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Digital technologies in the circular economy: a bibliometric analysis

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Abstract

Purpose – This study maps the scholarly landscape of digital technologies (DT) in the circular economy (CE) using bibliometric methods to identify key trends, contributors and thematic developments.

Design/methodology/approach – A bibliometric analysis of 722 Scopus-indexed publications (2016–early 2025) was conducted, using VOSviewer and Bibliometrix for citation, co-authorship, keyword co-occurrence and thematic evolution analyses.

Findings – The analyzed literature shows rapid growth post-2020, with key contributions from Europe. Influential journals include *Sustainability, Journal of Cleaner Production, Procedia CIRP and Resources, Conservation and Recycling*. Core themes evolved from foundational concepts toward Industry 4.0 technologies (IoT, AI and Blockchain) and policy-related topics like digital product passports (DPPs), suggesting growing interest in data-driven circularity.

Research limitations/implications – The dataset is limited to Scopus and English-language sources, which may affect comprehensiveness. Future research should explore empirical applications, integration strategies and sector-specific digital solutions.

Practical implications – The findings inform industry and policy actors on emerging digital enablers that support resource efficiency, transparency and sustainable innovation in circular transitions.

Originality/value – This paper offers an up-to-date, data-driven overview of the DT–CE research domain, extending prior qualitative reviews by mapping its structure and evolution over time.

Keywords Digital technologies, Bibliometric analysis, Circular economy, Artificial intelligence, Digital product passports

Paper type Literature review

Introduction

In recent years, the circular economy (CE) has emerged as a transformative solution to tackle resource scarcity, environmental degradation and rising costs by focusing on reuse, recycling and regenerative practices to promote sustainability and innovation (MacArthur, 2013; Korhonen *et al.*, 2018; Corvellec *et al.*, 2022; Velenturf and Purnell, 2021). Supported by technological advancements, shifting consumer preferences and stricter regulatory frameworks, circular models reduce waste, extend product lifecycles and unlock new economic opportunities across various industries (MacArthur, 2013; Sánchez-García *et al.*, 2024).

Digital technologies (DT) play a critical role in enabling and scaling CE practices, as they provide the infrastructure, data and connectivity required to optimize resource use, reduce waste and support sustainable operations (Rizvi *et al.*, 2021; Banihashemi *et al.*, 2024;

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Liu *et al.*, 2022). The concurrent rise of digital innovation and the increasing urgency of CE transitions underscore the importance of understanding the intersection between these two domains. As sustainability challenges intensify, the integration of DT into CE strategies is gaining prominence as a critical pathway toward systemic change.

Despite growing scholarly interest, research in this area remains fragmented. Existing studies often approach the topic from diverse disciplinary perspectives and employ predominantly qualitative methods, particularly Systematic Literature Reviews (SLRs). For instance, Okorie *et al.* (2018) developed an early framework linking digital tools to circular strategies while Cagno *et al.* (2021) analyzed digital enablers through the ReSOLVE framework, identifying gaps in the integrated CE approaches. In addition, Chauhan *et al.* (2022) synthesized key enabling technologies, barriers to adoption and emerging digital business models such as Product-Service Systems. These reviews collectively highlight the fragmented nature of existing research and emphasize the importance of a comprehensive, data-driven perspective and this bibliometric analysis aims to contribute to this canon.

While these reviews offer valuable insights through content synthesis, they tend to lack a comprehensive, quantitative perspective on the intellectual structure of the field. Notably, according to our observation, only one bibliometric review to date has systematically examined the DT–CE interface, leaving a significant gap in the literature.

Given the rapid evolution of digital solutions and their expanding role in CE, there is a pressing need for a bibliometric analysis that can quantitatively map the landscape. Such an approach complements existing qualitative reviews by identifying research trends, influential contributors, thematic clusters and structural patterns within the literature (Donthu *et al.*, 2021). Moreover, it enables a clearer understanding of how knowledge in this domain is organized and how it has evolved over time.

In response to this gap, the present study conducts a comprehensive bibliometric analysis of 722 Scopus-indexed publications from 2016 to early 2025. Using established bibliometric techniques – citation analysis, co-authorship networks, keyword co-occurrence and thematic evolution – it provides an integrated and data-driven overview of the field. This methodology allows for the identification of emerging research directions and offers a foundation for both academic exploration and practical application of digital innovations in support of circular economy transitions.

The study makes a timely and significant contribution by extending the depth and scope of previous reviews. It captures recent, policy-relevant developments, such as digital product passports, and applies a broader set of bibliometric tools to offer a dynamic and nuanced understanding of research progression. Furthermore, it introduces a novel conceptual model linking digital technologies with CE principles, providing a structured framework for interpreting the field's thematic evolution. Together, these contributions reinforce the study's originality and relevance to ongoing academic, industrial and policy discussions on sustainable development.

The subsequent sections of this paper are organized as follows: First, the paper presents the theoretical background of the study, discusses the research gap and then outlines the research design, which serves as a guiding framework for the research process. Next, it delves into the methodology, offering a structured approach used to conduct the study. Following this, the paper examines the knowledge roots (past), maps the current landscape (present) and proposes how DT and CE might develop further (future). Finally, the paper concludes by emphasizing its originality and contributions, addressing its limitations and providing recommendations for future research.

Theoretical background

Core concepts of the circular economy

Core concepts are the foundational constructs that form the basis of a study on the CE or theoretical framework based on the study of Le *et al.* (2024):

(1) *Waste Elimination*: The circular economy promotes waste elimination by designing products and processes that minimize material use, prevent pollution and integrate renewable energy, reducing environmental impact across the product lifecycle.

(2) *Resource Utilization*: The circular economy maximizes material value through product longevity, repair and recycling, reducing raw material use and enhancing sustainability.

(3) *Value Retention*: The circular economy promotes value retention by encouraging reuse, remanufacturing and recycling to extend product lifecycles and minimize waste and resource depletion.

Principles of the circular economy

The CE principles guide the design, production and consumption of products and services to eliminate waste, maximize resource efficiency and retain value across the entire lifecycle (Le *et al.*, 2024).

(1) *Design for Circularity*: Product design should enable disassembly, reuse and recycling by emphasizing modularity, durability and recyclable materials to support circular economy goals.

(2) *Product Longevity*: Circular economy promotes extending product life through maintenance, repair, refurbishment and upgradability to reduce waste and resource consumption.

(3) *Material Recovery*: Circular economy emphasizes recovering and reusing materials through recycling, waste management systems and recovery technologies to reduce waste and conserve resources.

(4) *Sustainability Integration*: Implementing circular economy effectively requires aligning values, operations and decisions with sustainability principles to foster environmental responsibility and long-term development.

(5) *Collaboration and Innovation*: Collaboration across the value chain drives innovation, enabling new circular solutions, business models and technologies through shared resources, knowledge and best practices.

Digital technologies used in the circular economy

Based on the literature as mentioned above (Le *et al.*, 2024), the key digital technologies used in the CE are as follows:

(1) *Internet of Things (IoT)*: A computational system that collects and exchanges data acquired from electronic devices (Okorie *et al.*, 2018). It consists of sensors and actuators connected by networks to monitor or manage objects (Pagoropoulos *et al.*, 2017).

(2) *Big Data/Analytics*: Technologies that assist in extracting business value through the analysis of data (Pagoropoulos *et al.*, 2017). It involves analyzing large volumes of data for insights and decision-making (Wynn and Jones, 2022).

(3) *Artificial Intelligence (AI)*: Intelligence demonstrated by machines, involving tasks such as learning and problem-solving (Wynn and Jones, 2022). AI-associated digital

technologies could increase energy efficiency and facilitate the circular economy (Wynn and Jones, 2022).

(4) *Blockchain*: A secure, immutable, traceable and visible public ledger system. It can reduce supply chain inefficiencies through its tracking and authentication capabilities (Wynn and Jones, 2022).

(5) *Cloud Computing*: Using a network of remote servers hosted on the internet to store, manage and process data rather than a local server or personal computer (Chauhan *et al.*, 2022).

(6) *Smart Tags/RFID*: Smart tags are small devices that integrate memory, data processing and communication capabilities (Demestichas and Daskalakis, 2020). Smart tags were often used with Radio-frequency identification (RFID), which is a data collection technology that uses electromagnetic fields to automatically identify and track tags attached to objects (Pagoropoulos *et al.*, 2017). Networked smart tags and RFID systems provide complete product lifecycle information (Pagoropoulos *et al.*, 2017).

(7) *Additive Manufacturing*: Additive manufacturing, especially 3D printing, represents agile and connected prototyping of parts or products on a large scale, enabling customization (Okorie *et al.*, 2018). It can improve material recovery rates in plastic recycling (Liu *et al.*, 2021).

(8) *Cyber-physical systems (CPS)*: Computational systems that collect and exchange data acquired from electronic devices and are listed as key technologies of Industry 4.0 (Okorie *et al.*, 2018).

(9) *Automation/Robotics*: The use of technology to automate tasks and processes, often involving machines that can perform complex actions (Wynn and Jones, 2022). Robot technology in waste management can improve disposal efficiency (Liu *et al.*, 2021).

(10) *Digital Twin*: Closely related to CE design, digital twin is a digital representation of a physical entity or system, enabling simulation and analysis (Liu *et al.*, 2021).

Research design

Existing literature reviews

Focus on integrating DT like IoT, AI, blockchain and big data analytics into the CE has been growing in recent years, recognizing their potential to enable and accelerate sustainable circular strategies, as explored in numerous reviews (Table 1).

As illustrated in Table 1, the existing literature highlights the integration of DT into the CE through various methodologies and objectives. Pagoropoulos *et al.* (2017) and Okorie *et al.* (2018) explored the role and maturity of DTs such as IoT and Industry 4.0 in CE transitions while Liu *et al.* (2022) addressed how DT functions enhance circularity and Uçar *et al.* (2020) identified DT roles for CE transition through case studies. Barriers to a smart CE, which is an advanced form of the circular economy that integrates digital technologies and smart systems, were analyzed by Trevisan *et al.* (2023) and Demestichas and Daskalakis (2020). Additionally, reviews by Cagno *et al.* (2021) and Chauhan *et al.* (2022) examined DTs within CE frameworks such as ReSOLVE and CE implementation pathways. Bibliometric insights by Liu *et al.* (2021) mapped trends, while Neri *et al.* (2024) and Hariyani *et al.* (2024) explored DT contributions and mediators in CE adoption.

