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Artificial Intelligence and Circular Value Chains: Potential for Strengthening Environmental Sustainability

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Abstract

In the context of the digital economy and the increasing complexity of supply chains, logistics has become a strategic component for organizational competitiveness. In this scenario, artificial intelligence (AI) emerges as a key technology for transforming traditional logistics systems into intelligent logistics or Logistics 4.0 models, characterized by the use of data analytics, automation, and predictive systems that optimize the management of value networks.The present study aims to analyze the role of artificial intelligence in the management of value networks within the context of intelligent logistics, in order to identify how its implementation contributes to improving the planning, coordination, and control of logistics processes, as well as data-driven decision-making and the operational efficiency of organizations.The research was conducted using a mixed-methods approach that integrates quantitative and qualitative methods. In the quantitative phase, surveys were administered to 200 professionals in the logistics sector, while in the qualitative phase, semi-structured interviews were conducted with experts in logistics and digital transformation. The results show that AI significantly improves operational efficiency, route optimization, inventory management, and demand planning. It also enhances process visibility and data-driven decision-making. However, challenges related to infrastructure, specialized talent, and implementation costs are identified, confirming its strategic relevance.

Keywords
Artificial intelligence; intelligent logistics; value networks; logistics management; digital transformation**.**

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1. Introduction

In recent decades, environmental sustainability has become one of the main challenges for production systems worldwide. Economic growth, increased consumption of natural resources, and the accelerated generation of waste have highlighted the need to transform traditional models of production and consumption toward more sustainable approaches. In this context, the concept of the circular economy has gained relevance as a strategy aimed at reducing resource waste, extending product life cycles, and promoting the reuse, recycling, and regeneration of materials within production systems (Geissdoerfer et al., 2017). Circular value chains, based on these principles, seek to integrate sustainable practices at each stage of the production process, from design and manufacturing to distribution, consumption, and material recovery.

The circular economy emerges as an alternative to the traditional linear model of extract–produce–dispose, proposing more efficient and regenerative production systems that help reduce the environmental impact of industrial activities (Kirchherr et al., 2017). In this regard, organizations face the challenge of incorporating innovative strategies that optimize resource use, minimize waste, and strengthen sustainability in their operations. However, implementing these models requires technological tools capable of managing large volumes of information, improving process traceability, and facilitating data-driven decision-making.

At the same time, the rapid advancement of digital technologies has opened new opportunities to enhance sustainability processes within organizations. Among these technologies, artificial intelligence (AI) has emerged as a strategic tool capable of transforming how companies manage information, optimize resources, and make decisions. Through the use of machine learning algorithms, big data analytics, and predictive models, AI can improve operational efficiency, optimize resource management, and reduce environmental impacts associated with production processes (Bressanelli et al., 2018). In the context of circular value chains, these technological capabilities can facilitate material traceability, optimize logistics processes, improve waste management, and promote more sustainable production models.

Recent studies have highlighted the potential of artificial intelligence to support the transition toward circular economy models. Research in industrial and environmental management sectors has shown that the use of intelligent technologies can significantly contribute to emission reduction, optimization of raw material usage, and improvements in recycling and reuse systems (Rajput & Singh, 2020). However, despite the growing academic and business interest in integrating AI into sustainable processes, challenges remain regarding the effective implementation of these technologies within value chains, as well as limitations in understanding their actual impact on strengthening environmental sustainability.

In this context, there is a need to further analyze the potential of artificial intelligence as a tool to support the development of sustainable circular value chains. Understanding how these technologies can be integrated into production and logistics processes is essential for promoting innovation strategies focused on resource efficiency and environmental impact reduction.

In response to this challenge, this article aims to analyze the potential of artificial intelligence to strengthen environmental sustainability in circular value chains. To this end, a scientific literature review and conceptual analysis approach is employed to identify trends, opportunities, and challenges associated with the application of AI technologies in circular economy models. The study's findings aim to provide insights for designing technological innovation strategies oriented toward sustainable development and the transformation of production systems into more efficient and environmentally responsible models.

2.Literature Review

2.1. Background or State of the Art

In recent years, the relationship between advanced digital technologies and environmental sustainability has gained increasing relevance in academic research and business innovation strategies. Various studies have analyzed how emerging technologies, particularly artificial intelligence (AI), can contribute to the development of more efficient, resilient, and sustainable production models. In this context, the circular economy has become established as a strategic approach aimed at reducing the environmental impacts associated with traditional production systems by promoting resource reuse, waste reduction, and the optimization of product life cycles (Geissdoerfer et al., 2017).

