption, production, and circular economy practices?
2. How do the research clusters interconnect, and what are the most influential keywords and themes in the context of SDG 12?
3. What are the collaborative patterns among researchers, institutions, and countries in this domain?

4. What research opportunities exist to advance the integration of responsible consumption and production into sustainability strategies?

2. Background

Sustainable Development Goal 12, focusing on responsible consumption and production, aims to ensure sustainable use of natural resources while minimizing waste and environmental impact. The integration of circular economy practices—such as recycling, resource efficiency, and waste management—is recognized as pivotal to achieving this goal. Over the past decade, academic interest in these areas has surged, reflecting the urgency of transitioning to sustainable systems.

In the 1970s, the scientific community recognized that unsustainable development posed significant risks of environmental and economic collapse. This realization was encapsulated in the "limits to growth" model proposed by the Club of Rome (Meadows et al., 1972). Over the decades, sustainable development has become an essential strategy for the survival of humankind, with researchers emphasizing it as a "no alternative" approach (Seiffert & Loch, 2005). Sustainable development integrates consumption and production systems as a critical goal, elevating the importance of sustainable consumption and production (SCP) patterns to a global priority (Akenji & Bengtsson, 2014; Lozano et al., 2015).

The sustainable management of natural resources is integral to achieving economic growth without compromising environmental health, as emphasized in Sustainable Development Goal (SDG) 12. Globally, the value of natural capital has increased by 26.8% between 1995 and 2018, demonstrating the possibility of economic growth alongside resource preservation (World Bank, 2021). However, disparities persist; for instance, while Vietnam doubled its natural capital through sustainable practices like expanding renewable resources, Nigeria experienced a 50% decline due to unsustainable resource use (World Bank, 2021). Such unsustainable trajectories, as seen in the United Arab Emirates, highlight the risk of depleting non-renewable resources, which constrains long-term economic stability.

Governments, private sectors, and individuals play vital roles in promoting sustainability. Government actions, such as reducing fossil fuel subsidies, address SDG Target 12.c by discouraging reliance on non-renewable resources and mitigating greenhouse gas emissions (UNSD, 2021). The private sector can contribute by incorporating sustainability practices into

operations, exemplified by increased sales of electric vehicles and the rising number of companies publishing sustainability reports in high-income countries (IEA, 2022; World Bank, 2023). For citizens, reducing food waste, particularly in wealthier regions where significant losses occur at the consumption stage, can lower the demand for natural resources and support SDG Target 12.3 (Flanagan et al., 2019).

International conferences have further emphasized SCP, with key milestones including the Johannesburg Plan of Implementation in 2002, which urged all countries to promote SCP patterns, led by developed nations for the benefit of all. The 2012 United Nations Conference on Sustainable Development (Rio+20) reaffirmed SCP as a cornerstone of sustainable development, proposing the 10-Year Framework of Programmes on SCP (Akenji & Bengtsson, 2014).

To achieve comprehensive risk and sustainability assessments in water resource management, a systems-thinking approach is essential to address the complex interrelations between human and natural environments (Simonović, 2009). Research on environmental and natural resource management, particularly water resource management, highlights the value of systems thinking to reduce complexity and interpret interconnected elements as a whole (Seiffert & Loch, 2005; Kotir et al., 2016; Smithson et al., 2008). Studies further support systems-thinking methodologies to effectively manage risk and sustainability challenges in real-world scenarios (Di Baldassarre et al., 2013; Onat et al., 2017; Mai et al., 2020; Rubio-Martin et al., 2020). Achieving SDG 12 is crucial for aligning economic growth with environmental conservation. Failure to adopt sustainable practices could impede progress on climate change (SDG 13), clean energy (SDG 7), and sustainable cities (SDG 11), while exacerbating global challenges like pollution and biodiversity loss (World Bank, 2021). Collaborative efforts from all stakeholders are essential to ensure that production and consumption patterns support long-term sustainability.

3. Methodology

A bibliometric approach provides an effective means to analyse the vast and diverse body of literature, offering insights into emerging themes, collaborative networks, and the intellectual structure of the field. Bibliometric analysis employs quantitative methods to evaluate scholarly outputs, highlighting publication trends, influential authors, and thematic clusters. By applying Boolean keywords (e.g., "Responsible Consumption,"

"Circular Economy," "Sustainability") and analysing their co-occurrence, researchers can uncover critical linkages and areas requiring further exploration. This approach is instrumental in bridging research gaps and guiding future studies to align with SDG 12 objectives. This method allows researchers to filter out irrelevant studies and retrieve a more targeted set of publications that specifically address themes linked to SDG 12, such as resource efficiency, sustainable production, waste reduction, and circular economy practices.

3.1 Data Collection and screening

The bibliometric analysis was conducted using Scopus, a widely recognized academic database. Boolean keywords, including "Responsible Consumption," "Sustainable Production," "Circular Economy," and "SDG 12," were applied to retrieve relevant records. The search was restricted to peer-reviewed articles and reviews published in English between 2000 and 2024 to ensure high-quality and contemporary data. Retrieved records were screened to remove duplicates, conference papers, and irrelevant publications. A final dataset comprising 1,500 records was curated for analysis.

3.2 Analysis Tools

The study utilized VOSviewer for data visualization and network analysis. These tools facilitated the identification of co-occurrence of keywords, citation networks, and research clusters.

3.3 Key Metrics

3.3.1 Keyword Co-occurrence

Keyword co-occurrence analysis is a powerful bibliometric technique used to evaluate the frequency and strength of relationships among keywords within the selected body of literature. By analyzing the co-occurrence of keywords, this study aims to uncover key themes and research topics that dominate the discourse on Sustainable Development Goal 12 (SDG 12) and circular economy practices. The analysis will also help to identify emerging areas of interest and conceptual overlaps, providing insights into the interconnectedness of ideas. Using visualization tools, such as VOSviewer or Gephi, the study will construct keyword networks, highlighting clusters of closely related terms and their connections.

3.3.2 Citation Analysis

Citation analysis serves as a measure of the academic impact and influence of articles, authors, and journals in the field of responsible consumption and production. This study will identify highly cited works to determine foundational studies, groundbreaking contributions, and leading researchers. Furthermore, citation analysis will reveal citation patterns that can indicate the direction of scholarly interest and the evolution of critical concepts over time. By identifying the most influential journals, this analysis will provide guidance for future researchers seeking high-impact publication outlets.

3.3.3 Collaboration Networks

Collaboration networks analysis investigates the partnerships among researchers, institutions, and countries contributing to research on SDG 12 and circular economy practices. This metric will examine the structure of co-authorship networks to identify key collaborators, the density of collaborations, and the global or regional hubs of knowledge production. By mapping the extent and nature of these collaborations, the study will provide insights into how interdisciplinary and cross-institutional partnerships shape the advancement of this field. Patterns of international collaboration will also reveal the role of global and local efforts in addressing sustainable consumption and production challenges.

