



International Journal of Services and Operations Management

ISSN online: 1744-2389 - ISSN print: 1744-2370

<https://www.inderscience.com/ijson>

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DOI: [10.1504/IJSOM.2026.10081547](https://doi.org/10.1504/IJSOM.2026.10081547)

Article History:

Received:	29 July 2024
Last revised:	24 October 2025
Accepted:	05 April 2026
Published online:	22 October 2026

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Abstract: The circular economy (CE) replaces the linear extract-produce-consume-discard paradigm with regenerative systems designed to preserve the lifespan and value of materials, components, and products. This article reviews current CE literature to identify trends, models, challenges, and opportunities for goods and services organisations. Employing a qualitative, descriptive methodology, the study analyses 50 articles – selected from an initial 372 – published between 2020 and 2026 in operations, production, logistics, and supply chain management journals. Findings highlight prominent CE trends, notably additive manufacturing and information technology integration. Additionally, key operational frameworks such as the regeneration and resource recovery models are identified. Ultimately, navigating inherent challenges and capitalising on CE opportunities requires the formulation of robust policies to strengthen sustainability, alongside the active participation of all economic stakeholders.

Keywords: circular economy; operations management; circular supply chains; circularity models; sustainability; reverse logistics.

Reference to this paper should be made as follows: Cáceres-Mariño, S.A., Angarita-Monroy, A.G. and Henao-Gómez, L.M. (2026) ‘Exploring the trends, models and challenges of the circular economy: a review of the literature’, *Int. J. Services and Operations Management*, Vol. 55, No. 7, pp.1–23.

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1 Introduction

The circular economy is an economic model that challenges traditional concepts of production and consumption. It is based on the extraction of resources, the production of goods, consumption, and the disposal of waste, which affects ecosystems by creating shortages and having a negative impact through the use of resources that belong to future generations. Unlike the linear model, the circular model aims to preserve the value of materials, components, and products through strategies of reduction, reuse, repair, remanufacturing, recycling, and regeneration, seeking to close the resource cycle by protecting the environment and designing products with a long service life (European Parliament, 2023).

The concept of the circular economy has gained significant importance in recent decades due to the need to address global environmental issues, including resource scarcity, pollution, and climate change. According to the Ellen MacArthur Foundation (2026), the circular economy is a framework of systemic solutions used to address global challenges such as climate change, rising waste and pollution, and biodiversity loss. Furthermore, this transition enables increased prosperity, employment, and resilience, thereby reducing greenhouse gas emissions and the generation of pollutants that harm the planet. That is why various economic sectors have identified actions aimed at adopting new organisational practices that contribute to reducing waste generation and optimising processes, as well as the use of raw materials and inputs, thereby leading to a sustainable transformation in the design, manufacturing, consumption, and disposal of goods, as well as in the provision of services. It is important to note that sustainability is not only environmentally focused but also represents a business opportunity, a reduction in costs, an increase in efficiency, the opening of new markets, a social contribution through the enhancement of the dignity of occupations, and the creation of employment opportunities that can make a difference (CECODES, 2023).

This article is divided into three key sections: the definition and fundamentals of the circular economy; the identification of trends, models, challenges and opportunities associated with this topic; and, in the third section, the recommendations and strategies proposed to facilitate the transition toward economic models that demonstrate greater

sustainability. During the review of the current state of research related to the circular economy, the most frequently addressed topics regarding this concept were identified. This review provided insight into the volume of publications over the past decade, the key factors associated with specific areas of research, and a co-occurrence map that helped establish the most relevant components of the circular economy. Following this, the literature review is presented, describing the trends, circular economy models, challenges, and opportunities documented in recent specialised literature. Each of these findings is divided into separate sections to facilitate the differentiation of the results obtained. Finally, the authors of this article propose a set of recommendations and strategies aimed at contributing to the transition toward a more sustainable economic model, as long as the various production and service units take steps to gradually integrate the concepts and procedures proposed by experts, with a view to promoting sustainability.

2 Definition and fundamentals of the circular economy

2.1 Concepts related to the circular economy

The circular economy is based on the principles of sustainability and resource efficiency, promoting practices geared toward economic development, environmental protection, and contributions to society that favour the procurement of raw materials, inputs, products, or services of greater utility and value at all times, with minimal harm to the environment. With this in mind, initiatives are established for reuse, the creation of new business ideas, product regeneration, recycling, and material sourcing, among other actions that help manage a supply chain that is responsible toward the resources of future generations (Ministerio de Ambiente y Desarrollo Sostenible, 2019). Hence the importance of conducting literature reviews to access guidance on how to implement these initiatives.

As part of the processes carried out to conduct the literature review on the circular economy, Figure 1 identifies keywords with an occurrence (frequency) of 30 or more, including ‘recovery’, ‘valorisation’, ‘life cycle assessment’, ‘manager’, ‘waste’ and ‘enabler’, all of which relate to the production, consumption, and management of resources.

The circular economy trend has focused on the importance of analysing production methodologies and consumption patterns in order to make the most of resources and waste, while avoiding the excessive use of the planet’s resources. In this regard, the recovery, reuse, recovery, and monetisation of eco-friendly products, as well as the benefits generated for communities, are key contributors to reducing inequalities.

According to the literature review, between 2020 and 2026 there has been a steady upward trend in the number of publications related to the circular economy, reflecting a high level of academic and scientific interest in the development of projects aligned with sustainability and aimed at addressing real-world problems and needs in society. It is important to note that Figure 2 shows only a partial report of the research conducted in 2026, as data was collected only through May of that year.

Regarding the number of publications by country, as shown in Figure 3, China is one of the leading contributors to knowledge generation in the circular economy, followed by England and India. In the case of China, this leadership stems from the promotion of circularity strategies aimed at reducing emissions and transforming sectors such as the

built environment, mobility, food, textiles, and electronics (Ellen MacArthur Foundation, 2026; Tankova and Moneva, 2026). Meanwhile, England has strengthened its position by launching the first United Nations-backed International Center of Excellence for Sustainable Resource Management in the Circular Economy, which reinforces its role as a leader in research and public policy (UK Government, 2024; UNECE, 2024). In addition, India, Germany and Portugal continue to play a prominent role in scientific output in this field, while Brazil maintains a significant presence and remains one of the most visible Latin American countries in this line of research (Tankova and Moneva, 2026; Ospina et al., 2023).