Table 1. Existing literature on digital technologies in the circular economy

Paper	Objective	Number of papers
Pagoropoulos *et al.* (2017)	Investigated the emerging role of IoT and Big Data in CE transition, identifying key technologies for data collection, integration and analysis in this growing field	12
Okorie *et al.* (2018)	Concluded digital tech aids circular material flows (though maturity is debated) and highlighted the untapped potential of integrating DT/Industry 4.0 to enable CE	174
Uçar *et al.* (2020)	Conceptualized CE and identified the roles and functionalities of relevant DTs for CE transition	8
Demestichas and Daskalakis (2020)	Investigated information and communication technology role in CE transition and identified potential challenges and barriers to its use	63
Cagno *et al.* (2021)	Determined the role of DTs within the ReSOLVE framework and identified detailed relationships between DTs and the framework's action areas	66
Liu *et al.* (2021)	A bibliometric analysis. It explored research progress and trends in CE/digital economy integration, outlining future research directions	125
Trevisan *et al.* (2023)	Identified and summarized the main research streams addressing CE and DTs, including their methods, concepts, journals and aims	40
Chauhan *et al.* (2022)	Summarized scholarly work on the CE/DT intersection and illuminated paths for CE implementation	123
Liu *et al.* (2022)	Addressed which DT functions are most useful for improving circularity and how they enhance CE strategies	174
Trevisan *et al.* (2023)	Analyzed the multi-level barriers to a smart circular economy and proposed a new theoretical framework for these barriers	56
Neri *et al.* (2024)	Examined the DT adoption/CE implementation relationship and identified its moderators and mediators	170
Hariyani *et al.* (2024)	Examined DT contributions to CE initiatives and the life cycle analysis of the organizational value chain within CE	153

Source(s): Created by the authors

Research questions

The research questions of this study, which are related to uncovering the foundations, current trends, collaboration and predicting research directions, are as follows.

RQ1. What are the works, key authors and most cited publications that have shaped the development of applications based on digital technologies in the circular economy?

RQ2. What are the emerging themes, collaboration patterns and dominant research clusters in IT applications for the circular economy?

RQ3. What are the potential research frontiers and future directions for digital technologies and their applications in advancing the circular economy?

Together, these three questions structure the investigation. RQ1 establishes historical context, RQ2 examines the present landscape and RQ3 explores future possibilities. The following diagram (Figure 1) illustrates this sequential relationship, which underpins the study's narrative.

Review scope and conceptual foundations

Building on existing literature and our previous work (Le *et al.*, 2024), we propose the *Review Scope and Conceptual Foundations* framework (Figure 2) to provide a structured lens for

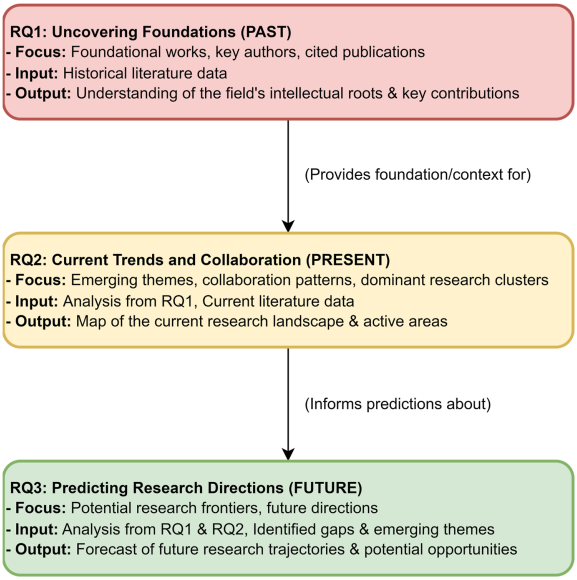

Figure 1. The sequential relationship between research questions guiding the study. Source: Created by the authors

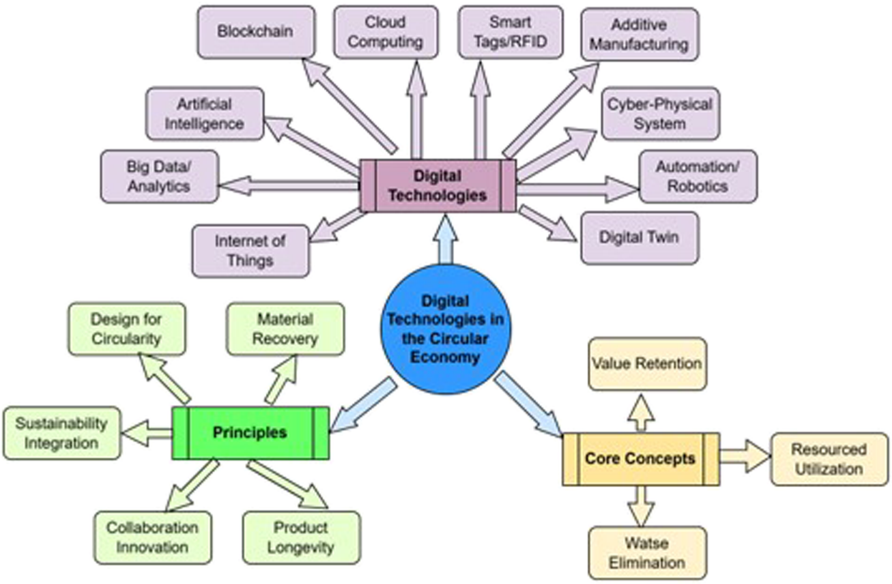

Figure 2. The research model. Source: Created by the authors

interpreting the bibliometric findings. This framework defines the boundaries of the review, clarifies its thematic focus and introduces the core concepts and theoretical foundations that underpin the analysis. Specifically, it synthesizes three interrelated components frequently discussed at the intersection of digital technologies (DT) and the circular economy (CE): core concepts, principles and digital technologies. Rather than serving as a model for empirical testing, the framework functions as a conceptual guide to structure the subsequent analysis and discussion.

Research methodology

This study employs a bibliometric analysis to investigate existing research on the integration DTs within the CE. As mentioned in Figure 3, the methodology is structured into the following steps (Donthu *et al.*, 2021): Data collection, study screening, study selection, final selection and bibliometric analysis.

Data Collection. Scopus was selected as the sole database due to its comprehensive coverage of peer-reviewed journals across relevant fields (e.g. engineering, environmental science, information systems) and its compatibility with bibliometric tools including VOSviewer and Bibliometrix (Burnham, 2006). Using a single, high-quality source ensures consistency in metadata and citation structures (Donthu *et al.*, 2021). The potential limitation regarding database coverage is explicitly discussed in the Limitations section. The search string was designed to include key terms such as "digital technologies" and "circular economy," and their synonyms in titles, abstracts and keywords. After this step, there were 1,230 papers selected.

Study Screening and Selection. This review employs a bibliometric analysis protocol designed to quantitatively map the research landscape, rather than synthesize content qualitatively (Donthu *et al.*, 2021). Our approach emphasizes identifying publication trends,

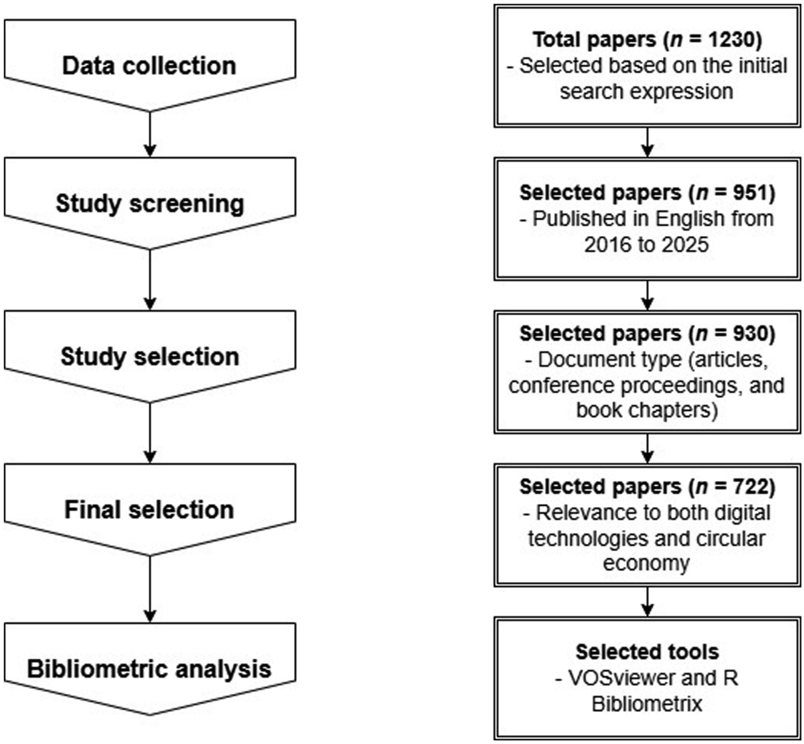

Figure 3. Flowchart of data collection. Source: Created by the authors

co-authorship networks, keyword co-occurrence and thematic evolution – core elements of structure-focused reviews. This protocol is particularly suitable for capturing the dynamic and interdisciplinary nature of research on DTs in the CE. Moreover, the study limited the timeframe from 2016 to 2025 to focus on the recent surge in research linking digital technologies with circular economy strategies, coinciding with the rise of Industry 4.0 and sustainability-driven digital transformation initiatives. Following an exploratory search, the initial 1,230 publications were screened by year (2016–2025) and language (English) to yield 951 papers. Further filtering by document type (articles, proceedings, chapters) resulted in 930 potentially relevant publications, retrieved using the refined Scopus query structured as follows:

(TITLE-ABS-KEY(“circular economy” OR “circularity” OR “resource efficiency” OR “closed loop” OR “resource recovery” OR “waste management” OR “remanufacturing”) AND TITLE-ABS-KEY(“digital technology” OR “digitalisation” OR “digitalization” OR “industry 4.0” OR “I4.0” OR “IoT” OR “internet of things” OR “artificial intelligence” OR “AI” OR “machine learning” OR “blockchain” OR “big data” OR “analytics” OR “cyber physical system” OR “CPS” OR “digital twin” OR “additive manufacturing” OR “3D printing”)) AND PUBYEAR >2015 AND PUBYEAR <2026 AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “cp”) OR LIMIT-TO (DOCTYPE, “ch”)) AND (LIMIT-TO (LANGUAGE, “English”))

Final Selection. The 930 papers obtained through objective filtering then underwent a final relevance screening. This step was essential to focus the corpus on studies directly addressing the DT-CE intersection, as the broad search inevitably included papers with only tangential mentions. Two authors independently reviewed these papers against predefined inclusion/exclusion criteria linked to our Review Scope and Review Scope framework and specific research questions. Papers were retained (*n = 722*) only if they substantively met *both* core requirements: *(1)* explicit discussion of specific DT applications (e.g. IoT, AI, Blockchain, specific tools beyond generic digitalization) impacting or enabling CE principles/strategies (e.g. waste elimination, resource utilization, design for circularity) *AND (2)* demonstration that both DT and CE were central themes, not peripheral context. Papers focusing solely on DT or CE without a clear interactive link, or on related but out-of-scope topics, were excluded. Inter-rater discrepancies were resolved through consensus discussion with the third author. The resulting 722-paper dataset represents publications judged highly relevant to the study’s core questions.