3.3.4 Cluster Analysis

Cluster analysis involves grouping similar research topics or themes into clusters based on their interconnections, using bibliometric data such as keyword co-occurrence or citation relationships. This study will employ cluster analysis to identify thematic clusters within the literature, revealing the major research areas and subfields in SDG 12 and circular economy practices. The resulting thematic maps will illustrate how clusters interact and overlap, highlighting potential areas for interdisciplinary research and knowledge integration. Cluster analysis will also enable the identification of niche topics that have yet to gain significant attention, providing a roadmap for future studies.

3.3.5 Visualization:

Graphical representations of keyword networks, thematic clusters, and collaborative networks were generated to provide actionable insights into the research landscape. Visualization is a crucial component of bibliometric analysis, offering a clear and intuitive representation of complex data

related to SDG 12 and circular economy practices. By utilizing advanced visualization tools such as VOSviewer, Gephi, and R-based libraries, the study will present data through networks, heatmaps, and thematic maps. These visualizations will include keyword co-occurrence networks, citation networks, and collaboration networks to provide an interactive and dynamic understanding of relationships between various entities.

Visual maps will help identify dominant research themes, influential authors and institutions, and patterns of global collaboration. Furthermore, cluster visualizations will depict the thematic grouping of research topics, allowing for the exploration of trends and interconnections within the field. Time-based visualizations, such as overlay maps, will illustrate the evolution of research focus over time, showcasing how the discourse around responsible consumption and production has progressed and adapted to emerging challenges. These visual tools will serve not only as analytical aids but also as a means to communicate findings effectively to diverse audiences.

By employing this methodology, the study aims to systematically map the intellectual structure of responsible consumption and production research, offering valuable insights for academia, policymakers, and practitioners striving to advance sustainability.

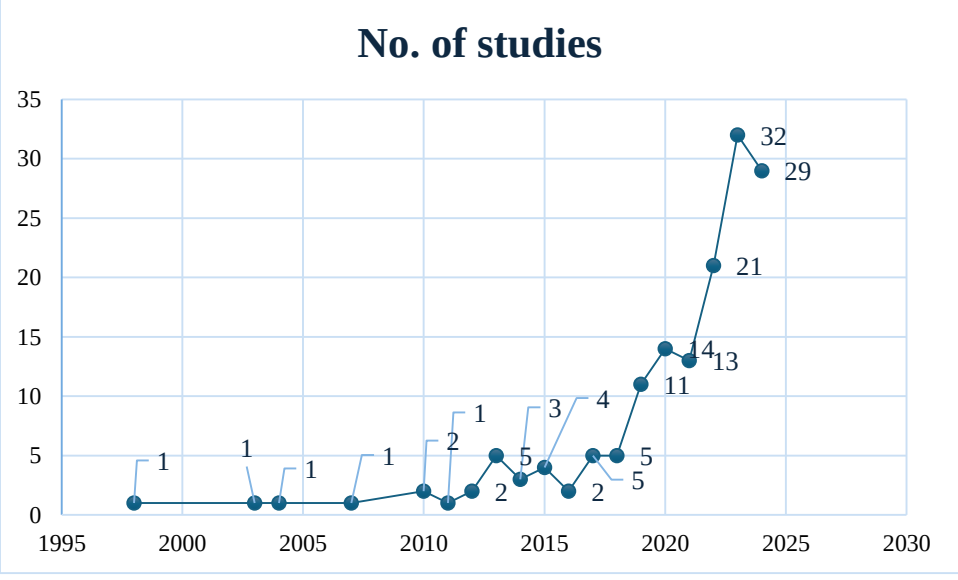
4. Overview of the studies

4.1 Evolution of the studies

The evolution of the study on responsible consumption and production, particularly within the framework of SDG 12 and circular economy practices, reflects the growing global emphasis on sustainable development as a response to environmental, social, and economic challenges. Figure 1 shows the evolution of the studies on SDG 12 and the circular economy.

Figure 1

Evolution of the study



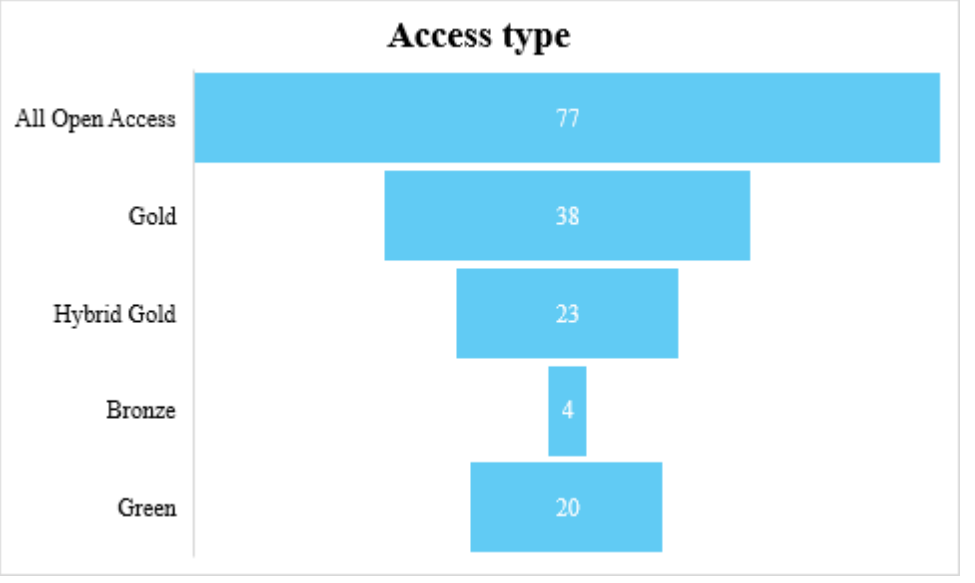
The results show a noticeable increase in the number of studies related to circular economy and sustainability from 2010 to 2024. There was a steady growth in publications, particularly in the past few years, with 29 studies in 2024 and 32 studies in 2023, suggesting a rising academic interest in these topics. The trend indicates that the concept of circular economy has gained significant traction in recent years, especially from 2018 onwards, with the number of studies consistently growing each year. This surge could be attributed to the increasing global focus on sustainability and environmental concerns, as well as advancements in related technologies and practices. The earlier years (prior to 2015) had comparatively fewer studies, reflecting the more recent emergence of circular economy as a prominent field of research.

4.2 Access type

Access type in journals refers to the classification of journal articles based on their availability to readers, distinguishing between open access, where articles are freely available to the public, and subscription-based access, where articles are behind paywalls and require a subscription or institutional access for full-text retrieval. Figure 2 demonstrates the access type of the journals.