Figure 1 Map of co-occurrences associated with the keywords in the analysed literature (see online version for colours)

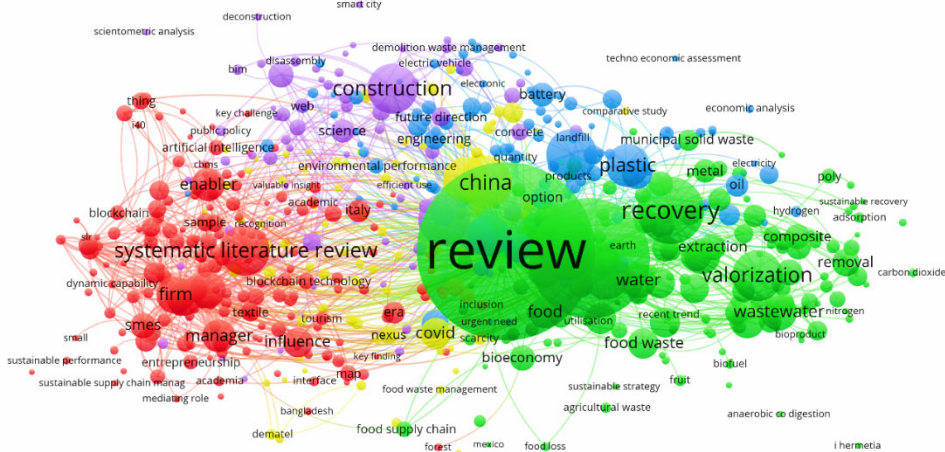


Figure 2 Number of publications per year on the circular economy (see online version for colours)