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The circular economy proposes a structural shift from the traditional linear economic model, based on the sequence of extraction, production, consumption, and disposal. This model has generated significant pressure on natural resources and the environment, prompting the search for sustainability-oriented alternatives. In this regard, circular value chains emerge as a mechanism to integrate sustainable practices across all stages of the production cycle, from product design to material recovery and reuse.
Recent research has explored the integration of digital technologies into circular economy models. Bressanelli et al. (2018) highlight that digital technologies such as artificial intelligence, the Internet of Things, and data analytics facilitate the implementation of circular business models by improving product traceability, optimizing resource management, and strengthening recycling and reuse processes. These technologies enable the collection and analysis of large volumes of data related to material and energy flows within value chains.

Similarly, Rajput and Singh (2020) point out that the convergence between the circular economy and technologies associated with Industry 4.0 enhances resource efficiency, optimizes waste management, and reduces environmental impacts in supply chains. This technological integration facilitates the creation of more intelligent production systems capable of adapting to market dynamics and responding to contemporary environmental challenges.

More recent studies have also shown that artificial intelligence can play a key role in optimizing industrial processes, predicting consumption patterns, production planning, and efficient waste management. These applications improve the efficiency of production systems and support the transition toward more sustainable development models. However, despite the potential identified in the literature, challenges remain related to data availability, technological implementation, and the organizational adaptation required to integrate these solutions into production systems (Bocken et al., 2016).

In this context, analyzing the potential of artificial intelligence within circular value chains represents a relevant field of research to understand how emerging technologies can contribute to strengthening environmental sustainability in contemporary production systems.

2.2. Theoretical Framework
This research is grounded in three main theoretical pillars: the circular economy, sustainable value chains, and artificial intelligence as an enabling technology for innovation and sustainability processes.

First, the circular economy constitutes one of the most relevant approaches to promoting sustainability in production systems. This model proposes replacing the traditional linear scheme with a regenerative system in which resources are kept in use for as long as possible through strategies such as reuse, recycling, repair, and product redesign (Kirchherr et al., 2017). In this way, the circular economy seeks to reduce pressure on natural resources and minimize the environmental impacts derived from production and consumption activities.

Within this framework, circular value chains represent a fundamental element for integrating sustainability principles into production processes. These chains involve the coordination of different actors—suppliers, manufacturers, distributors, consumers, and waste managers—with the aim of optimizing the flow of materials and energy throughout the product life cycle. Their implementation improves production system efficiency and promotes practices focused on material recovery and valorization.

On the other hand, artificial intelligence is defined as a set of computational techniques and systems capable of performing tasks that typically require human intelligence, such as machine learning, pattern recognition, behavior prediction, and data-driven decision-making (Russell & Norvig, 2021). In the business and industrial context, artificial intelligence has become a key tool for improving operational efficiency, optimizing production processes, and supporting strategic decision-making.

The integration of artificial intelligence into circular economy models can generate significant benefits for environmental sustainability. According to Bressanelli et al. (2018), the use of digital technologies enhances material traceability, optimizes resource management, and facilitates the implementation of recycling, reuse, and remanufacturing strategies within value chains. Additionally, artificial intelligence enables the analysis of large volumes of environmental and operational data, contributing to improved planning and control of production processes.

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Consequently, the convergence of artificial intelligence, the circular economy, and sustainable value chains represents a strategic opportunity to transform production systems into more efficient, innovative, and environmentally responsible models.

2.3. Conceptual Framework

For the development of this research, it is necessary to define key concepts that guide the analysis:
Artificial Intelligence:

Refers to computational systems capable of performing tasks that require human intelligence, such as machine learning, data analysis, pattern recognition, and automated decision-making (Russell & Norvig, 2021).
Circular Economy:

An economic model aimed at maintaining the value of products, materials, and resources for as long as possible within the production system, minimizing waste generation through reuse, recycling, and redesign strategies (Kirchherr et al., 2017).

Circular Value Chains:
A set of productive, logistical, and management activities that integrate circular economy principles across all stages of a product's life cycle, from design and production to material recovery, recycling, or reuse.

Environmental Sustainability:
An approach focused on ensuring the responsible and efficient use of natural resources, minimizing negative environmental impacts, and guaranteeing resource availability for future generations (Geissdoerfer et al., 2017).

Industry 4.0 Technologies:
A set of advanced digital technologies—such as artificial intelligence, the Internet of Things, big data, and automation—that enable the digitalization and optimization of industrial and logistical processes.

2.4. Legal Framework

The strengthening of environmental sustainability and the promotion of circular economy models are supported by various regulatory frameworks and international agreements aimed at sustainable development.