Figure 2

Access type of journals



The distribution of open access articles shows a strong preference for "Gold" open access, with 38 articles published under this model, indicating that a significant portion of research is freely available immediately upon publication. "Hybrid Gold" follows with 23 articles, suggesting that many journals are offering open access as an option alongside subscription-based content. "Green" open access, where authors deposit preprints or accepted manuscripts in repositories, has 20 articles, reflecting a growing trend of making research publicly available through institutional repositories. The relatively low number of "Bronze" articles (4) indicates that there is limited access to articles that are freely available on publisher platforms but are not formally open access. Overall, these results highlight a positive movement towards increasing open access availability, with the majority of articles published under the more widely recognized gold and hybrid models.

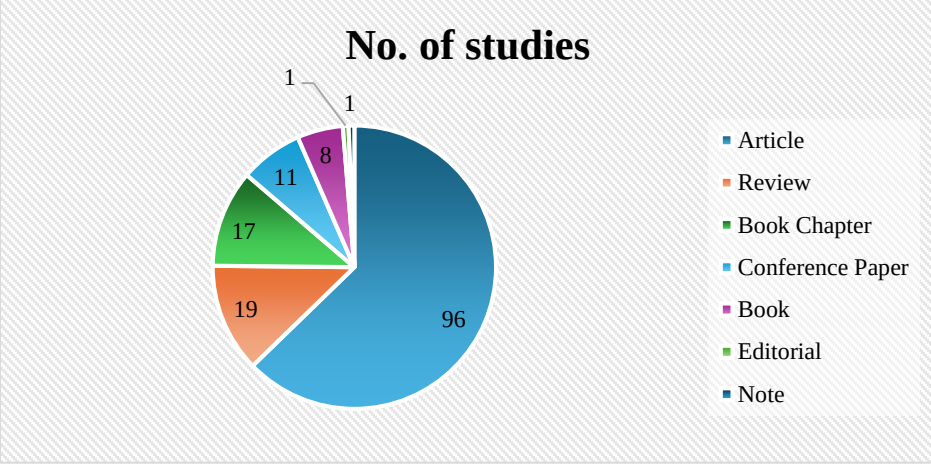
4.3 Document type

Document type refers to the classification of academic publications based on their format and purpose. Common document types in academic journals include original research articles, review articles, conference papers, editorials, book chapters, and short communications. Each document type serves a specific role in disseminating research findings, with original

research articles typically presenting new data and analyses, while review articles synthesize existing knowledge on a particular topic. Figure 3 represents the number of studies based on document type.

Figure 3

No. of studies based on document type



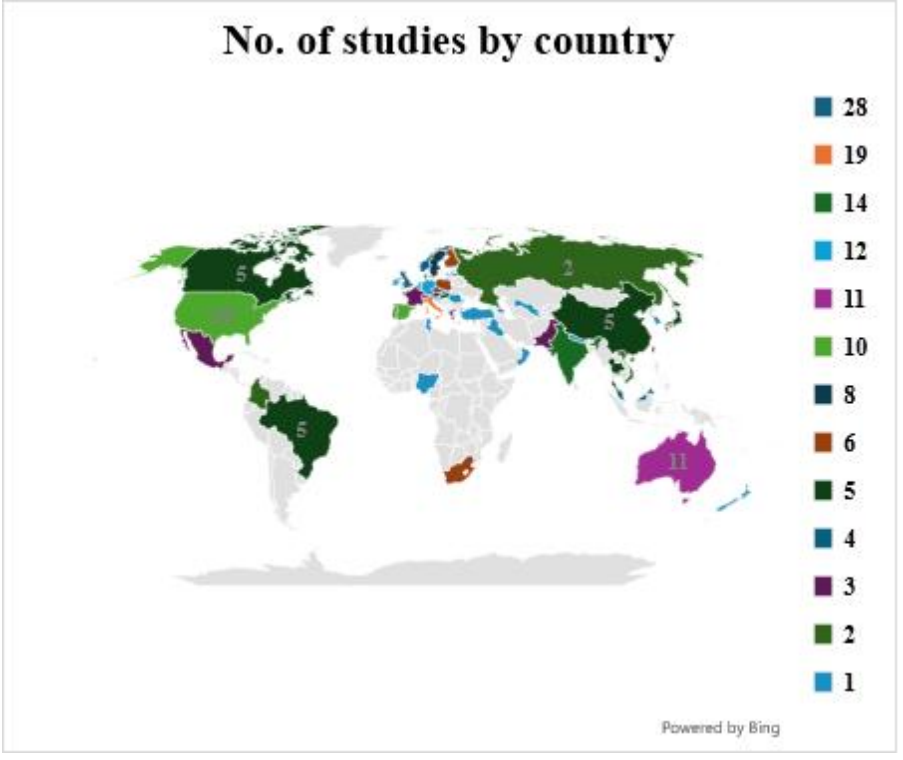
The majority of the studies are published as articles, with 96 articles representing the bulk of the research, indicating that journal articles are the primary format for disseminating research in this field. Reviews (19) and book chapters (17) follow, suggesting that there is a notable effort to synthesize existing research and provide comprehensive insights on the topic. Conference papers (11) and books (8) also contribute to the academic discourse, though they are less frequent compared to articles. The presence of a single editorial and note implies that these formats are less commonly used for presenting research findings in this area. Overall, the results highlight that journal articles are the dominant form of scholarly communication in this field, with reviews and book chapters playing a supporting role in consolidating and discussing broader perspectives.

4.4 Country of publications

The country of publication on SDG 12 (Responsible Consumption and Production) can vary widely, as research on this topic is conducted globally. However, countries with strong environmental policies, sustainability initiatives, and active participation in the United Nations Sustainable Development Goals (SDGs) often have a higher number of publications. Figure 4 demonstrates the number of studies by country in the world map.

Figure 4

No. of studies by country



The distribution of studies by country reveals that the United Kingdom leads with 28 studies, followed by Italy (19) and India (14), indicating a strong research presence in Europe and India. Germany, the Netherlands, and Australia each contribute a notable number of studies (12, 12, and 11, respectively), showing their active engagement in the field as well. Other countries, such as Spain, the United States, and Sweden, also have a substantial number of studies, though at slightly lower frequencies.

The diversity in geographic representation highlights a global interest in the subject, with studies emerging from a wide range of regions, including South Africa, Brazil, China, Japan, and Thailand, all of which have five studies each. However, there are also several countries with fewer studies, such as Azerbaijan, Croatia, Cyprus, and Iraq, each contributing just one study, suggesting a more limited focus on circular economy and sustainability research in these regions. Additionally, the category "Undefined" suggests some studies lack clear country attribution. Overall,

the results demonstrate a broad global engagement with the topic, with a higher concentration of research in Europe, Asia, and Australia.