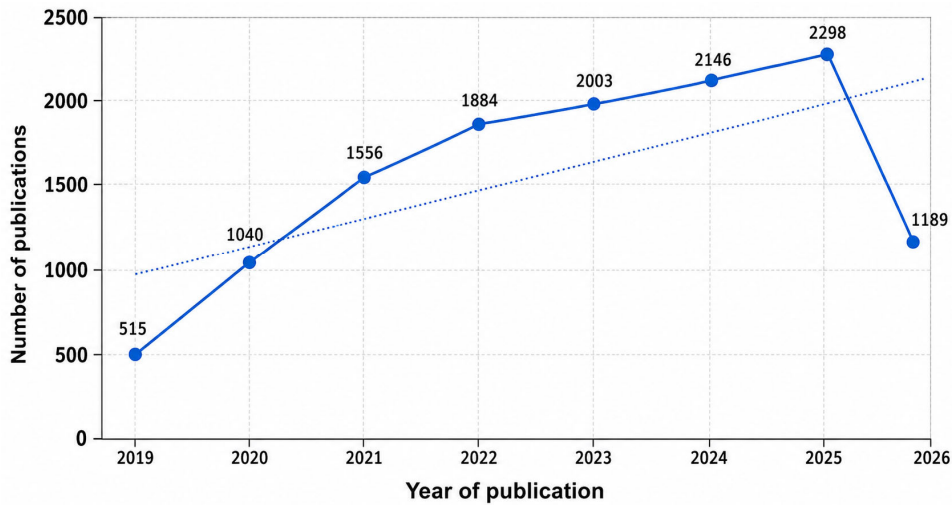


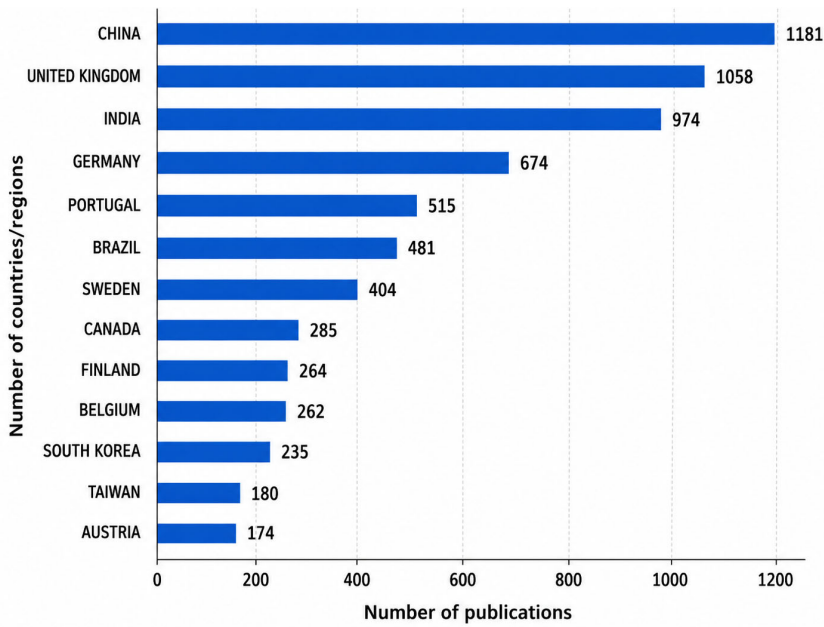
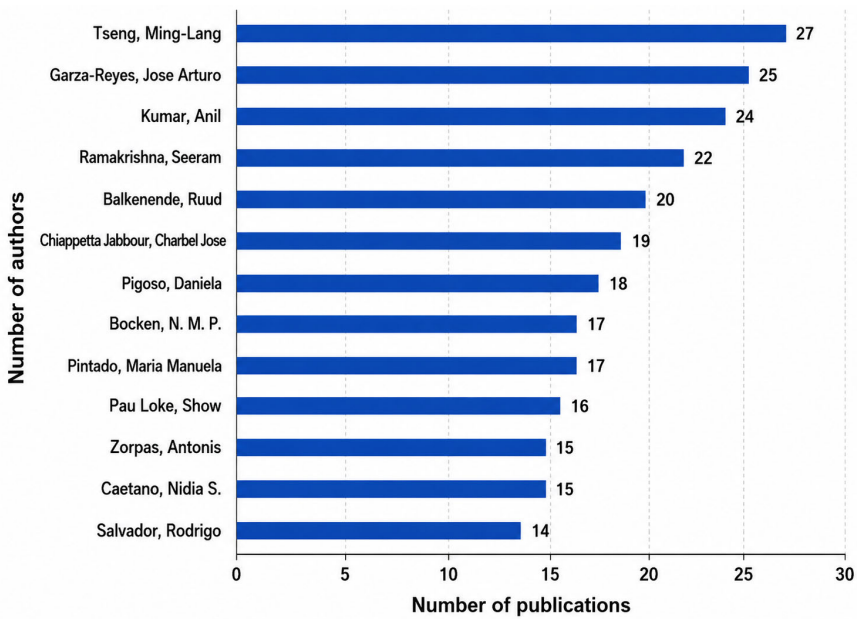
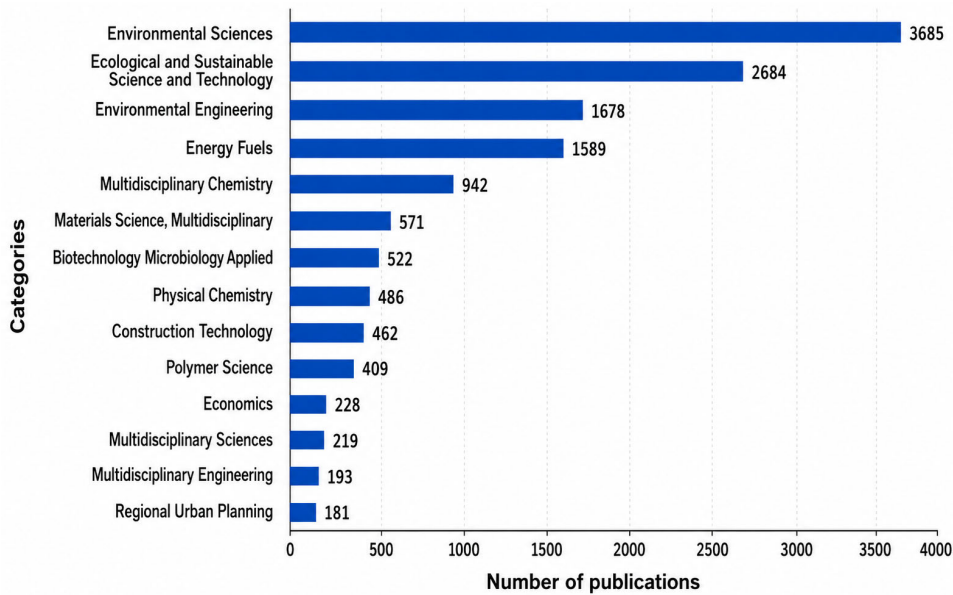
Figure 3 Publications by country (see online version for colours)**Figure 4** Publications by author (see online version for colours)

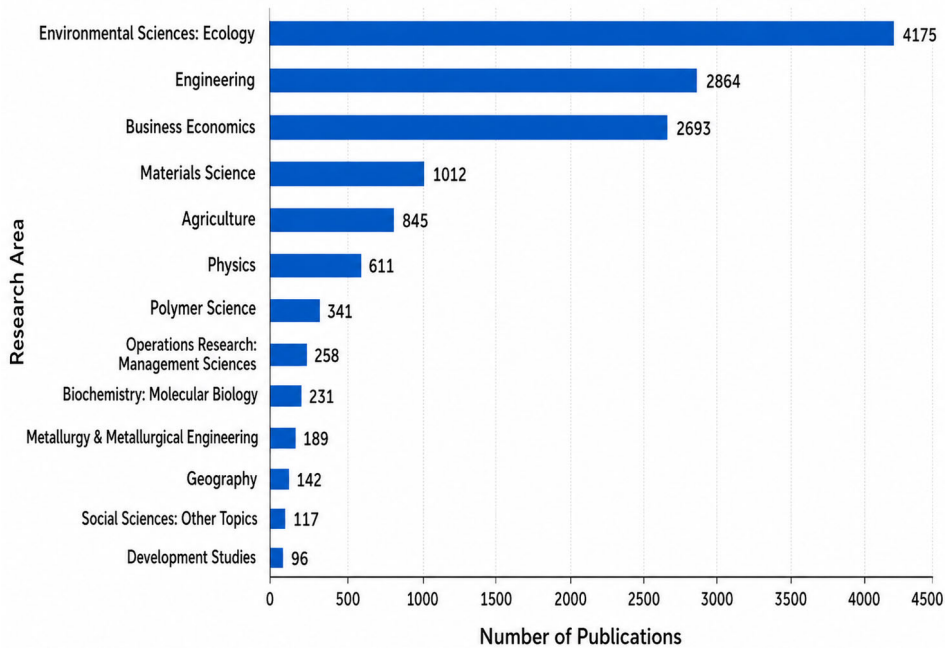
Figure 4 shows some of the most prolific authors in the field of the circular economy through 2026, along with the number of publications attributed to each. For example, authors such as Tseng, Garza-Reyes, Kumar and Ramakrishna confirm the consolidation of the field and its progressive thematic specialisation.

The most relevant categories within research related to the circular economy are environmental sciences, green and sustainable science and technology, environmental engineering, environmental studies and energy fuels. These terms are closely linked to environmental sustainability, resource optimisation, and the reduction of impacts on ecosystems, as well as a significant expansion into areas related to materials, management, planning, and digital technologies, which provide relevant economic, social, and environmental alternatives for strengthening sustainability (Garcilazo et al., 2026; Tankova and Moneva, 2026; Percuoco et al., 2026).