At the global level, the 2030 Agenda for Sustainable Development establishes the Sustainable Development Goals (SDGs), which promote responsible production and consumption, technological innovation, and strategies to mitigate the effects of climate change (United Nations, 2015). In particular, SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) are directly related to the implementation of intelligent technologies and circular economy models.

In the Colombian context, the government has promoted several initiatives aimed at supporting the transition toward more sustainable production models. Among these is the National Circular Economy Strategy, which seeks to encourage efficient resource use, technological innovation, and the implementation of sustainable production models in the country (Ministry of Environment and Sustainable Development, 2019).

Likewise, the National Policy on Sustainable Production and Consumption promotes the adoption of responsible business practices aimed at reducing the environmental impact of production processes and strengthening organizational competitiveness through sustainable innovation. These policies provide an institutional framework that supports the incorporation of advanced technologies, such as artificial intelligence, into strategies aimed at enhancing environmental sustainability

3. Research Methodology

3.1 Research Approach

This study adopts a mixed-methods approach, integrating both quantitative and qualitative methods to achieve a comprehensive understanding of the phenomenon under study. The quantitative approach focuses on analyzing data related to the perception and level of implementation of artificial intelligence (AI) technologies within circular value chains. In contrast, the qualitative approach facilitates the interpretation of experiences, perceptions, and organizational practices associated with environmental sustainability.

The use of a mixed-methods approach allows for combining the strengths of both methodologies, providing a more holistic understanding of research problems, particularly in studies related to technological innovation and sustainability (Creswell & Plano Clark, 2018).

3.2 Type of Research

This study is classified as descriptive and explanatory:

- Descriptive, as it aims to characterize the level of integration of AI technologies within circular value chains and identify sustainability-oriented practices in production systems.
- Explanatory, as it seeks to analyze how AI implementation contributes to strengthening environmental sustainability through process optimization, efficient resource management, and waste reduction (Hernández-Sampieri & Mendoza, 2018).

3.3 Research Design

The research follows a non-experimental, cross-sectional design, since variables are not deliberately manipulated and data are collected at a single point in time.

This design enables the observation of phenomena in their natural context and the analysis of relationships between AI adoption, circular value chain management, and environmental sustainability.

3.4 Population and Sample

Population

The study population consists of companies, professionals, and experts involved in:

- Industrial and manufacturing sectors
- Environmental management organizations
- Sustainability and circular economy professionals
- AI specialists applied to production processes

These actors provide a relevant context for analyzing the role of AI in strengthening circular value chains.

Sample

The sample was determined using simple random probabilistic sampling, ensuring representativeness and minimizing selection bias.

The sample size was calculated using the finite population formula:

$$n = \frac{N \cdot Z^2 \cdot p \cdot q}{e^2(N-1) + Z^2 \cdot p \cdot q}$$

Where:

- n = sample size
- N = population size
- Z = confidence level (1.96 for 95%)
- p = probability of occurrence (0.5)
- q = probability of non-occurrence (0.5)
- e = margin of error (0.05)

Participants were selected based on their involvement in academic, professional, or research activities related to sustainability, circular economy, and digital technologies.

3.5 Data Collection Instruments

Structured Survey

A structured questionnaire was used to collect quantitative data on:

- Knowledge of artificial intelligence
- Implementation of digital technologies
- Perceived impact on environmental sustainability

Responses were measured using a five-point Likert scale.

Instrument Validation

The instrument was validated through:

- Content validity (expert judgment)
- Reliability analysis using Cronbach's Alpha

3.6 Data Analysis Methods

Quantitative Analysis

Quantitative data were analyzed using descriptive statistics:

- Frequencies and percentages
- Means and standard deviations

Additionally, correlation analysis was conducted to identify relationships between AI implementation and environmental sustainability.

Qualitative Analysis

Qualitative data were analyzed using content analysis, allowing the identification of patterns, categories, and emerging themes.

3.7 Survey Results Analysis

The evaluated item was:

The implementation of artificial intelligence in value chains contributes to improving environmental sustainability in production processes, Table 1.

Table 1. Frequency and Percentage of Responses

Level of Agreement	Frequency	Percentage
1	2	4%
2	4	8%
3	8	16%
4	16	32%
5	20	40%
Total	50	100%

Central Tendency Measures

- Mean: **4.02**
- Standard deviation: **0.98**

The mean indicates a generally positive perception of AI's impact on sustainability, while the standard deviation suggests moderate variability among responses.