Bibliometric Analysis. The bibliometric analysis was conducted using *VOSviewer* and *R Bibliometrix* packages (Arruda *et al.*, 2022; Derviş, 2019). These tools enabled the extraction of citation data, co-authorship networks, keyword co-occurrence and thematic clusters. Visualization techniques were utilized to identify patterns and relationships, such as influential authors, journals, institutions and geographic regions (Arruda *et al.*, 2022; Derviş, 2019).

This study applies four core bibliometric techniques aligned with the three research questions (RQs). To address RQ1 (works, key authors and citations), *co-citation analysis* was used to uncover intellectual structures that have shaped the digital technologies–circular economy (DT–CE) field. For RQ2 (emerging themes, collaboration, clusters*), most cited papers and frequent words*, *bibliographic coupling* and *co-authorship analysis* identified current research clusters, institutional collaborations and dominant contributors. *Co-word analysis* complemented this by mapping thematic concentrations and keyword trends. Finally, to explore RQ3 (future research directions), *co-occurrence network*, *thematic map* and *thematic evolution* forecasted potential research frontiers and underexplored niches.

Bibliometric performance

Evolution of papers per year

The evolution of papers per year shows a steady increase over time, with notable growth observed in recent years and continuing into early 2025 (Figure 4). Starting with just nine

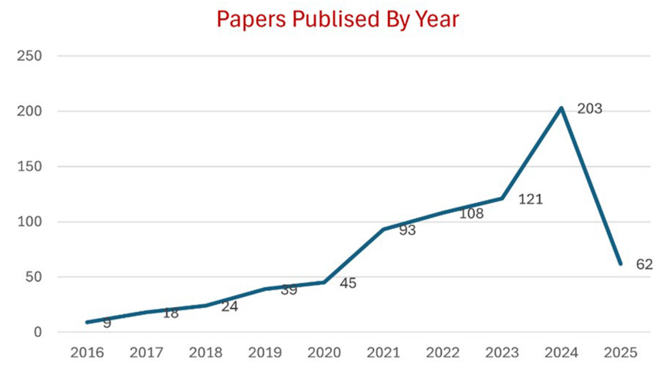

Figure 4. Evolution of papers published per year. Source: Created by the authors

papers in 2016, production rose gradually, reaching 45 by 2020. A sharper increase followed, with 93 papers in 2021 and 121 in 2023. By 2024, a significant leap to 203 papers occurred, reflecting rapid expansion, likely due to improved efficiency or higher demand.

Papers by subject areas

The subject areas related to this study demonstrate the interdisciplinary nature (Figure 5). *Environmental Science* leads with 301 papers, reflecting the focus on sustainability, followed by *Engineering* (286) and *Computer Science* (209), highlighting technological innovations related to digital technologies. *Energy* (185) and *Social Sciences* (149) emphasize renewable systems and socio-economic impacts, while *Business* (148) and *Economics* (71) explore financial and operational strategies. Fields including *Decision Sciences* (57), *Materials Science* (33) and *Chemistry* (24) focus on optimizing processes and materials, while contributions from *Psychology* (12) and *Arts and Humanities* (5) address human and cultural dimensions, showcasing the diverse yet uneven engagement across disciplines.

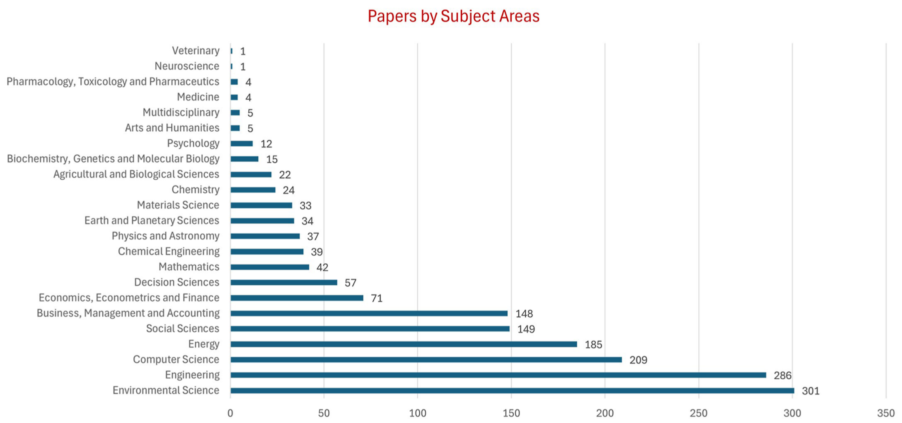

Figure 5. Papers by subject areas. Source: Created by the authors

Citation analysis
Citation analysis helps highlight the most influential publications, authors and journals by evaluating metrics such as total citations and H-index, offering insight into research impact and visibility (Donthu *et al.*, 2021).

Journal performance
As shown in Table 2, among the top 20 sources, the *Journal of Cleaner Production* stands out with 2,901 citations for 36 papers, yielding an impressive 80.58 citations per paper and the journal's H-index of 354 (metrics based on Scopus data as of March 2025). *Sustainability (Switzerland)*, though leading in volume with 53 papers, has a lower impact per paper (29.85 citations, H-index 207). *Technological Forecasting and Social Change* achieves the highest average impact per paper at 107.22 with 965 citations from just nine papers (H-index 209). Other high-impact journals include *Resources, Conservation and Recycling* (51.65 citations/paper) and *Waste Management* (47.90).

Author performance
Bibliometric indicators are grounded on the premise that the impact of a scientific paper can be assessed by the number of times it is cited by other publications. Based on its analysis, this study identifies 391 unique authors, each contributing between one and five publications to the field (Table 3). Among the authors in the field, several stand out with *more than 100 total citations*, indicating significant scholarly influence. For example, *Surajit Bag* leads with *803 citations* from four papers, averaging an exceptional *200.75 citations per paper*, highlighting both high productivity and impact. Furthermore, *Yigit Kazancoglu* has *550 citations* across three papers (*183.33 per paper*), followed by *Charbel J. Chiappetta Jabbour* with *333 citations* from three papers (*111.00 per paper*).

Table 2. Leading sources

Sources	Papers	Citations	TC/ Paper	H-index
SUSTAINABILITY (SWITZERLAND)	53	1,582	29.85	207
JOURNAL OF CLEANER PRODUCTION	36	2,901	80.58	354
PROCEDIA CIRP	24	604	25.17	115
RESOURCES, CONSERVATION AND RECYCLING	20	1,033	51.65	218
BUSINESS STRATEGY AND THE ENVIRONMENT	12	540	45.00	173
LECTURE NOTES IN MECHANICAL ENGINEERING	10	21	2.10	35
WASTE MANAGEMENT	10	479	47.90	239
IFIP ADVANCES IN INFORMATION AND COMMUNICATION TECHNOLOGY	9	34	3.78	70
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	9	965	107.22	209
ENERGIES	8	247	30.88	175
IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE	8	77	9.63	58
BUILDINGS	7	262	37.43	71
JOURNAL OF ENVIRONMENTAL MANAGEMENT	7	294	42.00	268
LECTURE NOTES IN CIVIL ENGINEERING	7	2	0.29	28
SCIENCE OF THE TOTAL ENVIRONMENT	7	419	59.86	399
ACM INTERNATIONAL CONFERENCE PROCEEDING SERIES	6	37	6.17	164
JOURNAL OF INDUSTRIAL ECOLOGY	6	88	14.67	141
SMART AND SUSTAINABLE BUILT ENVIRONMENT	6	133	22.17	36
SUSTAINABLE PRODUCTION AND CONSUMPTION	6	138	23.00	96
CEUR WORKSHOP PROCEEDINGS	5	4	0.80	69

Source(s): Created by the authors

Table 3. Most influential authors

Author name	Papers	Citations	TC/ Papers	H-index
Bag, Surajit	4	803	200.75	44
Kazancoglu, Yigit	3	550	183.33	43
Chiappetta Jabbour, Charbel Jose	3	333	111.00	6
Mendoza, Joan Manuel F.	4	279	69.75	23
Gallego-Schmid, Alejandro	3	278	92.67	30
Çetin, Sultan	3	278	92.67	5
Govindan, Kannan	3	268	89.33	114
Ramakrishna, Seeram	5	267	53.40	181
Sassanelli, Claudio	4	231	57.75	29
Terzi, Sergio	4	230	57.50	37
Sarkis, Joseph	3	229	76.33	119
Rosa, Paolo	3	144	48.00	15
Ghoreishi, Malahat	3	122	40.67	6

Source(s): Created by the authors

Thematic insights

Our bibliometric analysis addresses the research questions sequentially: co-citation analysis identifies works (RQ1), bibliographic coupling reveals current trends and collaborations (RQ2) and co-word analysis highlights emerging themes and future directions (RQ3). This combined approach offers a comprehensive map of the field's past development, current state and potential trajectories.