5. Keywords co-occurrences

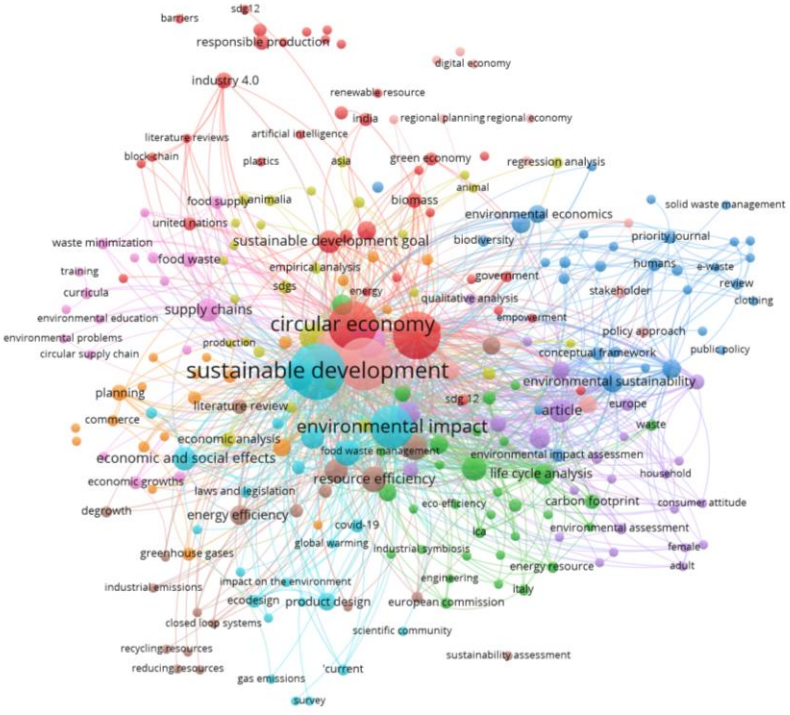
The co-occurrence analysis of author keywords**,** index keywords**,** and all keywords reveals several interconnected clusters, each representing a thematic focus. In all three network diagrams, the central nodes such as circular economy**,** sustainable development**,** and sustainable production exhibit the highest frequency and strongest link strengths, reflecting their pivotal role in the research domain. These terms are surrounded by smaller clusters that represent sub-topics, such as environmental impact**,** waste management**,** and sustainable consumption**,** highlighting the interdisciplinary nature of sustainability and circular economy research.

5.1 All keywords co-occurrence

The occurrence of keywords in research related to SDG 12 (Responsible Consumption and Production) provides valuable insights into the key themes, trends, and areas of focus within the field, reflecting the evolving priorities in sustainable development and circular economy practices. Figure 5 demonstrates keyword cooccurrence analysis of all keywords.

Figure 5

Co-occurrence analysis of all keywords



5.1.1 Overview and Central Keywords

The co-occurrence analysis of all keywords highlights circular economy, sustainable development, and environmental impact as the most frequently used and interconnected terms, positioned prominently in the network. These terms form the backbone of sustainability research, attracting links from various clusters that focus on subtopics such as waste management, sustainability practices, and economic implications. Their central position underscores their multidisciplinary influence, integrating concepts across environmental science, economics, and social studies.

5.1.2 Cluster Insights

The **red cluster**, dominating the figure, represents production and resource management themes, with terms like industrial ecology, resource efficiency, and supply chain forming its core. The green cluster emphasizes environmental concerns, featuring keywords such as ecological effects, pollution, and biodiversity. Meanwhile, the blue cluster revolves around

waste management and recycling, with terms like waste reduction, recycling systems, and solid waste management. These clusters reveal thematic specializations while maintaining strong interconnections through central nodes like circular economy.

5.1.3 Structural Dynamics and Emerging Trends

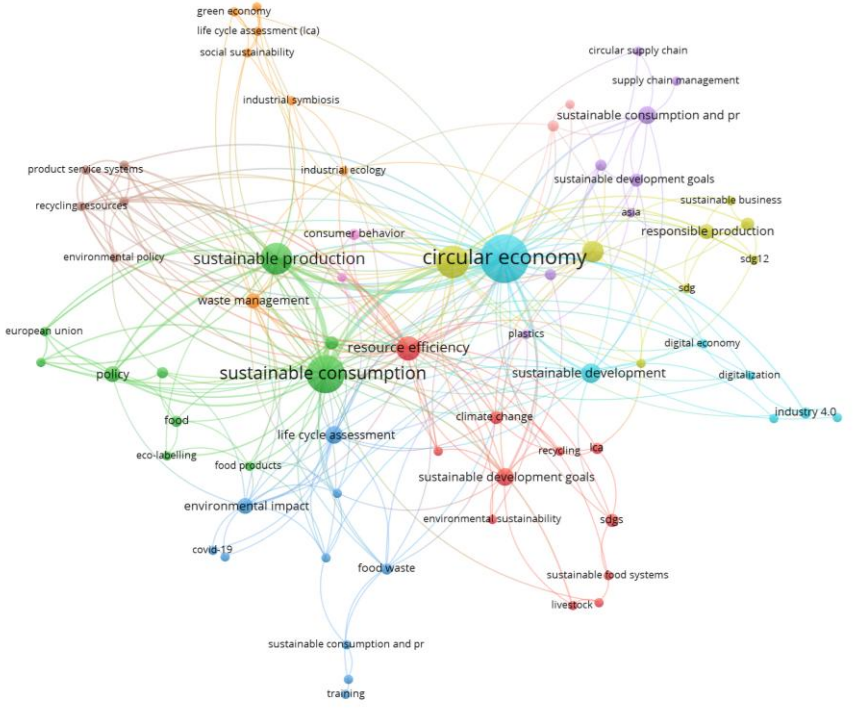
Peripheral clusters highlight emerging trends and niche areas. For example, terms like digital economy, smart cities, and renewable energy suggest technological advancements intersecting with sustainability. The network also reveals cross-disciplinary links, with keywords like social responsibility and economic impact bridging gaps between environmental and economic considerations. The visualization demonstrates the growing integration of sustainability themes with cutting-edge technologies and global policy frameworks.

5.2 Author keywords occurrence

Author keyword occurrence refers to the frequency with which specific terms or phrases chosen by authors appear in research publications related to SDG 12, providing a quantitative measure of the most prevalent topics, concepts, and emerging trends in responsible consumption and production within the academic community. Figure 6 represents the keyword cooccurrences by authors.

Figure 6

Keyword cooccurrence analysis by authors



5.2.1 Central Themes and Focus Areas

The co-occurrence analysis of author keywords shows circular economy and sustainable consumption as dominant terms. These are surrounded by highly linked keywords like sustainable production, resource efficiency, and sustainability goals, indicating a focus on the transition to sustainable business practices. The network reflects author-defined focal points, emphasizing theoretical and applied aspects of sustainability.