Figure 5 Publications by category (see online version for colours)



As shown in Figure 6, the research areas that have contributed most to scientific articles on the circular economy have been ecology, engineering, business economics, and materials science, demonstrating that the field of environmental sciences has a solid foundation in environmental sustainability, resource efficiency, and the transformation of production systems. Additionally, growth is observed in areas such as agriculture, physics, polymer science and operations research, reflecting an interdisciplinary expansion of the topic toward technological, analytical, and applied approaches. This diversification shows that the circular economy is no longer limited to the environmental component but integrates business, industrial, and optimisation perspectives to address contemporary sustainability challenges (Garcilazo et al., 2026; Tankova and Moneva, 2026).

Figure 6 Contribution by research area (see online version for colours)

3 Methodology applied to the literature review process

A descriptive literature review was conducted to identify trends, models, challenges, and opportunities associated with the circular economy in the context of goods-producing and service-providing organisations. Google Scholar was used as the primary search source for document retrieval, using the following search query: ('economía circular' OR 'circular economy') AND ('tendencias' OR 'trends') AND ('modelos de economía circular' OR 'circular economy models'). The search initially yielded 2,180 results, which were narrowed down to 2,026, resulting in a total of 372 studies. The documents were then screened based on publication type, thematic relevance, and direct relationship to the review's objectives, allowing for the consolidation of a subset of 50 articles relevant to the analysis. The selection of the years to be examined was based on the lessons learned following the pandemic caused by the SARS-CoV-2 virus, during which interactions within society underwent significant changes, beginning with companies that have been called upon to transform their operations, the resources they use, and their emergency preparedness (BBC, 2020).

The inclusion criteria were: articles published between 2020 and 2026; documents in Spanish or English; research related to the circular economy, trends, models, challenges, opportunities, corporate sustainability, innovation, applied technologies, resource management, or process optimisation; review articles, systematic reviews, bibliometric studies, and conceptual works with relevant contributions to the field. Priority was given to documents with a global or cross-cutting perspective, so that the review would not be

restricted to a single economic sector and could provide useful information for organisations that produce goods and provide services.

Exclusion criteria included duplicate documents, publications without complete bibliographic information, texts not directly related to the areas of analysis, studies focused exclusively on local cases without the potential for conceptual transfer, popular science articles without academic backing, and works that do not address the circular economy. The 50 articles were subjected to thematic review and organised into four categories: trends in the circular economy, circular economy models, challenges to its implementation, and opportunities for organisations. This allowed us to structure the results and focus the review on contributions applicable to the business, manufacturing, and service sectors.

4 Results obtained following the literature review process

After completing the stages of selection, refinement, and analysis of the articles that addressed the thematic areas of interest, we were able to identify the trends, models, challenges, and opportunities discussed in the literature on the circular economy.

4.1 Trends in the circular economy

The literature review identified various emerging trends related to the circular economy. These trends were grouped into categories such as ‘concepts, principles, and general aspects of the circular economy’, ‘workplace and management practices’, ‘product manufacturing in the circular economy’, ‘integration of technology in the circular economy’ and ‘circular economy assessment tools’. These categories demonstrate that the circular economy requires simultaneous actions in design, production, procurement, logistics, organisational culture.

Among the findings identified regarding concepts, principles, and general guidelines, emphasis is placed on the foundation of the circular economy as a set of actions aimed at transforming the production and consumption of goods and services so that they meet requirements for durability, repair, and recycling, with the goal of extending the useful life of products and thereby minimising the need to replace them frequently. Furthermore, it promotes the use of strategies known as the ‘R’ principles, which help reduce pressure on natural resources and generate value from waste, recovered materials, or products with extended useful lives (Kirchherr et al., 2023; Correa et al., 2024; Calzolari et al., 2025). It is important to note that the circular economy is based on a full life-cycle approach, considering the different stages involved in the manufacture of goods and the provision of services. In the first case, this ranges from the extraction of raw materials to final disposal, reducing waste; in the second case, it ranges from the planning of key activities and resources to the fulfilment of intangible needs requested by consumers.

The principles identified in the literature review range from the implementation of terms such as recycling, reuse, recovery, and regeneration, among others, to the application of these concepts in the business environment, driven by the need to develop efficient waste management systems or to optimise processes and resources to mitigate environmental impact. Additionally, the review highlights the current economy’s demand for recovering valuable materials to reintroduce them into the production chain, thereby

reducing pressure on natural resources and creating new economic opportunities through new sources of raw materials (Raudales et al., 2023; Ospina, 2023).

There are trends that help us understand the concept of the circular economy, including the creation of sustainable infrastructure, waste management through biological processes, sustainable development and recycling in developing countries, and the importance of establishing new policies that enable the implementation of sustainability-oriented actions (González et al., 2023; Al-Haj Eid and Al-Abdallah, 2024; Kandpal et al., 2024). Finally, we were able to identify the approaches that have emerged from a business perspective for integrating the circular economy, including emissions analysis, environmental governance, and analysis of the impact that organisational processes have on the environment and communities (Ahmed, 2023; Al-Zoubi, 2024; Von Braun, 2024).

Moving on to the topic of labour and management practices, it has been observed that these have been impacted by the transition toward a circular economy, with a focus on the specific training and skill-building initiatives that have been implemented in preparation for supporting this economic model. Consequently, some research has focused on addressing social aspects aimed at developing competencies oriented towards the circular economy (Padilla, 2020; Haque et al., 2023). The circular transition demands new technical and strategic competencies; therefore, organisations need personnel capable of managing resources, designing recovery processes, analysing material data, coordinating reverse logistics, and developing collaborative relationships with suppliers and customers to minimise waste at every stage of the production process. Furthermore, attention is being given to the importance of actions that ensure respect for human rights, promote social inclusion, respect for individuality, and the creation of decent jobs (Kurniawan et al., 2026).