Uncovering foundations (RQ1)

To uncover the foundations of a research field, bibliometric analysis offers powerful tools for exploring its intellectual structure and historical evolution. Focusing on the past, this approach seeks to identify the key contributions and knowledge bases that have shaped the integration of DT into the EC. Central to this analysis is *co-citation analysis, which* reveals thematic clusters and intellectual linkages by examining how often two works are cited together (Surwase *et al.*, 2011).

Co-citation analysis

Co-citation analysis reveals relationships through shared citations. Document co-citation links related publications, journal co-citation helps identify core journals and author co-citation is widely used to map a field's intellectual structure and thematic connections (Surwase *et al.*, 2011).

Author co-citation analysis

Figure 6 presents the author co-citation network, revealing influential authors and distinct intellectual clusters within the DT-CE research landscape. The prominence of *Sarkis*, indicated by the largest node size, confirms his foundational role and significant influence across the field. His work is central and highly influential in the intersection of DT and the CE, as his publications are frequently referenced with other scholars' work.

Concerning the clustering of authors, Figure 6 displays several distinct clusters of authors, indicated by different colors (red, blue, green):

(1) The blue cluster forms a dense core, uniting highly co-cited authors such as *Sarki, Govindan, Kazançoğlu* and *Bag*. The strong interconnections suggest a well-established theoretical base within this group.

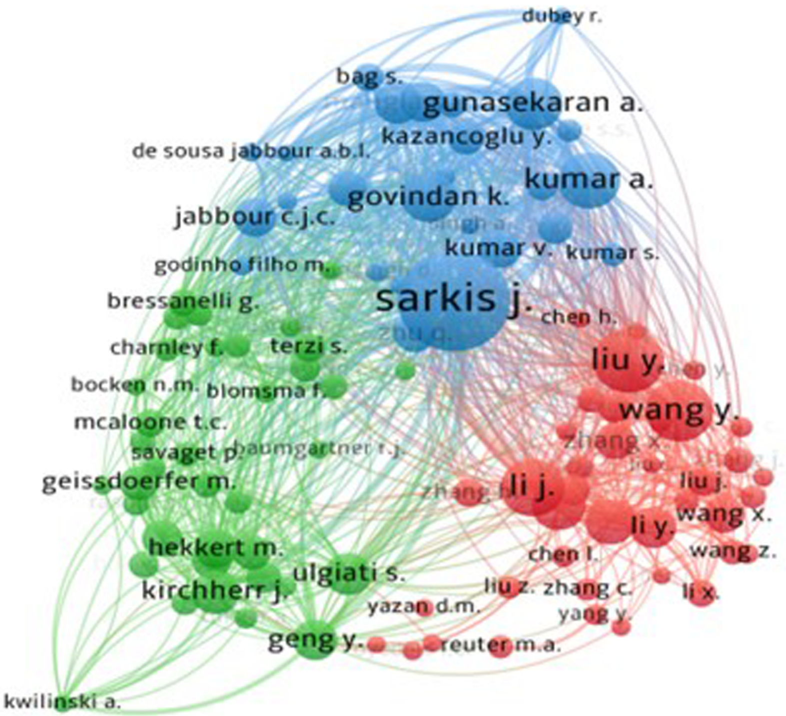

Figure 6. Author co-citation analysis. Source: Created by the authors

(2) The red cluster is another prominent group featuring authors including *Liu, Y. Wang, Li J., Chen, Li X.* and Z. *Wang.* While these authors may not be among the most globally cited, the predominance of Chinese names might suggest a regional focus or a specific thematic concentration. Further investigation into the specific works of these co-cited authors is warranted to fully delineate this cluster's thematic identity.

(3) The green cluster is led by some of the most influential authors, such as *Terzi, Rosa, Ramakrishna* and *Sassanelli*. This cluster likely represents another distinct set of researchers contributing to this field, possibly with a different focus compared to the red and blue clusters.

Overall, the distinct author clusters suggest that the field, while interconnected, is shaped by several distinct research streams or schools of thought. Recognizing these different intellectual anchor points helps researchers effectively position their contributions within the existing scholarly landscape.

Journal co-citation analysis

The journal co-citation network (Figure 7) maps the influential publication venues and delineates the core thematic pillars of DT-CE research. Three major clusters emerge, representing distinct but interconnected knowledge domains.

(1) *Green Cluster – Environmental and Sustainability Science*: This cluster is characterized by journals such as Journal of Cleaner Production, International Journal of Production Research and International Journal of Production Economics

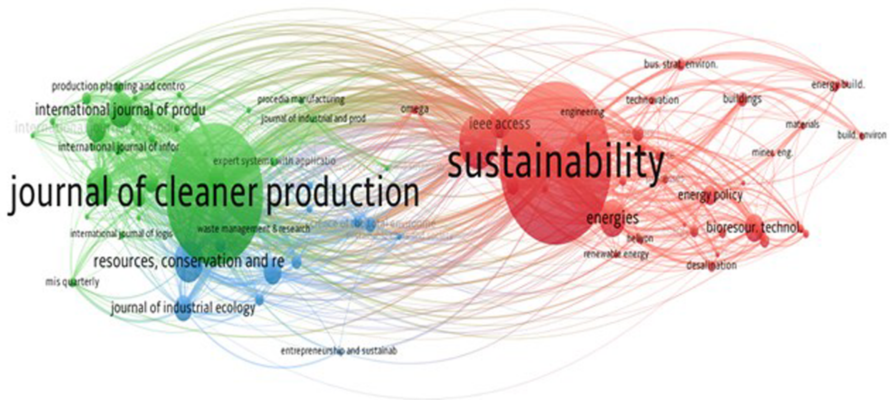

Figure 7. Journal co-citation analysis. Source: Created by the authors

and is strongly aligned with the core concepts of the research model. Its central position and the prominence of the Journal of Cleaner Production underscore the foundational importance of environmental management and process optimization perspectives in this field.

(2) *Blue Cluster – Recycling Technologies*: This cluster includes journals such as *Resources, Conservation and Recycling*, *Journal of Industrial Ecology* and *Waste Management* and is closely aligned with the *principles* of the research model, particularly Material Recovery and Product Longevity. The cluster's focus on resource efficiency, waste valorization and industrial process optimization reflects key circular economy strategies aimed at extending product lifecycles, enabling recycling systems and fostering technical innovations that reduce material loss and environmental impact.

(3) *Red Cluster – Technology Foresight*: This cluster is anchored by journals such as *Sustainability*, *Procedia CIRP* and *Engineering* and is strongly associated with the Digital Technologies identified in the research model. This cluster reflects research on digital transformation, Industry 4.0 and business model innovation in CE, driven by technologies including IoT, AI, blockchain, CPS and digital twins, which form the backbone of digitally-enabled circular strategies.

Current trends and collaboration (RQ2)

Having established the foundations (RQ1), we now examine present-day trends (RQ2). This section analyzes the current research landscape, mapping thematic clusters, collaboration networks and the state of DT-CE research using cited document analysis, frequent words, bibliographic coupling and co-authorship networks.

Most cited papers

Most cited papers serve as intellectual pillars representing works in the evolution of the research field and trend indicators reflecting dominant paradigms and emerging areas (Paunović *et al.*, 2024). Table 4 presents the ranking of the Top 10 Most Cited that serves as the intellectual backbone of the research domain, with Kristoffersen *et al.* (2020) and Upadhyay *et al.* (2021) leading in total citations.

Table 4. Most cited papers

Paper	Total citations (TC)	TC per year	Summary
Kristoffersen *et al.* (2020)	463	77.17	Introducing the Smart CE framework, linking digital technologies and business analytics to support circular strategies and sustainable production in manufacturing
Upadhyay *et al.* (2021)	443	88.60	Examining Blockchain's role in enabling CE goals, highlighting its sustainability, ethical implications and potential to improve supply chain transparency and reduce environmental impact
Bag *et al.* (2021)	399	79.80	Developing and validating a model linking Industry 4.0 adoption to enhanced 10R manufacturing capabilities, demonstrating their positive impact on sustainable development
Despeisse *et al.* (2017)	394	43.78	Proposing a research agenda exploring how 3D printing can enable CE goals by identifying enablers, barriers and key focus areas such as design, supply chains and business models
Chauhan *et al.* (2022)	378	94.50	Reviewing literature linking CE and digitalization, proposing a systems-based framework and highlighting key themes such as AI, IoT, Product-Service System models and implementation barriers
Antikainen *et al.* (2018)	363	45.38	Exploring how digitalization enables CE models, identifying key opportunities and challenges in adoption, data management, collaboration and business model innovation
Olabi and Abdelkareem (2022)	306	76.50	Developing 87 novel indicators to assess how pre-combustion carbon capture technologies contribute to all 17 UN Sustainable Development Goals
Bag *et al.* (2021)	301	60.20	Developing and validating a model identifying key resources for Industry 4.0 adoption, demonstrating its positive impact on sustainable production and CE capabilities
Fischer and Pascucci (2017)	289	32.11	Developing a conceptual framework showing how institutional incentives and inter-firm collaboration shape CE transitions in the Dutch textile industry through two distinct organizational pathways
De Jesus *et al.* (2018)	287	28.70	Synthesizing literature linking eco-innovation and CE, highlighting the need for systemic, multi-level innovations to drive CE transitions effectively

Source(s): Created by the authors

These papers are core intellectual drivers in DT and CE, combining strategic frameworks, digital enablers and empirical methods. High TC/year indicates strong recent relevance – especially Chauhan *et al.* (2022) leads with 94.5 citations/year, indicating it is a rapidly influential paper despite being recent. Moreover, Upadhyay (2021) and Bag *et al.* (2021) follow closely, showing sustained high relevance in integrating digital transformation and circular economy.

Most frequent words

Most frequent words highlight a research domain's key themes, concepts and methodological approaches (Figure 8). In this study, high-frequency author keywords such as *circular economy*, *sustainable development*, *recycling*, *waste management* and *digital technologies* indicate the field's core focus and evolving research directions. These keywords reflect both foundational environmental concerns and growing digital integration, helping researchers identify dominant topics and thematic clusters.