5.2.2 Cluster Analysis

The red cluster centres on production systems and industrial sustainability, featuring terms like green supply chain, industrial ecology, and closed-loop systems. The green cluster focuses on consumer behaviour and efficiency, with keywords like consumer behaviour, energy efficiency, and waste minimization. The yellow cluster highlights the policy and economic

dimensions, including policy frameworks, business models, and socio-economic impacts. These clusters reveal a balanced distribution of theoretical, practical, and behavioural insights in sustainability research.

5.2.3 Emerging Connections

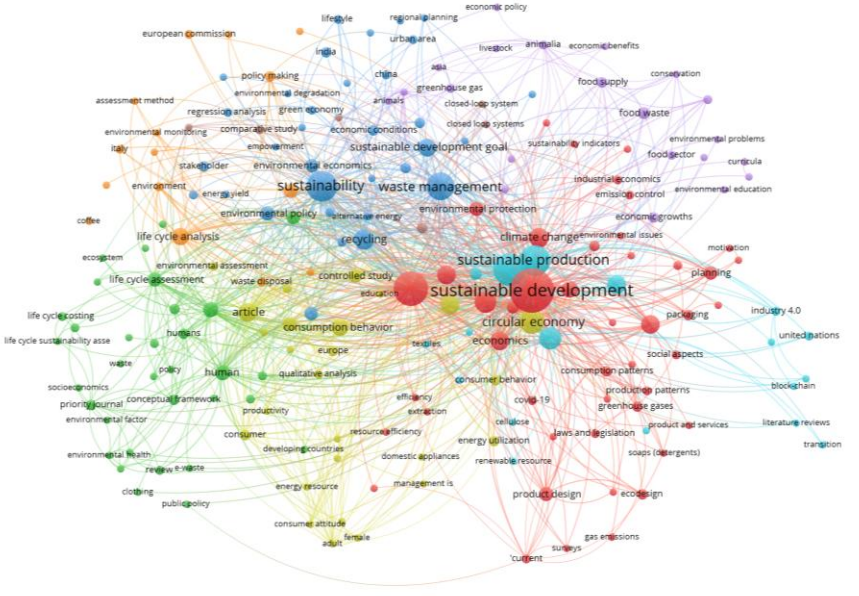
This figure reveals a greater emphasis on actionable strategies, as seen in terms like policy alignment, business innovation, and sustainable resource management, which link multiple clusters. Smaller nodes such as agriculture, bioeconomy, and technology adoption indicate niche areas gaining attention. The co-occurrence patterns suggest a robust interdisciplinary approach, with researchers leveraging diverse fields to develop sustainable solutions.

5.3 Index keywords occurrence

Index keyword occurrence refers to the frequency with which specific terms assigned by the indexing databases appear in research articles, offering insights into the prominent themes and areas of focus related to SDG 12. These keywords reflect the key subjects that databases associate with the articles, enabling a broader understanding of the topics explored in the literature on responsible consumption and production. Figure 7 presents index keyword co-occurrences.

Figure 7

Index keyword co-occurrences



5.3.1 Keyword Dominance and Interrelations

In the analysis of index keywords, sustainable development, sustainable production, and circular economy emerge as central nodes with high frequencies and strong connections. These terms anchor the research network, linking concepts such as sustainable waste management, economic growth, and social equity. Their prominence highlights the importance of systemic approaches in addressing sustainability challenges.

5.3.2 Clusters and Thematic Focus

The red cluster emphasizes industrial systems and production strategies, with terms like life cycle assessment, circular supply chain, and energy management. The blue cluster focuses on waste and recycling systems, incorporating terms like recycling technologies, waste hierarchy, and landfill reduction. The green cluster explores socio-environmental themes, with keywords like community engagement, pro-environmental behaviour, and public policy. These clusters highlight diverse yet interconnected pathways toward achieving sustainability goals.

5.3.3 Network Trends and Opportunities

Peripheral keywords such as climate resilience, halal tourism, and industrial symbiosis point to emerging areas of research within sustainability. The visualization also highlights the growing importance of integrative approaches, with terms like policy integration, circular innovation, and socio-economic impact bridging clusters. The structural dynamics of the network reflect a shift towards holistic, collaborative, and innovative solutions to complex sustainability issues.

Distinct clusters emerge, each characterized by specific themes. For instance, the red cluster in all visualizations focuses on production-oriented aspects, incorporating keywords like supply chain, industrial ecology, and resource efficiency. The green cluster emphasizes consumer and behavioural aspects, linking terms such as consumer behaviour, sustainable consumption, and pro-environmental behaviour. The blue cluster is associated with waste and environmental policies, featuring keywords like waste management, life cycle assessment, and recycling. These clusters demonstrate thematic cohesion while also indicating their interdependence through shared keywords and co-occurrence patterns.

The network structure underscores the centrality of terms like circular economy and sustainable development**,** with numerous connections radiating outwards to peripheral themes. Keywords such as policy**,** economic impact**,** and digitalization connect multiple clusters, suggesting cross-cutting topics that influence various research areas. The variation in node size and link strength represents differing levels of research intensity and thematic focus, with smaller nodes like agriculture**,** halal tourism**,** and renewable energy pointing to niche yet growing areas within the broader sustainability discourse. Collectively, the analysis highlights the dynamic interplay of technological, policy, and behavioural dimensions in advancing circular economy practices.

6. Co-authorship analysis

The co-authorship analysis highlights the interconnected nature of research collaboration among authors and countries. The first visualization reveals the central role of Serenella Sala, acting as a pivotal hub connecting multiple authors from diverse clusters, suggesting her influence and collaboration in multidisciplinary research. In contrast, the second visualization illustrates the interplay of countries in co-authorship, with the

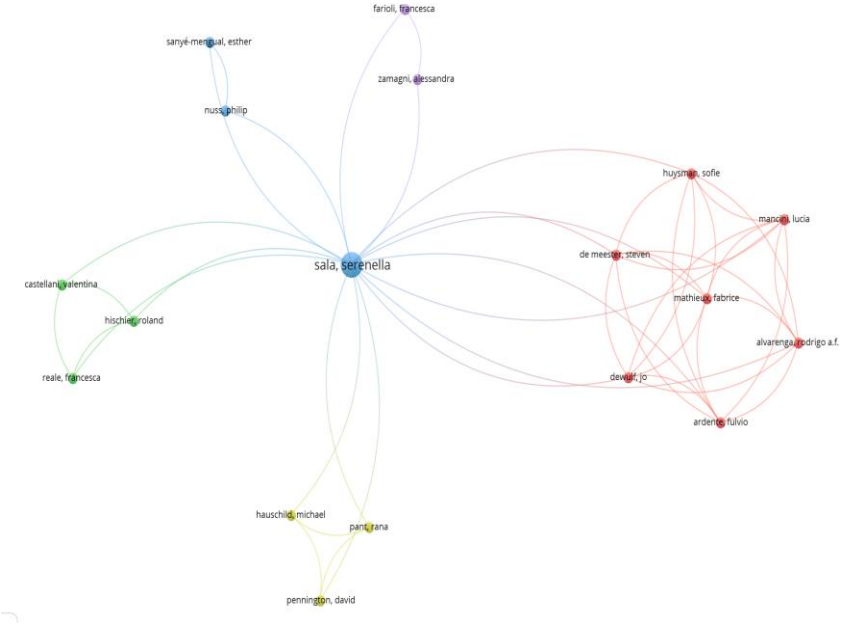
United Kingdom, Italy, and Germany emerging as prominent nodes, indicating their active participation and leadership in global research efforts.