That is why, at present, job roles are being redefined with a focus on training circular design engineers, recovery and repair technicians, and other new programs that are emerging alongside this economic model (Del Vecchio et al., 2021). Corporate education is an essential practice aimed at ensuring that personnel are trained to adapt to changes in the environment, thereby transforming organisational culture to promote a focus on sustainability. This is being achieved through training programs and internal campaigns that offer recognition and incentives to those who contribute to the circular economy (Ahmed, 2023). Moreover, it is worth noting that business entities have identified the establishment of subsidies, tax exemptions, and cross-sector collaboration as strategies that have helped motivate more organisations to integrate the circular economy and participate in projects focused on sustainability and the transformation of business operations. Furthermore, these strategies contribute to strengthening competitiveness and innovation within companies, which in turn enable sustainable development that benefits society and future generations (Von Braun, 2024; Al-Haj Eid and Al-Abdallah, 2024).

On the other hand, among the topics related to trends in business management, the following were identified: circular city, urban metabolism, planning, cultural heritage, Industry 4.0 and 5.0, emissions (water, energy, flows, and air), reduction, measurement, and efficiency strategies, information flows, circularity indicators, urban agriculture, proper water management, regeneration, supply chain management, adaptive reuse, urban mining, governance and the built environment (Brglez et al., 2023; Ahmed, 2023; Kumar, 2023; Raudales et al., 2023; Correa et al., 2024). Some of the case studies identified involved companies such as the Virgin Group, which has integrated the 9 Rs (rethink,

reuse, repair, restore, remanufacture, reduce, repurpose, recycle and recover) into its processes. In Colombia, the work of the National Association of Industrialists (ANDI) in promoting circular economy strategies stands out, as does the case of the company ECOALF, which ventured into the production of textiles made from plastic recovered from the oceans (Ospina, 2023). Finally, it is important to mention the adoption of reverse logistics as a strategy for implementing the circular economy, as it helps optimise operations by reducing logistics costs, minimising waste and maximising organisational profits (Correa et al., 2024).

Regarding the manufacturing of products within the framework of the circular economy, it has been determined that one of the most significant trends identified through a review of the literature is the use of recycled and sustainable materials. In addition to the use of bio-based products, which are designed to break down waste, reduce dependence on virgin resources, and help lower the carbon footprint of production processes (Dahiya et al., 2020). One of the raw materials being used to manufacture new products is recycled cooking oil, which has served as a base for eco-friendly chemicals such as epoxies, binders, plasticisers, surfactants, lubricants, biomaterials, and polymers (Orjuela and Clark, 2020).

In addition, modular and demountable manufacturing is gaining significant momentum within sustainable initiatives, as it promotes resource and material efficiency. Moreover, the production of eco-friendly electronic goods is being encouraged, with a fundamental focus on the proper disposal and recycling of waste generated by this industry. It is worth noting that additive manufacturing has become a production model based on 3D printing as a mechanism for producing customised goods with minimal waste, using recovered materials and contributing to the efficient use of resources. Some waste materials used in this trend include algae, wood waste, PET, and construction waste, which are employed as raw materials in the production of furniture, buildings, clothing, and other items (Nabeela et al., 2021; Misra et al., 2021; Romani et al., 2021; Hadidi et al., 2024; Ratsimandresy and Miemczyk, 2025). One of the sourcing alternatives for circular businesses has been the management of their own waste, although the creation of a materials bank for the recovery of materials such as metal, wood, and concrete has also been proposed, with the construction sector being one of those that has sought to implement this strategy (De Oliveira et al., 2024).

With regard to the integration of technology with elements of the circular economy, one of the trends identified is the use of the internet of things (IoT), which is being applied to improve traceability and resource management, enabling real-time monitoring of production processes as well as supply chain management. Additionally, the use of sensors and devices associated with smart manufacturing has facilitated the collection of data on material usage, product condition, and energy efficiency, enabling decisions to be made to optimise processes and reduce waste, thereby facilitating life-cycle analysis of goods and strengthening resource management (Cioffi et al., 2020; Agrawal et al., 2021; Rumetshofer and Fischer, 2023). Another technological advancement being used to promote sustainability is artificial intelligence (AI), which is increasingly focused on analysing large volumes of data to identify patterns and opportunities for companies through machine learning algorithms that can predict demand for recycled products, optimise waste collection routes, and improve the efficiency of recycling systems.

Meanwhile, the use of blockchain has gained ground in the circular economy due to its ability to provide security and transparency in supply chains, ensuring compliance with quality and sustainability standards, as well as preventing fraud. Finally, the

automation of repetitive tasks and the digitisation of workflows have improved efficiency in the use of materials and energy, promoting sustainable operations. This has been achieved thanks to Industry 4.0 and 5.0, which – through intelligent systems such as cloud manufacturing, the internet of everything (IoE), supply chain management simulation applications, and surveillance and monitoring devices, have enabled the planning of sustainable actions, data analysis, the assessment of environmental impacts, and the development of new products, among other benefits (Voulgaridis et al., 2022; Han et al., 2023; El Jaouhari and Arif, 2024).

On another note, it is important to highlight the role played by the assessment processes that have been used to measure actions related to the circular economy. Currently, the application of circular economy assessment tools is becoming a necessity; these tools are essential for monitoring and measuring progress toward circularity and sustainability. One of the best-known tools is life cycle assessment (LCA), which seeks to analyse a product's environmental impact throughout all stages of its life cycle, from material extraction to final disposal, to identify areas for reducing environmental impact and improving resource efficiency (Imoniana et al., 2021). Moreover, the definition and use of circularity indicators have gained momentum; these indicators are used to quantify the degree to which a company, product, or service is circular, measuring recycling rates, efficiency in the use of raw materials, the proportion of recycled materials, waste management, and ecological footprint measurement, among other factors. In addition, material flow analysis (MFA) is essential for understanding how materials move through economic and environmental systems, making it possible to track the flow of resources and identify losses within the system. Finally, eco-certification and eco-labeling are tools used to provide a framework for evaluating the environmental performance of products based on parameters such as ISO standards, thereby increasing consumer confidence in sustainable products (Roos et al., 2022; Fassio and Chirilli, 2023).

Figure 7 summarises the categories related to trends in the circular economy that were identified during the literature review process.