Analyzing keyword frequency over time (Figure 9) reveals evolving research focus. While terms such as "*circular economy*," "*sustainable development*" and "*recycling*" grew steadily

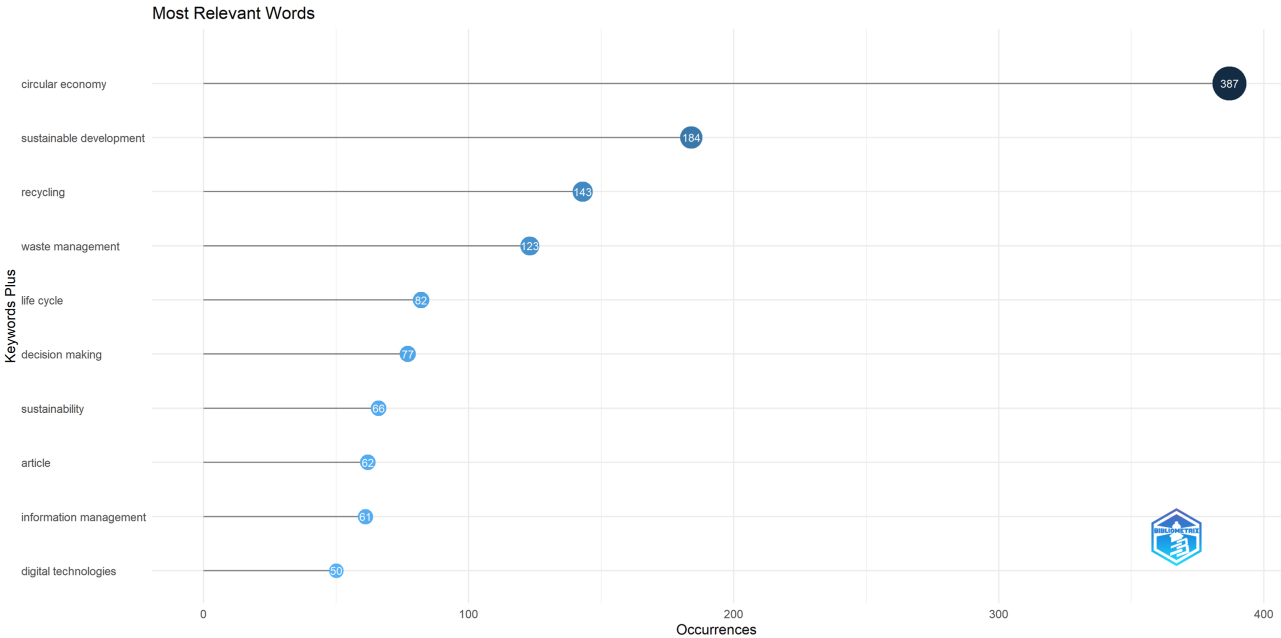

Figure 8. World frequency over time. Source: Created by the authors

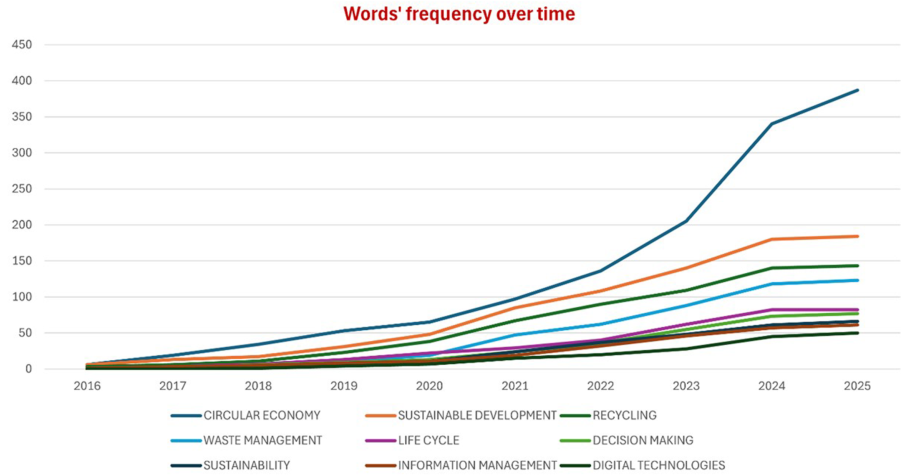

Figure 9. World frequency over time. Source: Created by the authors

from 2016–2025, "*digital technologies*" and "*information management*" surged notably after 2020, highlighting increasing digital integration and suggesting a paradigm shift towards digitally-enabled circular practices.

Bibliographic coupling

Clustering by bibliographic coupling identifies papers that share similar reference lists, thereby revealing contemporary research fronts and thematic cohesion. Unlike co-citation (which reflects intellectual roots), coupling highlights ongoing scholarly conversations (Gheno, n.d.). Figure 10 presents a strategic diagram based on bibliographic coupling, mapping the current research fronts (themes actively citing similar recent literature) by their centrality (*X*-axis) and density/impact (*Y*-axis).

The purpose of a cluster in a clustering map is to represent a group of closely related nodes that share strong conceptual or citation links. Table 5 identifies five thematic clusters in DT and CE research, ranging from core topics like circular economy and sustainability to emerging areas such as digital product passports. These clusters reflect thematic maturity, niche focus and growing innovation trends.

Most influential countries and collaboration world map

The publication data reveal significant global contributions to DT-CE research (Table 6). Italy emerges as the most prolific country in this dataset with 89 papers, followed by the UK (79), India (78), China (68) and Germany (61). Several other nations also demonstrate substantial output, including Spain (47), the USA (40), the Netherlands (34) and Sweden (32). Further contributions from countries such as Brazil (27), France (27) and Finland (24) underscore the broad international engagement. Overall, these figures highlight a diverse and competitive global research landscape in this field.

The geographical distribution of citations (Figure 11) reveals variations in impact. While Italy leads in paper volume, its average citations per paper (TC/Paper) are lower (22.01), whereas the USA shows high impact (50.38 TC/Paper) from fewer papers. The UK and the Netherlands demonstrate a balance of volume and impact (over 45 TC/Paper), while high-output countries such as India and China show moderate citation averages. (Note: Averages for countries with very few papers, including South Africa, should be interpreted cautiously).

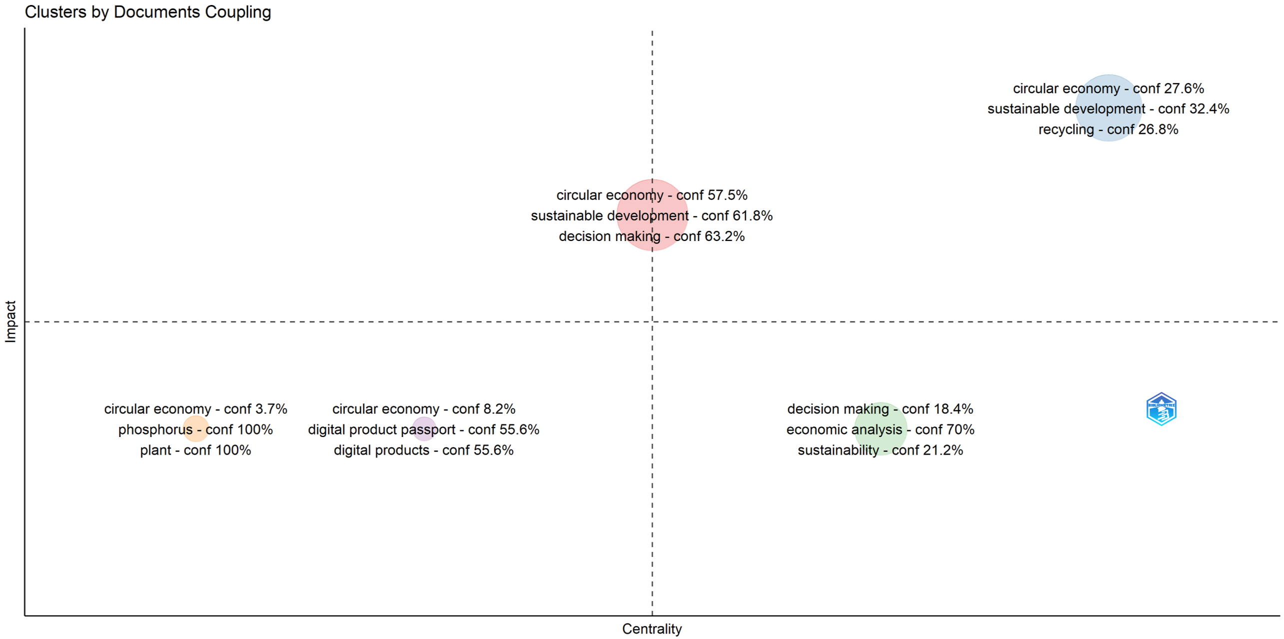

Figure 10. Clustering by coupling (RQ2-Current trends). Source: Created by the authors

Table 5. Coupling map clusters

Cluster	Keywords	Discussion
1 (Red) – Motor Themes	Circular economy, Sustainable development, Decision making	This is a core and well-developed cluster that represents the mainstream and strategic themes in DT and CE research. These topics are heavily interconnected with others and form the backbone of the field. The high confidence scores (e.g. decision-making – 63.2%) reflect strong thematic cohesion
2 (Blue) – Basic and Transversal Themes	Circular economy, Sustainable development, Recycling	These are fundamental themes that are broadly used across the literature but are less internally cohesive. They function as entry points or connecting concepts that span multiple subfields. The presence of "recycling" here underscores its foundational status in CE-related research
3 (Green) – Niche Themes	Decision-making, Economic analysis, Sustainability	This cluster consists of specialized topics that are well-developed internally but less connected to the broader field. "Economic analysis" with a 70% confidence score suggests a strong niche focus – likely used in techno-economic assessment or policy evaluation within CE
4 (Orange) – Emerging themes	Circular economy, Phosphorus, Plant	These topics are isolated and underdeveloped, potentially representing early-stage research or declining interest. However, "phosphorus" and "plant" with 100% confidence may point to high specificity, possibly in agricultural or bioresource loops within CE
5 (Purple) – Emerging but Promising	Digital product passport, Digital products	This emerging cluster is particularly relevant in the context of digitally enabled CE policy and product traceability. The high confidence scores (55.6%) suggest increasing academic interest, although broader integration is still developing

Source(s): Created by the authors

Additionally, Figure 11 illustrates international collaboration links, identifying China, India, USA, Germany and the UK as key hubs, with notable partnerships like China-UK/USA and India-USA/Europe.