6.1 Author collaboration

Author collaboration refers to the interactions and partnerships between researchers in the field of responsible consumption and production (SDG 12), which can be mapped to examine how knowledge is shared and exchanged. By analysing co-authorship patterns, we can identify key collaborators, networks, and emerging research hubs. These collaborations may indicate trends in interdisciplinary research, international partnerships, and the overall research dynamics contributing to advancements in circular economy practices and sustainable consumption and production patterns. Figure 8 demonstrates author collaboration in the field of SDG 12.

Figure 8

Authors collaboration



The author-based network reveals distinct clusters that signify collaborative groups working on related research themes. Serenella Sala serves as the

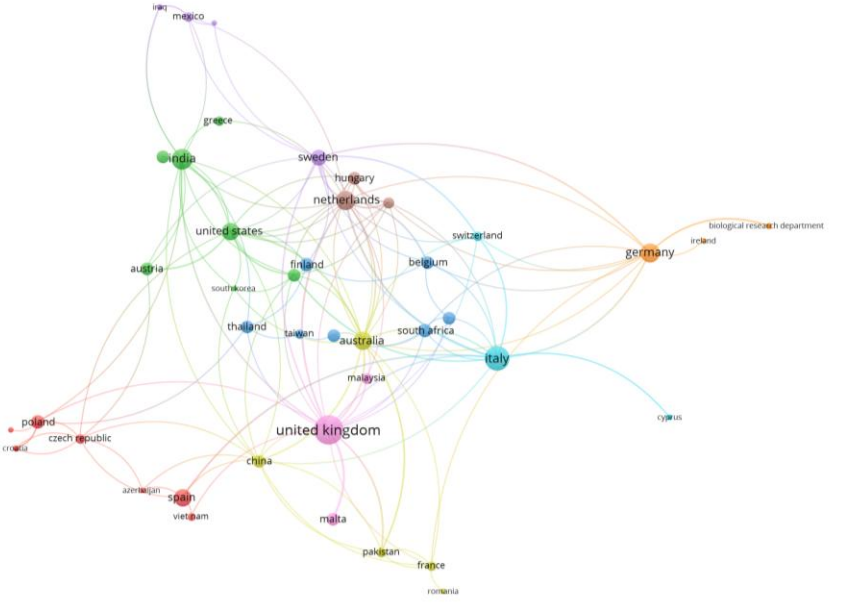
primary node linking multiple clusters, each represented by varying colours. For instance, the blue cluster, including authors like Philip Nuss and Esther Sanyé-Mengual, likely signifies collaboration in a specific research domain. Meanwhile, clusters such as the green (Valentina Castellani and Roland Hischier) and red (Sofie Huysman and Jo Dewulf) highlight specialized teams. The interconnectedness of these clusters through Serenella Sala underlines her role as a unifying figure, fostering multidisciplinary research connections.

6.2 Country collaboration

Country collaboration in research refers to the international partnerships and cooperative efforts between countries in advancing studies related to responsible consumption and production (SDG 12). By analysing country collaboration patterns, we can identify global networks of research, areas of shared interest, and key regions contributing to the development of circular economy practices. These collaborations reflect the cross-border exchange of knowledge, resources, and expertise, which are essential for addressing global sustainability challenges and achieving the targets of SDG 12. Mapping country collaborations helps in understanding the geographical distribution of research and the level of international engagement in promoting sustainable practices. Figure 9 presents country collaboration in the field of SDG 12.

Figure 9

Country collaboration



The country-based network shows several significant clusters denoting regional and international collaborations. The United Kingdom forms the central hub, connecting extensively with countries like the United States, India, and Germany, signifying its global research influence. Smaller, tightly knit clusters, such as those involving Spain and Poland, indicate regional collaborations. Germany stands out with independent connections to specialized entities like the biological research department, showcasing its niche expertise. The diverse interplay among clusters emphasizes the importance of both regional and global collaboration in advancing research.

Both analyses underline the importance of interconnectedness in research. At the individual level, authors like Serenella Sala facilitate knowledge exchange across specialized groups. At the national level, countries like the United Kingdom and Germany play central roles in fostering international research collaboration. The networks highlight the intricate balance between regional specialization and global integration in advancing collective knowledge.

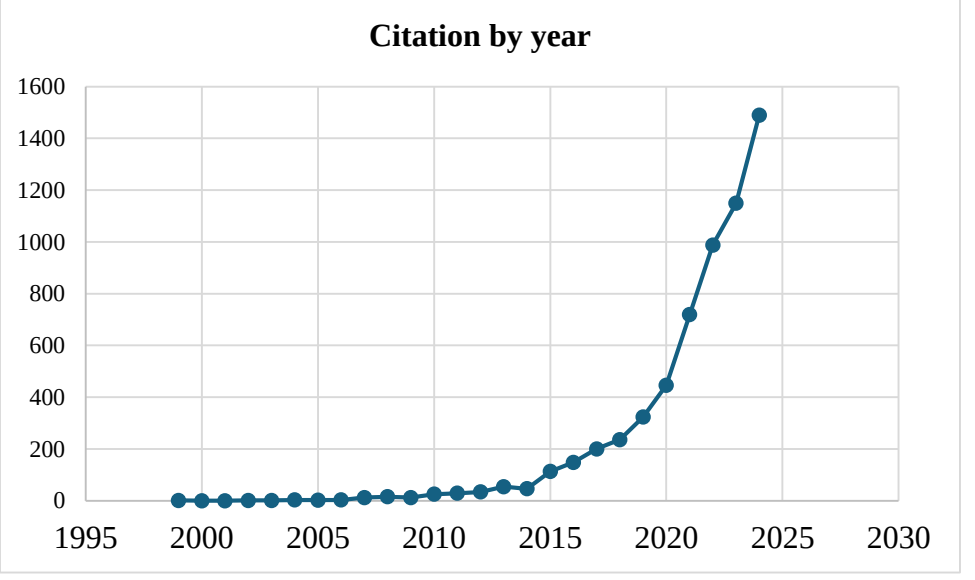
7. Citation analysis

7.1 Year-wise citation

Year-wise citation analysis tracks the frequency of citations over time, providing insights into the evolution of academic interest, the impact of research, and the emerging trends in a specific field, such as responsible consumption and production (SDG 12) and circular economy practices. This analysis helps to identify key turning points in research, highlight influential papers, and understand how scholarly attention to these topics has grown or shifted over the years. Figure 10 demonstrates citation by year.