Figure 7 Categories identified in circular economy trends (see online version for colours)

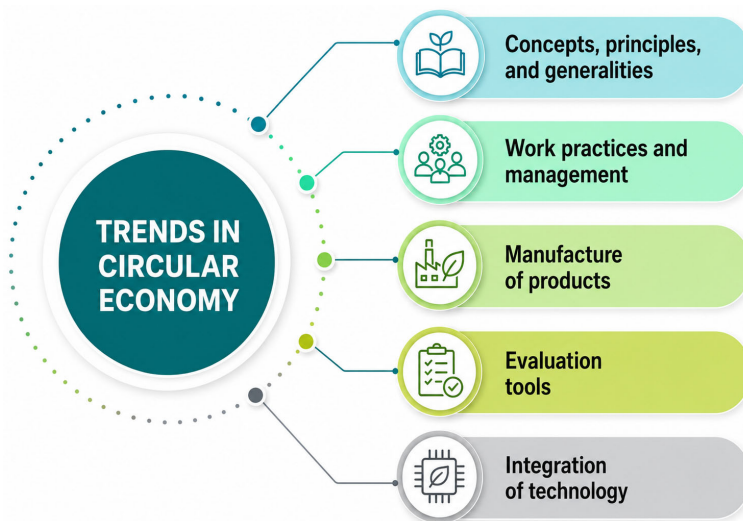


Table 1 presents a summary of the findings for each of the identified trends.

Table 1 Summary of findings on circular economy trends

<i>Trend</i>		<i>Finding</i>
Concepts, principles and general information	1	Life cycle approach.
	2	Environmental governance.
	3	The 9 Rs (refuse, reduce, reuse, repair, remanufacture, redesign, recycle, recover, and rethink).
	4	Efficient waste management systems.
	5	Emissions analysis.
	6	Sustainability impact analysis.
Work and management practices	1	Development of technical skills in efficient resource management and strategic thinking to support the economic model.
	2	Strategic thinking.
	3	Guarantee and respect for human rights, promoting inclusion.
	4	Redefinition of job roles: circular design engineers, recovery and repair technicians.
	5	Transformation of organisational culture toward sustainability.
	6	Recognition and incentives (grants and tax exemptions) for contributions to the circular economy.
	7	Cross-sector collaboration.
	8	Key terms: circular city, urban metabolism, planning, cultural heritage, Industry 4.0 and 5.0, emissions (water, energy, material flows, and air), information flows, circularity indicator, urban agriculture, proper water management, regeneration, supply chain management, adaptive reuse, urban mining, governance and built environment.
Product manufacturing	1	Use of recycled and sustainable materials.
	2	Bio-based products. Examples: recycled oil for manufacturing eco-friendly chemicals (epoxies, binders, plasticisers, surfactants, lubricants, biomaterials, and polymers).
	3	Manufacturing eco-friendly electronic goods.
	4	Additive manufacturing (3D printing): use of algae, wood waste, PET, and construction waste as raw materials.
	5	Creation of a database of construction materials (metal, wood and concrete).
Technology integration	1	Use of the internet of things (IoT): traceability and tracking.
	2	Artificial intelligence (AI): data analysis, pattern prediction, and opportunity identification, among others.
	3	Blockchain: information security and transparency.
	4	Industry 4.0 and 5.0: automation and digitisation of workflows.
Assessment tools	1	Life cycle assessment (LCA).
	2	Circularity indicators: recycling rates, efficiency in the use of raw materials, proportion of recycled materials, waste management, ecological footprint measurement, among others.
	3	Material flow analysis (MFA).
	4	Eco-certification and labelling.

4.2 Circular economy models

Given that a model is a representation of the interaction of various variables that characterise a particular phenomenon, circular economy models have been approached through frameworks and guidelines that are themselves considered models, as they present a series of characteristics that organisations can apply in their transition toward sustainability (Zils et al., 2025). One of the most prominent models is the *resource recovery model*, in which actions are focused on the collection and recycling of waste to be reintroduced into the production process. On the other hand, the *product life cycle extension model* aims to extend the useful life of products; through repair and reuse, it optimises resource use so that products can continue to be used by consumers. The *shared platform model* was also identified, which consists of the shared use of products to maximise their utilisation, so that consumers can use these goods for a period of time and then return them or share the benefits with others (Jiménez et al., 2020; Melendez et al., 2021; Zhang, 2023; Trevisan et al., 2025).

From an innovation perspective, contributions to the circular economy can be made through product design, which includes the creation of easily recyclable or biodegradable goods, as well as through process innovation focused on energy efficiency and waste reduction. Finally, innovations in business models, which promote adding value to waste through new products that serve as inputs or materials, as well as goods ready for consumer use (Chioatto et al., 2020; Marinina et al., 2022).

On the other hand, the *circular production model* focuses on designing products and processes that minimise resource use and waste generation, thereby integrating two important perspectives within environmental sustainability; another relevant approach is the *collaborative economy model*, which promotes the exchange and reuse of goods among users; in this respect, it is similar to the shared platform model, but differs in that products cannot be returned and must instead circulate in the market. Meanwhile, the *closed-loop supply chain model* integrates stakeholders from the design phase through the return of materials, ensuring that physical and information flows remain within the system and are utilised for as long as possible. This latter model is closely related to the *reverse logistics model*, which focuses on managing the return of products and materials for reuse, recycling, or the provision of services that benefit more organisations (Fassio and Chirilli, 2023; Trevisan et al., 2025).

Another model identified is the *remanufacturing model*, which has created a need within companies to offer services that restore used products to their original condition so they can be reintroduced to the market, an approach also embraced by the *school of regenerative economics*. Finally, the *eco-industrial park model* encourages clusters to create manufacturing environments where resource use is optimised and waste is minimised through synergy among organisations (Otero, 2023; Leyva et al., 2023; Zhang, 2023; Suárez et al., 2023).