Predicting research directions (RQ3)

To predict future research directions (RQ3), this section analyzes the field's conceptual structure using co-word analysis. Based on keyword co-occurrence patterns, we utilize the *co-occurrence network*, *thematic map* and *thematic evolution* outputs (Bibliometrix approach) to identify emerging themes and potential gaps (Derviş, 2019).

Co-occurrence network

Figure 12 presents a keyword co-occurrence network to visualize how frequently and closely keywords appear together in publications, thus revealing thematic clusters, conceptual linkages and emerging areas in a research field (Derviş, 2019).

As presented in Figure 12, two main clusters emerge.

(1) *Cluster 1 (Red):* The dominant terms in this cluster are *recycling* and *waste management*. Other significant keywords include *decision-making*, *sustainability*, *economics*, *environmental impact* and *environmental technology*. This cluster appears

Table 6. The ranking of countries attending the highest number of papers

Country	Papers	Citations	TC/ Paper
Italy	89	1,959	22.01
United Kingdom	79	3,568	45.16
India	78	2,652	34.00
China	68	1,605	23.60
Germany	61	1,408	23.08
Spain	47	1,250	26.60
United States	40	2,015	50.38
The Netherlands	34	1,545	45.44
Sweden	32	1,311	40.97
Brazil	27	870	32.22
France	27	1,112	41.19
Finland	24	1,548	64.50
Poland	22	506	23.00
Canada	21	319	15.19
Portugal	21	544	25.90
Australia	18	527	29.28
Austria	18	266	14.78
Russian Federation	18	134	7.44
Greece	17	290	17.06

Note(s): TC/Paper: total citations per paper
Source(s): Created by the authors

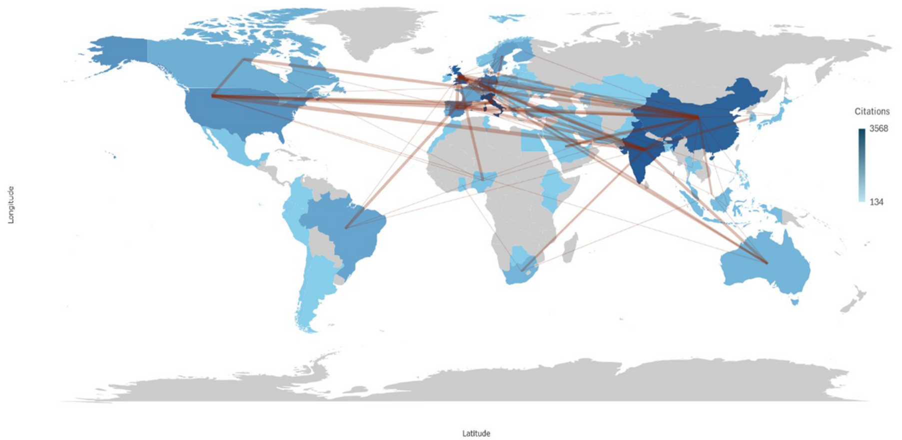

Figure 11. Density map according to citations and collaboration network. Source: Created by the authors

to be centered on the more traditional aspects of the circular economy, focusing on waste treatment, recycling processes and their economic and environmental implications. The presence of *artificial intelligence* and *information and communication technology* suggests the application of digital tools to optimize recycling and waste management processes.

(2) *Cluster 2 (Blue):* This cluster is heavily focused on the intersection of circular economy, sustainable development and digital technologies. Prominent related terms include *information management*, *supply chains*, *information and communication*

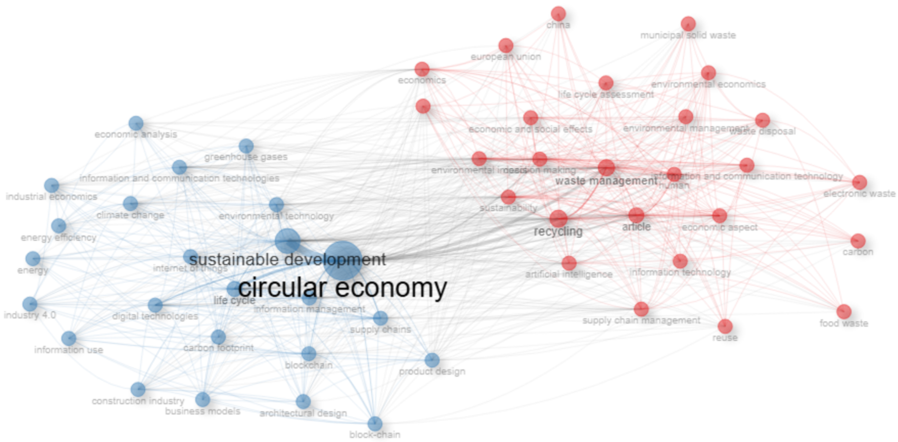

Figure 12. Co-occurrence network. Source: Created by the authors

technology, *supply chain management*, *blockchain*, *IoT* and *Industry 4.0*. This suggests a theme centered around how digital technologies are being applied to improve supply chains' and industrial processes' circularity and sustainability, potentially leveraging concepts like blockchain and IoT for better information management. The presence of terms like *product design*, *building information modeling* and *digital product passport* indicates a focus on incorporating circular economy principles from the design stage and using digital tools for product lifecycle tracking.

Thematic map

The thematic map in Figure 13 provides a dynamic view of the research landscape, categorizing themes based on their centrality (relevance) and density (development).

(3) *Cluster 1 - Green:* This cluster includes keywords "economic aspect" and "human". Its position signifies a niche theme – one that is relatively well-developed internally (higher density) but less connected to the rest of the field (lower centrality). This suggests a specialized research stream focusing perhaps on the socio-economic factors, human behavior aspects or cost-benefit analyses related to CE and potentially DT, operating somewhat apart from the core technical or strategic discussions.

(4) *Cluster 2 - Blue:* This cluster contains the keywords "waste-management" and "sustainability". This position characterizes it as a basic theme – highly central and relevant to the entire field, but perhaps less internally developed or cohesive as a distinct research program (lower density). These keywords represent foundational pillars or cross-cutting concepts that are essential starting points or integration points for much of the research in the DT-CE domain.

(5) *Cluster 3 - Red:* This cluster features "sustainable development" and "life cycle". Its low centrality and low density suggest this theme is either emerging and not yet fully integrated into the field's core structure, or potentially declining or fragmenting. The presence of those broad terms here, rather than in the basic or motor quadrants, is somewhat surprising and might indicate their use in specific, less connected contexts within the analyzed literature, or perhaps represent older foundational concepts losing

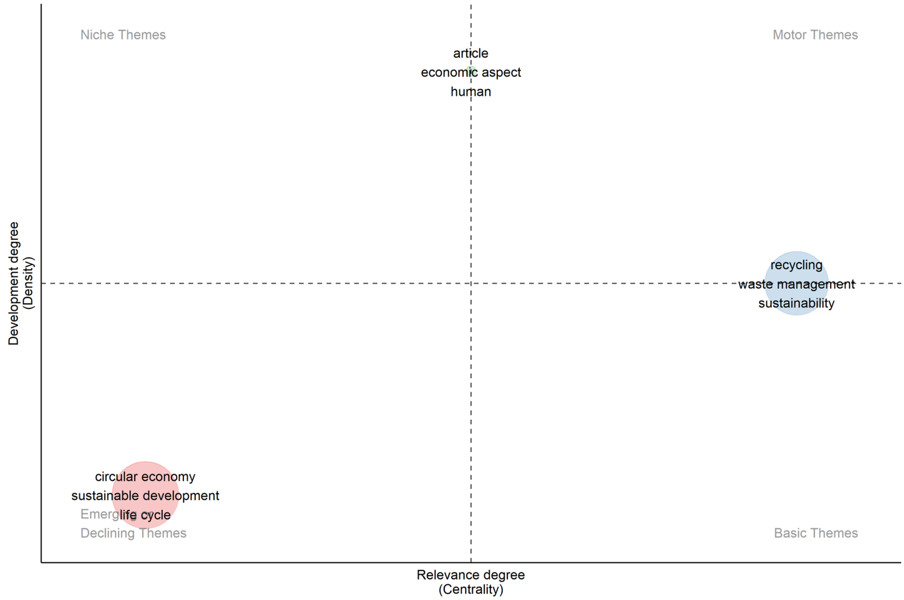

Figure 13. Thematic map. Source: Created by the authors

thematic momentum compared to newer DT-focused terms (which are notably absent as major themes in this specific map visualization).

The difference between the co-occurrence network (two clusters) and the thematic map (three clusters) is not unusual and does not affect the reliability of the results and these methods serve different analytical purposes. The thematic map, based on Callon *et al.*'s centrality and density measures, identifies clusters by examining how strongly themes are developed and how much they interact with others (Callon *et al.*, 1983). In contrast, co-occurrence analysis groups keywords that frequently appear together, showing dominant topic relationships (Van Eck and Waltman, 2009). Rather than contradicting each other, these methods offer complementary insights and together provide a clearer view of the research field.