Figure 10

Citation by year



The citation data reflect a significant increase in the academic impact of research on circular economy and sustainability over time. Initially, the number of citations was relatively low, with only a few citations in the early years (1999-2007). However, from 2008 onward, there has been a steady and substantial rise, particularly after 2015, when citations began to escalate rapidly. By 2021, citations had increased dramatically, reaching 719, and this upward trend continued through 2022 (988 citations) and 2023 (1149 citations). In 2024, the number of citations surged to 1489, indicating that the topic has gained significant recognition and influence in recent years.

This increase in citations suggests a growing interest in circular economy and sustainability research, likely driven by the global emphasis on environmental issues, climate change, and sustainable practices. The sharp rise in citations from 2015 onward also points to the rapid growth of this field, as more studies are published and referenced, highlighting its relevance and importance in both academia and policy.

7.2 Comparison among the journals based on cite score

The table below provides a concise comparison of key academic journals based on their CiteScore range and total citations, highlighting their citation impact and influence across various research areas.

Table 1

Top journals with CiteScore range and total citations

Source	CiteScore Range	Total Citations
Journal of Cleaner Production	5.1 - 20.4	18
Resources, Conservation and Recycling	3.7 - 22.9	18
Science of the Total Environment	5.1 - 17.6	18
Sustainability (Switzerland)	0.2 - 12.5	18
Sustainable Production and Consumption	0.2 - 17.4	22

The data compares sources of citations in terms of their CiteScore, highlighting differences among journals such as Journal of Cleaner Production, Resources, Conservation and Recycling, Science of the Total Environment, Sustainability (Switzerland), and Sustainable Production and Consumption. The CiteScores for these sources vary widely, with higher scores indicating greater citation impact. For instance, Sustainable Production and Consumption demonstrates significant variability, with scores ranging from 0.2 to 17.4, and a strong overall presence with 22 citations. Similarly, Sustainability (Switzerland), despite having lower scores (mostly below 6), shows consistent contributions across many score levels, reflecting broad citation engagement. In contrast, journals like

Journal of Cleaner Production and Science of the Total Environment have relatively higher CiteScores, including values exceeding 14, indicating stronger individual contributions in high-impact areas.

Meanwhile, Resources, Conservation and Recycling stands out for achieving scores as high as 22.9, illustrating its strong influence in specific research areas. This range of CiteScores highlights how different journals contribute to academic impact, with some providing consistent citation engagement across varied levels, while others excel in high-impact categories.

8. Thematic analysis

The integration of circular economy (CE) principles into various sectors has been pivotal for achieving sustainability. This discussion explores three significant themes: Sector-Specific Applications, Integration of Advanced Technologies, and Workforce Empowerment and Behavioural Studies.

8.1 Circular Economy and Resource Efficiency

The concept of the circular economy has emerged as a cornerstone of sustainability, focusing on reducing waste and optimizing resource efficiency through closed-loop systems and recycling processes. Studies emphasize its role in minimizing environmental impact while enhancing economic viability (Geissdoerfer et al., 2017). Resource efficiency, as part of the circular economy, is crucial for industries to adopt sustainable practices in production and supply chains (Geng et al., 2012). The prominence of circular economy and sustainable development as central keywords underscores their pivotal role in sustainability research. These terms encapsulate systemic approaches to resource efficiency, waste reduction, and industrial innovation, aligning with global policy frameworks such as the United Nations Sustainable Development Goals (SDGs). The focus extends to reimagining traditional production systems and transitioning to regenerative economic models, addressing challenges like resource depletion and environmental degradation (Geissdoerfer et al., 2017).

8.2 Environmental Impact and Resource Management

Environmental impact and resource management emerge as recurring themes, reflecting a growing interest in assessing ecological footprints, pollution control, and biodiversity conservation. Studies emphasize the integration of life cycle assessments (LCA) into industrial processes to evaluate environmental trade-offs and develop sustainable strategies

(Elkington, 2018). These insights bridge gaps between economic activities and ecological preservation, promoting resource circularity. This theme addresses the critical environmental impacts of human activity, including pollution, ecological effects, and biodiversity loss. Keywords emphasize the importance of sustainable practices to mitigate environmental degradation. Kirchherr et al. (2017) discuss how sustainable practices can help reduce ecological footprints and improve biodiversity conservation. Prieto-Sandoval et al. (2018) explore how environmental policies and frameworks can drive sustainability in industrial systems.

8.3 Sustainable Consumption and Consumer Behaviour

A shift toward sustainable consumption is evident, with a focus on consumer behaviour, waste minimization, and energy efficiency. Research highlights the role of consumers in reducing food waste, optimizing energy usage, and promoting environmentally conscious purchasing decisions (Vermeir & Verbeke, 2008). Understanding consumer attitudes and motivations is critical for driving behavioural changes toward sustainability goals.

8.4 Sustainable Development and Social Equity

Sustainable development continues to be a dominant theme, integrating environmental, economic, and social dimensions. It stresses the need to balance growth with ecological preservation and social welfare (Kirchherr et al., 2017). Social equity is increasingly recognized as a key factor, with studies highlighting the importance of inclusive policies that promote community engagement and equitable access to resources (Prieto-Sandoval et al., 2018).

8.5 Waste Management and Recycling

Waste management has become a pivotal area in sustainability research, focusing on strategies to reduce, reuse, and recycle waste materials. Recycling systems and waste minimization techniques are key to achieving circular economy objectives, as highlighted by various studies (Stahel, 2016). Effective waste management practices not only reduce environmental impacts but also contribute to resource conservation and economic efficiency (Velenturf & Purnell, 2021). Sarkis et al. (2011) investigate the role of green supply chains in waste reduction, showcasing its potential for industrial waste management. Ghisellini et al. (2016) explore recycling systems within the framework of circular economy to enhance waste recovery.

8.6 Policy Integration and Economic Impacts

The interplay between policy integration and economic impacts is a significant theme in sustainability literature. Keywords such as policy alignment and socio-economic impacts reveal the importance of creating regulatory frameworks that incentivize sustainable practices while fostering economic growth (Porter & van der Linde, 1995). Such frameworks address systemic barriers to circularity, emphasizing collaboration between governments and industries.

Economic growth and policy alignment remain critical in sustainability research. Business models that integrate sustainability into their core practices have proven to be effective in driving long-term economic benefits (Bocken et al., 2014). Policies supporting circular practices, such as tax incentives for green initiatives, are increasingly prioritized (Lieder & Rashid, 2016). Lozano (2015) examines how businesses can adopt sustainable practices to enhance both profitability and societal impact. Kirchherr et al. (2017) explore how circular economy principles align with social and economic dimensions of sustainability.