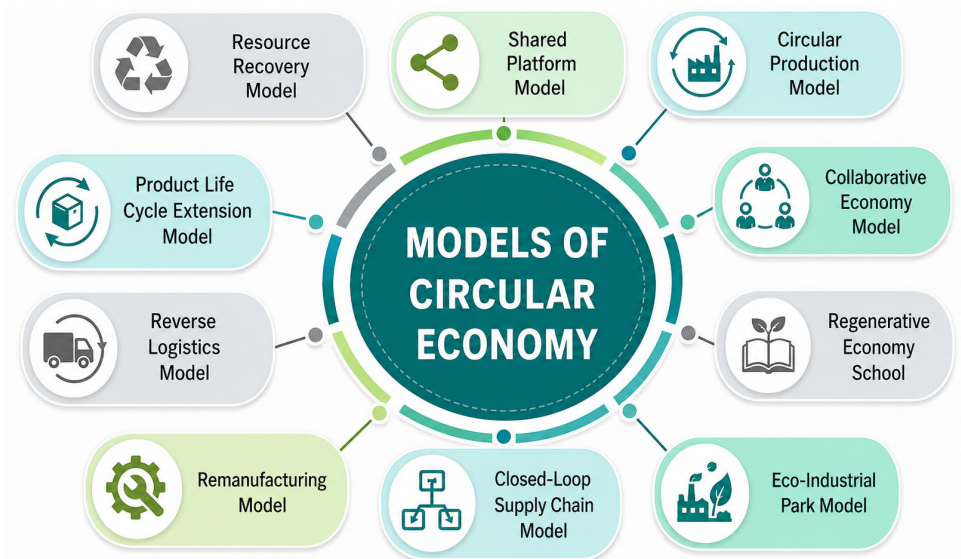
Some of the factors to consider when creating a circular economy model include:

- Market analysis, which must take into account the context in which the company or sector operates, so that it aligns with the needs and specific characteristics of the environment.
- An analysis of materials and waste, considering which raw materials and inputs should be replaced or eliminated to align with the circular economy.

- An analysis of clean technologies, which is necessary to identify technologies that can be integrated into the company's processes.
- Risk management, to determine the level of risk involved in implementing a circular economy model.

It is important to adapt the model to the parameters of the company or sector; after conducting preliminary analyses and developing the model, it must be validated by experts (Tola et al., 2023). Figure 8 compiles the various circular economy models identified during the literature review process.

Figure 8 Circular economy models (see online version for colours)



4.3 Challenges of the circular economy

Integrating the circular economy into the processes and procedures carried out in production and service units remains a challenge due to a lack of understanding and knowledge on the part of managers regarding its principles, innovations, and benefits, which has hindered its adoption and development within organisations. Additionally, analysing qualitative and quantitative data on waste streams and material needs has been a challenge for companies moving toward sustainability, as real-time information is not readily available. This is due to a lack of technical knowledge regarding circularity; thus, addressing this gap would ensure the technical feasibility of the sustainable alternatives that can be achieved by implementing circular models (Sopelana et al., 2021; Silvia et al., 2022; Fuertes et al., 2022; Vogiantzi and Tserpes, 2023; Upadhayay et al., 2024; Trevisan et al., 2025).

From a regulatory standpoint, there is still a lack of clearly defined parameters regarding activities associated with the circular economy, which has hindered the implementation of waste reuse projects, a situation that affects the dynamics of material recovery, particularly due to uncertainty about the safety of the materials. There has also

been community resistance to government policies where environmental fines and taxes have generated discontent among communities, even though these policies are strategies that have raised global awareness. A clear example of this was observed in the UK and China, where payments for environmental services or ecosystem services have been established, leading to greater resource optimisation, reduced pollution, and a lower negative impact on natural environments. It is important to note that there is a need for industrial oversight and regulation, along with the building of trust and confidence, to address the challenges of the transition toward a sustainable economy (Rehman et al., 2022; Turki, 2023; Choudhary et al., 2023). Therefore, the integration of Industry 4.0 technologies continues to improve and represents an option for avoiding issues such as cybersecurity risks, high investments with low returns, weak policies, and business risks.

To supplement the above, it is worth noting that there is also a significant challenge in incorporating tools to assess the integration of the circular economy into production processes. Some examples include life-cycle assessment, material flow analysis, and input-output analysis. It is also important to apply evaluation indicators, such as the longevity indicator, resource potential indicator, value-based resource efficiency indicator, sustainable circular index, value coefficient ratio, eco-efficiency index, global resources indicator, circular performance indicator, multi-criteria approaches, the analytic hierarchy process (AHP), and the integrated decision support tool (Vogiantzi and Tserpes, 2023; Kumar, 2023; Hoyng, 2023; Kandpal et al., 2024; Upadhayay et al., 2024).

4.4 Opportunities in the circular economy

The opportunities presented by the circular economy are vast, even though there are challenges to implementing sustainability-oriented actions within business environments. First, the creation of new value streams through the transformation of waste will enable the mitigation of pollution's impact, the recovery of materials, the provision of repair services, the creation of remanufactured products, and the adoption of product- or service-focused models, thereby reducing dependence on virgin raw materials and improving resilience to supply disruptions (Rossi and Srai, 2025).

Meanwhile, the application of new technologies to minimise environmental impacts and optimise operations through innovations, products, and services has also been seen as an opportunity for companies to integrate the circular economy. Furthermore, waste transformation represents a sustainable conversion that can lead to profit generation with minimal risk. In this regard, it is important to note that while there have been some developments regarding the generation and use of alternative energy sources, primarily solar and wind energy, research should be promoted that focuses on processes centered on bio-based products, among which the use of waste for the production of fuels or other sources (non-biological waste) that not only benefit the environment but also benefit communities by providing access to resources and services that can be both environmentally sustainable and economically affordable (Rehman et al., 2022; Upadhayay et al., 2024; Kandpal et al., 2024).

From an educational perspective, education has become a key pillar for unifying and advancing the concept of the circular economy, by designing effective strategies for the transition to sustainability; additionally, innovations in products and processes stemming from university research have made a significant contribution to reducing the use of

non-renewable resources, optimising energy use and maximising the use of materials (Sopelana et al., 2021; Silvia et al., 2022; Turki, 2023; Choudhary et al., 2023).