Thematic evolution

The thematic evolution map (Figure 14) traces the trajectory of core research themes across three distinct periods (Derviş, 2019), revealing a clear conceptual progression in the DT-CE field. These periods (2016–2020, 2021–2023, 2024–2025) were demarcated to analyze potential shifts corresponding to the field's early growth phase, its subsequent rapid acceleration (coinciding with increased volume seen in Figure 4 and major policy initiatives such as the 2020 EU CE Action Plan (Johansson, 2021)), and the most recent trends (potentially reflecting newer regulatory pushes like the ESPR proposal). While the resulting map (Figure 13) is visually dense due to the richness of keyword connections, it reveals a clear overarching narrative of conceptual progression:

2016–2020 – Laying the Foundations of Digital CE. During this initial phase, research explored enabling digital technologies including Big Data, Blockchain, IoT and Machine Learning for Circular Economy. Key themes involved applying these tools alongside concepts like Life Cycle Assessment (LCA) and remanufacturing to address waste, material recovery (e.g. via BIM in construction) and measure environmental impacts. Early considerations of business models, sustainability and Industry 4.0 framed the DT-CE link within a broader

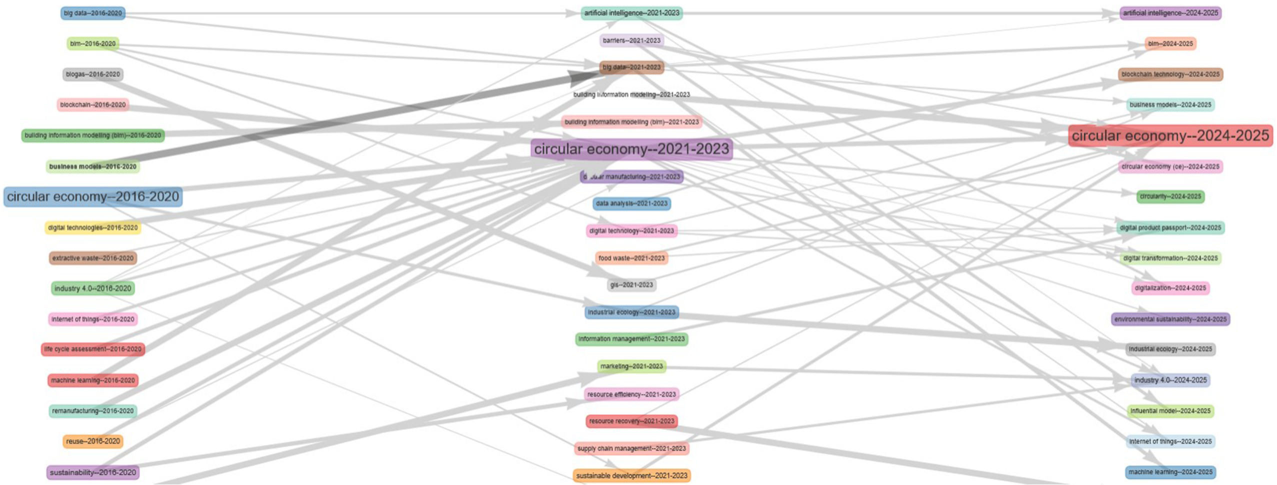

Figure 14. Thematic evolution map. Source: Created by the authors

systemic transformation, laying the conceptual and technological groundwork for future research.

2021–2023 – Strategic Integration and Systemic Alignment. This period shifted towards strategic integration and application. Key digital tools such as AI and Big Data were viewed less in isolation and more as integral components for decision-making, optimization and traceability, often linked to information management and resource efficiency across value chains. Research expanded into spatial dimensions (using BIM, GIS) for urban/territorial CE and focused on operationalization through themes including industrial ecology, resource recovery and supply chain management. The field also diversified, incorporating implementation barriers, marketing and sector-specific issues (e.g. food waste), while maintaining a strong link to sustainable development goals, indicating a phase of broader integration and application. Key terms including *information management*, *circular manufacturing* and *resource recovery* show principles being embedded through collaboration and innovation across value networks, spurred by pandemic-era digital acceleration and ISO 59000 CE standards drafts (Arana-Landin *et al.*, 2024).

2024–2025 – Operationalization, Policy Integration and Sectoral Impact. This 2024–2025 period signifies a shift towards practical implementation, policy alignment and measuring impact. The emergence of digital product passport (DPP) (Faraca *et al.*, 2024) is prominent, reflecting responses to regulations like Ecodesign for Sustainable Products Regulation (ESPR) and driving the use of blockchain, digitalization and digital transformation for traceability and compliance. Research also increasingly focuses on applied business models and assessing circularity to measure value creation and scale up practices. Core digital technologies (AI, ML, IoT, Industry 4.0, BIM) remain central but are now deeply interwoven with executional goals and system integration, grounded in industrial ecology and environmental sustainability. This phase marks an evolution towards tangible, policy-aligned and outcome-driven DT-CE research aimed at real-world transformation.

Conclusion

Key takeaways and implications

This study employed bibliometric analysis to map the evolving scholarly landscape at the intersection of DT and the CE, analyzing a corpus of 722 Scopus-indexed publications from 2016 to early 2025. The analysis highlights rapid publication growth post-2020 and identifies influential contributors, journals and collaboration networks within this dataset. Key thematic findings include a demonstrated evolution from foundational CE concepts towards operationalization and, more recently, towards digitally-enabled institutionalization, with technologies such as IoT, AI, Blockchain and Digital Product Passports becoming increasingly central.

The primary contribution of this work is providing an updated (2016–2025) structural overview of the DT-CE research field based on the analyzed corpus. By mapping key themes, their evolution and prominent players, this study offers a quantitative perspective complementing existing qualitative reviews, potentially aiding researchers in navigating this dynamic area. Identifying high-impact journals and keywords may also offer guidance. To enhance practical and research relevance, the study highlights key findings, offers actionable recommendations, such as using AI and blockchain for traceability, and suggests future research on digital product passports and technology adoption, ensuring alignment with the thematic analysis and supporting circular economy transitions.

While Liu *et al.* (2021) provided a bibliometric review of the digital economy and CE integration, our study offers distinct contributions based on several key differences. *Firstly,* our analysis covers a more extended and recent timeframe (2016-early 2025 vs Liu *et al.*'s likely earlier cutoff), capturing the significant acceleration in publications and thematic shifts post-2020, including the emergence of critical topics such as Digital Product Passports, which were less prominent previously. *Secondly,* our methodology employs a broader range of bibliometric techniques reported in detail, including thematic evolution analysis and detailed mapping of recent collaboration networks, allowing for a more dynamic view of the field's progression beyond the structural overview provided by Liu *et al. Thirdly,* our study uses co-occurrence and thematic mapping to explicitly link specific digital technologies with core CE principles. This offers a granular view of how distinct DTs enable specific CE strategies, complementing Liu *et al.*'s broader conceptual work. Our thematic evolution analysis further details the shift towards operationalization driven by specific digital innovations and policies, an insight missing previously. Thus, we provide a necessary, nuanced mapping of the maturing DT-CE landscape, justifying our contribution beyond an incremental update.

Knowledge potential

At first, key findings reveal rapid publication growth post-2020 and identify influential authors (e.g. Bag, Kazancoglu and Govindan from Table 3) and core works (e.g. Kristoffersen *et al.* from Table 4) within this literature set. High-impact journals including *Sustainability, Journal of Cleaner Production* and *Resources, Conservation & Recycling* are prominent outlets (Table 2). Analysis of frequent keywords (e.g. "circular economy," "recycling," "digital technologies" in Figure 8) confirms the field's focus on blending foundational environmental concerns with digital enablers like AI, IoT and blockchain. Network analyses revealed thematic clusters, including emerging niches focused on digital product passports (Table 5), highlighting the coexistence of technology-driven and policy-oriented approaches. Geographically, while European nations such as Italy and the UK, alongside India and China, lead in publication volume, while others including the USA show high citation impact despite lower output (Table 6, Figure 11).

Thus, synthesizing these findings suggests several overarching trends within the analyzed literature. First, the thematic evolution observed *suggests* moving from foundational concepts towards more data-driven approaches and implementation discussions. Second, while Environmental Science and Engineering remain dominant subject areas (Figure 5), the increasing presence of Business, Social Sciences and Economics points towards a broadening disciplinary perspective incorporating technical, managerial and policy considerations. Third, the growing publication focuses on digital solutions, particularly the post-2020 surge seen in keyword frequency (Figure 9), *indicates* their increasing importance in scholarly discussions surrounding how circular initiatives are planned and potentially governed.

Moreover, these findings can also be interpreted through the lens of the proposed Review Scope and Conceptual Foundations framework (Figure 2), which outlines Core Concepts, Principles and Digital Technologies based on existing literature. For instance, journal co-citation clusters (Figure 7) broadly correspond to these layers (e.g. environmental journals with Core Concepts, recycling journals with Principles, technology journals with Digital Technologies). Temporal analyses (Figure 9, Figure 14) suggest progression consistent with the model's logic, moving from Core Concepts to Principles and increasingly integrating Digital Technologies over time. While not a formal test, this alignment suggests the model serves as a useful heuristic for understanding the interplay between CE and DT in the literature. Future work using other methods is needed to validate the model's proposed mechanisms.

Finally, the study further emphasizes the prominent role of digital technologies within environmental science, engineering and computer science – disciplines that are pivotal to advancing CE strategies. Environmental science provides sustainability metrics and waste reduction frameworks, engineering drives innovations such as smart manufacturing and resource-efficient design, while computer science underpins data-driven solutions through technologies including AI, IoT, and Blockchain. The high volume of publications in these fields reflects their foundational contributions to digitally-enabled circular transitions. This interdisciplinary convergence highlights the field's strong technical and scientific underpinnings and reinforces the critical role of each domain in supporting sustainable digital transformation.

Limitations and future research directions

The findings must be interpreted with significant caution due to several limitations. The reliance on the Scopus database may omit relevant works, and the defined timeframe might miss the newest developments. More significantly, the construction of the final 722-paper corpus involved a manual relevance screening step; while guided by explicit criteria, this process carries an inherent risk of selection bias that could impact the representativeness and generalizability of the results. Furthermore, the quantitative nature of bibliometrics provides limited insight into the practical implementation or real-world nuances of DT adoption in the CE. Finally, data collection occurred in early 2025, potentially excluding later publications.

Acknowledging these constraints, future research should integrate bibliometric insights with qualitative methods including organizational case studies to assess DT adoption, readiness and policy effectiveness. Cross-industry and regional analyses could uncover specific challenges and best practices. Investigating the impact of emerging technologies such as edge computing and refining the understanding of digital twins within CE frameworks also remain important avenues for subsequent research.

Ethical considerations

This study used only publicly available data from Scopus, thus not requiring formal ethical approval or informed consent.

References

Antikainen, M., Uusitalo, T. and Kivikytö-Reponen, P. (2018), "Digitalisation as an enabler of circular economy", *Procedia CIRP*, Vol. 73, pp. 45-49, doi: 10.1016/j.procir.2018.04.027.