8.7 Technological Advancements in Sustainability

Emerging trends highlight the role of technological innovations like renewable energy, digital economy, and smart cities in advancing sustainability. These technologies are increasingly integrated into sustainability practices. These technologies enable real-time monitoring, efficient resource utilization, and data-driven decision-making. Scholars argue that leveraging digital solutions fosters transparency and scalability in sustainability initiatives, transforming traditional industrial models (Khan et al., 2021). Research highlights their role in advancing efficiency and enabling sustainable development (Konietzko et al., 2020). Innovations such as IoT and AI are paving the way for more effective resource management and reducing environmental footprints (Antikainen et al., 2018). Rifkin (2015) emphasizes the transformative potential of digital technologies and renewable energy in achieving smart and sustainable cities. Geissdoerfer et al. (2017) discuss how technological advancements can facilitate circular business models and resource efficiency.

9. Research gap and future research direction

Despite the extensive focus on the circular economy, sustainable development, and environmental impact, there are critical gaps in

integrating these concepts across diverse sectors and geographies. First, while much research has explored circular economy practices, the application to specific industries, such as agriculture, food, and tourism, remains underdeveloped, particularly in developing countries. Second, although sustainability research has advanced in addressing environmental and economic dimensions, the social aspects, such as workforce empowerment, behavioural change, and equity, are relatively unexplored. Third, the use of advanced technologies like artificial intelligence, blockchain, and digital twins in operationalizing circular economy practices is still in its infancy, highlighting a need for empirical validation and real-world implementation. Finally, there is limited research on the interconnectedness of upstream and downstream stages in supply chains to identify and mitigate systemic hotspots of inefficiencies and waste.

Table 2

Research gap and future research direction

Research Gap	Future Research Direction	In-Text Citation & References
1. Limited application of circular economy practices to specific industries in developing countries.	**Sector-Specific Applications:** Future studies should focus on tailoring circular economy principles to underrepresented sectors such as agri-food, tourism, and textiles, particularly in developing countries. Case studies and comparative analyses across contexts are essential.	Circular economy applications in agriculture and tourism have been underexplored (Geissdoerfer et al., 2017; Bocken et al., 2016).
2. Social dimensions of sustainability, such as workforce empowerment, behavioural change,	**Workforce Empowerment and Behavioural Studies:** Future studies should focus on workforce	Social aspects of sustainability are often overlooked in favour of environmental and economic factors

Research Gap	Future Research Direction	In-Text Citation & References
and equity, are under-researched.	development, pro-environmental behaviours, and social equity. Investigating how education, skill development, and leadership can empower individuals to contribute to sustainability.	(Elkington, 1997; Sroufe, 2017).
3. Limited use of advanced technologies like AI, blockchain, and digital twins in implementing circular economy practices.	**Integration of Advanced Technologies:** Investigate the role of advanced technologies (blockchain, IoT, machine learning) in improving supply chain transparency, reducing waste, and enhancing decision-making.	Technologies like AI and blockchain have limited real-world application in circular economy practices (Choi et al., 2020; Hübner et al., 2016).
4. Lack of research on the interconnectedness of upstream and downstream stages in supply chains to address systemic inefficiencies.	**Holistic Supply Chain Optimization:** Link upstream and downstream stages in supply chains to identify inefficiencies and hotspots. Implement integrative solutions for waste reduction, energy efficiency, and labour shortages.	Studies on supply chain optimization are often fragmented, with insufficient focus on interconnectedness between upstream and downstream stages (Korpela et al., 2017).
5. Insufficient research on policy frameworks and	**Policy Frameworks and Multi-Stakeholder Collaboration:**	Policy frameworks for circular economy practices are still

Research Gap	Future Research Direction	In-Text Citation & References
multi-stakeholder collaboration for circular economy implementation.	Investigate effective policy frameworks and foster collaborations between governments, industries, and communities to achieve circular economy goals.	developing, and collaboration between stakeholders is limited (Bocken et al., 2016; Kirchherr et al., 2018).

Future Research Directions Sector-Specific Applications Future studies should focus on tailoring circular economy principles to underrepresented sectors, such as the agri-food supply chain, tourism, and textile industries, with an emphasis on addressing unique challenges in developing countries. Case studies and comparative analyses across diverse contexts could offer valuable insights. Integration of Advanced Technologies Researchers should explore how cutting-edge technologies such as blockchain, IoT, and machine learning can be integrated into sustainable practices. This includes investigating their role in improving supply chain transparency, reducing waste, and enhancing decision-making capabilities. Workforce Empowerment and Behavioural Studies Greater attention is needed on the human dimension of sustainability, including workforce development, pro-environmental behaviours, and social equity. Studies should examine how education, skill development, and leadership strategies can empower individuals and communities to contribute to sustainability goals. Holistic Supply Chain Optimization Future research should focus on linking the upstream and downstream stages of supply chains to identify systemic inefficiencies. This involves mapping hotspots across the value chain and implementing integrative solutions that address interconnected issues such as waste reduction, energy efficiency, and labor shortages. Policy Frameworks and Multi-Stakeholder Collaboration Investigating effective policy frameworks and fostering multi-stakeholder collaborations between governments, industries, and communities can provide actionable strategies for achieving circular economy and sustainability objectives. By addressing these research gaps and future directions, the field can evolve to offer comprehensive, actionable solutions for global sustainability challenges.

Conclusion

This study has explored the integration of circular economy principles, sustainability practices, and their applications across various industries, with a particular focus on addressing the critical research gaps identified. The results indicate that while the adoption of circular economy practices has gained momentum, there is still limited application within specific sectors such as agriculture, food, and tourism, especially in developing countries. The study also reveals that the social dimensions of sustainability—such as workforce empowerment, pro-environmental behaviours, and social equity—remain underexplored, highlighting the need for a more comprehensive approach that considers human factors alongside environmental and economic aspects.

The investigation into the role of advanced technologies, such as AI, blockchain, and IoT, has shown promising potential for enhancing circular economy practices, yet empirical validation and real-world implementation are still in the early stages. Additionally, the analysis of supply chain inefficiencies across both upstream and downstream stages underscores the importance of a holistic approach to supply chain optimization, where integrating interconnected issues such as waste reduction, energy efficiency, and labor shortages can yield significant benefits.

The findings further emphasize the need for effective policy frameworks and multi-stakeholder collaborations to drive the implementation of circular economy practices on a larger scale. Overall, this study contributes valuable insights into the current state of circular economy research and provides clear directions for future investigations. By addressing these gaps, the field can better support global sustainability challenges and foster more sustainable, equitable, and resource-efficient systems.

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