In addition to the above, the application of concepts such as reuse, recycling, waste management, and sustainability in business settings, as well as the involvement of academia in scientific research focused on the circular economy, has led to collaborative projects focused on wastewater treatment and the use of construction and demolition waste, among other areas. Some industries where the application of circular economy strategies is evident include aerospace, transportation and automotive, wind energy, and sports equipment, although efforts are now being directed toward implementing actions in agribusiness, the furniture sector, and the construction industry. Moreover, eco-design of processes must be promoted in order to mitigate the impact caused by resource exploitation and excessive consumption, as well as to establish punitive liabilities for producers of goods and waste generators in cases that harm environmental balance, since sustainable actions can contribute to the Sustainable Development Goals, which encompass social, economic, and environmental aspects (Fuertes et al., 2022; Vogiantzi and Tserpes, 2023; Kumar, 2023; Hoyng, 2023).

5 Discussion

The literature review shows that the effective implementation of the circular economy does not depend solely on the adoption of environmental principles, but rather on organisations' ability to transform their operations, supply chains, and value creation models. In this regard, Kirchherr et al. (2023) argue that circularity requires a broad understanding of its principles, so that companies can move beyond isolated recycling or reuse efforts toward organisational redesign, innovation in products and services, and the reconfiguration of their production systems. This perspective is complemented by the work of Zils et al. (2025), who argue that the implementation of the circular economy in operations and supply chain management should be understood as a path to business transformation, in which companies integrate circular practices into planning, production, distribution, recovery, and value creation.

On the other hand, the transition to circular models requires institutional and organisational conditions that foster integration among stakeholders. Therefore, Calzolari et al. (2025) note that institutional pressures, together with supply chain integration, play a significant role in unlocking circularity, as they drive organisations to coordinate capabilities, resources, and information with suppliers, customers, and other stakeholders. From this perspective, regulatory clarity and public policies remain determining factors, as they reduce business uncertainty, guide investment in clean technologies, and stimulate projects based on recovery, recycling, reuse, and waste recovery; therefore, regulation should not be viewed solely as a control mechanism, but rather as an enabling condition for accelerating circular innovation in the manufacturing and service sectors.

With regard to the role of technology, the literature confirms that digital technologies are key factors in shaping circular ecosystems. Rossi and Srai (2025) highlight that tools such as data analytics, digital traceability, collaborative platforms, automation, and intelligent systems enable the connection of stakeholders, the monitoring of material flows, the optimisation of operational decisions, and the enhancement of transparency in supply chains. The above is consistent with Kurniawan et al. (2026), who demonstrate that companies leading the adoption of Industry 4.0 and 5.0 can become benchmarks for

productive transformation by integrating advanced technologies with approaches centered on sustainability, operational efficiency, and organisational adaptation, not only improving process efficiency but also enabling the design of circular models that are more scalable, measurable, and sustainable.

Furthermore, the circular economy requires forms of collaboration that transcend the traditional boundaries of a single industry. Ratsimandresy and Miemczyk (2025) show that cross-industry collaboration can generate significant opportunities to convert waste, byproducts, or alternative materials into new production inputs, thereby expanding the possibilities for circular innovation across seemingly unrelated sectors. This finding reinforces the need to bring together companies, governments, universities, suppliers, consumers, and communities in order to build shared capacities and develop solutions that simultaneously address environmental, economic, and social challenges. It is important to emphasise the training of human talent, which requires technical, strategic, and digital skills for resource management, process redesign, impact assessment, and waste reduction.

Consequently, the circular economy has evolved from an environmental approach to a systemic focus on organisational, technological, and inter-institutional transformation, with the goal that its effective implementation incorporate the principles of circularity, strengthen supply chain integration, leverage digital technologies, the promotion of clear regulatory frameworks, and the fostering of cross-sector collaboration, all with the aim of improving business competitiveness, reducing environmental impacts, optimising resource use, and moving toward more resilient and sustainable production models for present and future generations.

6 Conclusions

The circular economy represents a comprehensive solution to the environmental crisis the world is currently facing, as its focus on resource regeneration and waste minimisation offers a sustainable path that benefits not only today's communities but also those of the future. It is important to recognise that each organisation can make the transition according to its specific circumstances, needs, characteristics, and financial capacity; therefore, understanding the different models allows for the implementation of actions aimed at circularity and sustainability.

The opportunities and challenges are wide-ranging and diverse, and they can generate both uncertainty and hope among entrepreneurs and leaders who wish to implement processes focused on the circular economy. However, through training in new skills and strategic capabilities, it is possible to make more targeted efforts that can foster development and innovation in the economic, social, and environmental spheres.

This research article serves as a resource for other researchers to help them establish a state-of-the-art overview based on trends, models, challenges, and opportunities that can serve as a starting point for consulting projects, the development of diagnostic tools, and other applications, while identifying courses of action for integrating circularity into business environments. Additionally, it contributes to the identification of new lines of research focused on topics such as operations management, production, logistics, and supply chains, taking into account areas such as digitalisation, traceability, Industry 5.0,

business performance, interorganisational integration, and the analysis of the relationship between buyers and suppliers.

Although some of the study's limitations stem from the descriptive nature of the article, since it does not measure the actual impact of the circular economy, it serves as a starting point for identifying global trends and general models found in the literature published between 2020 and 2026. Therefore, future research should develop empirical studies that measure the effect of circular practices on operational, financial, environmental, and social indicators, as well as conduct longitudinal studies to help understand the evolution of relationships between buyers and suppliers during the implementation of circular projects and to identify governance mechanisms that reduce dependency risks. Another relevant line of research involves the design of integrated circularity indicators that incorporate life-cycle assessment, material flow analysis, economic performance, and social metrics. Moreover, it is recommended to study the role of digital technologies, such as artificial intelligence, blockchain, digital product passports, and digital twins, in shaping circular ecosystems.

Declarations

ChatGPT, developed by OpenAI, was used solely to assist in the creation and organization of graphical diagrams. All generated materials were reviewed, edited, and validated by the authors, who assume full responsibility for the accuracy, originality, and final content of the work.

All authors declare that they have no conflicts of interest.

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