Arana-Landin, G., Siguenza, W., Landeta-Manzano, B. and Laskurain-Iturbe, I. (2024), "Circular economy: on the road to ISO 59000 family of standards", *Corporate Social Responsibility and Environmental Management*, Vol. 31 No. 3, pp. 1977-2009, doi: 10.1002/csr.2665.

Arruda, H., Silva, E.R., Lessa, M., Proenca, D. Jr and Bartholo, R. (2022), "VOSviewer and bibliometrix", *Journal of the Medical Library Association: JMLA*, Vol. 110 No. 3, pp. 392-395, doi: 10.5195/jmla.2022.1434.

Bag, S., Gupta, S. and Kumar, S. (2021), "Industry 4.0 adoption and 10R advance manufacturing capabilities for sustainable development", *International Journal of Production Economics*, Vol. 231, 107844, doi: 10.1016/j.ijpe.2020.107844.

Banihashemi, S., Meskin, S., Sheikhoshkar, M., Mohandes, S.R., Hajirasouli, A. and Lenguyen, K. (2024), "Circular economy in construction: the digital transformation perspective", *Cleaner Engineering and Technology*, Vol. 18, 100715, doi: 10.1016/j.clet.2023.100715.

Burnham, J.F. (2006), "Scopus database: a review", *Biomedical Digital Libraries*, Vol. 3, pp. 1-8, doi: 10.1186/1742-5581-3-1.

Cagno, E., Neri, A., Negri, M., Bassani, C.A. and Lampertico, T. (2021), "The role of digital technologies in operationalizing the circular economy transition: a systematic literature review", *Applied Sciences*, Vol. 11 No. 8, p. 3328, doi: 10.3390/app11083328.

Callon, M., Courtial, J.-P., Turner, W.A. and Bauin, S. (1983), "From translations to problematic networks: an introduction to co-word analysis", *Social Science Information*, Vol. 22 No. 2, pp. 191-235, doi: 10.1177/053901883022002003.

Chauhan, C., Parida, V. and Dhir, A. (2022), "Linking circular economy and digitalisation technologies: a systematic literature review of past achievements and future promises", *Technological Forecasting and Social Change*, Vol. 177, 121508, doi: 10.1016/j.techfore.2022.121508.

Corvellec, H., Stowell, A.F. and Johansson, N. (2022), "Critiques of the circular economy", *Journal of Industrial Ecology*, Vol. 26 No. 2, pp. 421-432, doi: 10.1111/jiec.13187.

De Jesus, A., Antunes, P., Santos, R. and Mendonça, S. (2018), “Eco-innovation in the transition to a circular economy: an analytical literature review”, *Journal of Cleaner Production*, Vol. 172, pp. 2999-3018, doi: 10.1016/j.jclepro.2017.11.111.

Demestichas, K. and Daskalakis, E. (2020), “Information and communication technology solutions for the circular economy”, *Sustainability*, Vol. 12 No. 18, p. 7272, doi: 10.3390/su12187272.

Dervis, H. (2019), “Bibliometric analysis using bibliometrix an R package”, *Journal of scientometric research*, Vol. 8 No. 3, pp. 156-160, doi: 10.5530/jscires.8.3.32.

Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S.J., Garmulewicz, A., Knowles, S., Minshall, T.H.W., Mortara, L., Reed-Tsochas, F.P. and Rowley, J (2017), “Unlocking value for a circular economy through 3D printing: a research agenda”, *Technological Forecasting and Social Change*, Vol. 115, pp. 75-84, doi: 10.1016/j.techfore.2016.09.021.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N. and Lim, W.M. (2021), “How to conduct a bibliometric analysis: an overview and guidelines”, *Journal of Business Research*, Vol. 133, pp. 285-296, doi: 10.1016/j.jbusres.2021.04.070.

Faraca, G., Ranea Palma, A., Spiliotopoulos, C., Rodriguez Manotas, J., Sanye Mengual, E., Amadei, A.M., Maury, T., Pasqualino, R., Wirezgala, P. and Perez Camacho, M. (2024), *Ecodesign for Sustainable Products Regulation: Study on New Product Priorities*, Joint Research Centre, Örebro.

Fischer, A. and Pascucci, S. (2017), “Institutional incentives in circular economy transition: the case of material use in the Dutch textile industry”, *Journal of Cleaner Production*, Vol. 155, pp. 17-32, doi: 10.1016/j.jclepro.2016.12.038.

Gheno, G. (n.d.), “An new algorithm for citation analysis, international institute of social and economic sciences”, *proceedings of International Academic Conferences, RePEc:sek:iacpro:11113161*.

Hariyani, D., Hariyani, P., Mishra, S. and Sharma, M.K. (2024), “Leveraging digital technologies for advancing circular economy practices and enhancing life cycle analysis: a systematic literature review”, *Waste Management Bulletin*, Vol. 3, pp. 69-83, doi: 10.1016/j.wmb.2024.06.007.

Johansson, N. (2021), “Does the EU’s action plan for a circular economy challenge the linear economy?”, *Environmental Science and Technology*, Vol. 55 No. 22, pp. 15001-15003, doi: 10.1021/acs.est.1c06194.

Korhonen, J., Honkasalo, A. and Seppala, J. (2018), “Circular economy: the concept and its limitations”, *Ecological Economics*, Vol. 143, pp. 37-46, doi: 10.1016/j.ecolecon.2017.06.041.

Kristoffersen, E., Blomsa, F., Mikalef, P. and Li, J. (2020), “The smart circular economy: a digital-enabled circular strategies framework for manufacturing companies”, *Journal of Business Research*, Vol. 120, pp. 241-261, doi: 10.1016/j.jbusres.2020.07.044.

Le, T.D., LaBelle, F. and Le-Dinh, T. (2024), “A big picture of circular economy in organizations: a focus on North American Researchers”, *The Québec Circular Economy Research Network (RRECQ)*, p. 105.

Liu, Z., Liu, J. and Osmani, M. (2021), “Integration of digital economy and circular economy: current status and future directions”, *Sustainability*, Vol. 13 No. 13, p. 7217, doi: 10.3390/su13137217.

Liu, Q., Trevisan, A.H., Yang, M. and Mascarenhas, J. (2022), “A framework of digital technologies for the circular economy: digital functions and mechanisms”, *Business Strategy and the Environment*, Vol. 31 No. 5, pp. 2171-2192, doi: 10.1002/bse.3015.

MacAurthur, E. (2013), “Towards the circular economy”, *Journal of Industrial Ecology*, Vol. 2, pp. 23-44.

Neri, A., Cagno, E., Susur, E., Uruena, A., Nuur, C., Kumar, V., Franchi, S. and Sorrentino, C. (2024), “The relationship between digital technologies and the circular economy: a systematic literature review and a research agenda”, *R&D Management*, Vol. 55 No. 3, pp. 617-713, doi: 10.1111/radm.12715.

Okorie, O., Salonitis, K., Charnley, F., Moreno, M., Turner, C. and Tiwari, A. (2018), “Digitisation and the circular economy: a review of current research and future trends”, *Energies*, Vol. 11, p. 3009, doi: 10.3390/en11113009.

Olabi, A.G. and Abdelkareem, M.A. (2022), "Renewable energy and climate change", *Renewable and Sustainable Energy Reviews*, Vol. 158, 112111, doi: 10.1016/j.rser.2022.112111.

Pagoropoulos, A., Pigosso, D.C. and McAloone, T.C. (2017), "The emergent role of digital technologies in the circular economy: a review", *Procedia Cirp*, Vol. 64, pp. 19-24, doi: 10.1016/j.procir.2017.02.047.

Paunovic, M., Štrbac, D. and Živkovic, L. (2024), "The evolution of intellectual capital research: a bibliometric analysis of highly-cited papers", *Economic Analysis*, Vol. 57, pp. 1-19, doi: 10.28934/ea.24.57.1.pp1-19.

Rizvi, S.W.H., Agrawal, S. and Murtaza, Q. (2021), "Circular economy under the impact of IT tools: a content-based review", *International Journal of Sustainable Engineering*, Vol. 14 No. 2, pp. 87-97, doi: 10.1080/19397038.2020.1773567.

Sanchez-Garcia, E., Martinez-Falco, J., Marco-Lajara, B. and Manresa-Marhuenda, E. (2024), "Revolutionizing the circular economy through new technologies: a new era of sustainable progress", *Environmental Technology and Innovation*, Vol. 33, 103509, doi: 10.1016/j.eti.2023.103509.

Surwase, G., Sagar, A., Kademani, B.S. and Bhanumurthy, K. (2011), "Co-citation analysis: an overview", *The BOSLA National Conference Proceedings*, pp. 179-185.

Trevisan, A.H., Lobo, A., Guzzo, D., De Vasconcelos Gomes, L.A. and Mascarenhas, J. (2023), "Barriers to employing digital technologies for a circular economy: a multi-level perspective", *Journal of Environmental Management*, Vol. 332, 117437, doi: 10.1016/j.jenvman.2023.117437.

Ucar, E., Le Dain, M.-A. and Joly, I. (2020), "Digital technologies in circular economy transition: evidence from case studies", *Procedia Cirp*, Vol. 90, pp. 133-136, doi: 10.1016/j.procir.2020.01.058.

Upadhyay, A., Mukhuty, S., Kumar, V. and Kazancoglu, Y. (2021), "Blockchain technology and the circular economy: implications for sustainability and social responsibility", *Journal of Cleaner Production*, Vol. 293, 126130, doi: 10.1016/j.jclepro.2021.126130.

Van Eck, N. and Waltman, L. (2009), "Software survey: VOSviewer, a computer program for bibliometric mapping", *Scientometrics*, Vol. 84 No. 2, pp. 523-538, doi: 10.1007/s11192-009-0146-3.

Velenturf, A.P.M. and Purnell, P. (2021), "Principles for a sustainable circular economy", *Sustainable Production and Consumption*, Vol. 27, pp. 1437-1457, doi: 10.1016/j.spc.2021.02.018.

Wynn, M. and Jones, P. (2022), "Digital technology deployment and the circular economy", *Sustainability*, Vol. 14 No. 15, p. 9077, doi: 10.3390/su14159077.

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