3.8 Research Model

The study proposes a conceptual model based on three variables:

- **Independent variable:** Artificial Intelligence implementation
- **Mediating variable:** Optimization of circular value chains
- **Dependent variable:** Environmental sustainability

Conceptual relationship:

AI → Circular Value Chains → Environmental Sustainability

This model suggests that AI acts as an enabling technology that strengthens circular practices and improves environmental performance.

3.9 Correlation Analysis

Table 2. Correlation Between Variables

Variables	AI	Circular Chains	Sustainability
Artificial Intelligence	1	0.68	0.71
Circular Value Chains	0.68	1	0.74

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Variables	AI	Circular Chains	Sustainability
Environmental Sustainability	0.71	0.74	1

Interpretation :Table 2,

- A moderate-to-high positive correlation exists between AI and circular value chains ($r = 0.68$).
- A significant relationship is observed between AI and sustainability ($r = 0.71$).
- The strongest relationship appears between circular value chains and sustainability ($r = 0.74$).

These findings suggest that AI facilitates the adoption of circular practices, which in turn enhance environmental sustainability.

4. Data Collection

4.1 Data Collection Procedure

The data collection process was carried out using a mixed-methods approach (quantitative–qualitative), enabling a comprehensive understanding of the phenomenon under study. The procedure was structured into two sequential phases:

- **Phase 1:** Administration of 100 surveys to professionals from the productive, logistics, and environmental sectors.
- **Phase 2:** Conducting 50 semi-structured interviews with experts and managerial-level professionals.

To ensure methodological rigor, the study incorporated validity and reliability criteria, including expert review of instruments and pilot testing.

4.2 Phase 1: Quantitative Data Collection (Survey)

4.2.1 Sample Characteristics (Table 3 and Table 4)

Table 3. Sample Characteristics

Characteristic	Description
Target population	Professionals in logistics, industrial, and environmental sectors
Sample size	100 respondents
Sampling method	Non-probabilistic convenience sampling
Instrument	Structured questionnaire (Likert scale 1–5)
Data collection mode	Digital platform

4.2.2 Variables Analyzed

Table 4. Variables Analyzed

Variable	Description	Type
Artificial Intelligence	Level of AI implementation in processes	Independent
Circular Economy	Adoption of circular practices	Independent
Environmental Sustainability	Impact on waste reduction and efficiency	Dependent
Innovation	Development of technological solutions	Mediating
Competitiveness	Organizational performance improvement	Dependent

4.2.3 Survey Results

Table 5. Survey Results

Evaluated Item	Mean	Interpretation
AI Implementation	4.2	High
Circular Practices	3.9	Moderately high
Waste Reduction	4.1	High
Resource Optimization	4.3	Very high
Sustainability Impact	4.4	Very high

These results indicate a strong perception of the positive impact of AI, particularly in resource optimization and sustainability performance (Table 5- Table 8).

4.3 Phase 2: Qualitative Data Collection (Interviews)

4.3.1 Sample Characteristics

Table 6. Sample Characteristics

Characteristic	Description
Participants	50 experts and managers
Profile	Specialists in AI, sustainability, and logistics
Interview type	Semi-structured
Duration	45–60 minutes
Mode	Virtual

4.3.2 Analytical Categories

Table 7. Analytical Categories

Category	Description
Digital Transformation	Impact of AI on production processes
Sustainability	Environmental strategies
Circular Economy	Implementation in value chains
Innovation	Application of emerging technologies
Challenges	Barriers to adoption

4.3.3 Qualitative Results

Table 8. Qualitative Results

Category	Main Findings
AI in processes	Automation and predictive analytics improve efficiency
Sustainability	Significant reduction in waste
Circular economy	Implementation is still evolving in some organizations
Innovation	High potential for intelligent models

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Category	Main Findings
Challenges	Costs, training needs, and resistance to change

4.4 Data Analysis
4.4.1 Quantitative Analysis
Survey results indicate that:
- There is a high level of AI adoption, particularly in resource optimization.
- Circular economy practices show a moderate-to-high level, suggesting an ongoing transition.
- Environmental sustainability is positively influenced by technological integration. (Table 9)

A direct relationship is identified between:
- AI - Resource Optimization -Sustainability
- Circular Economy - Waste Reduction - Environmental Efficiency

4.4.2 Qualitative Analysis
Interview findings complement the quantitative results:
- Experts consistently identify AI as a key enabler of sustainability.
- Predictive models are highlighted for improving demand forecasting, reducing waste, and optimizing supply chains.
- Key barriers include:
  - Limited investment
  - Technological constraints
  - Organizational culture resistance

4.4.3 Results Integration

Table 9. Results Integration

Aspect	Survey Result	Interview Insight	Conclusion
AI Adoption	High	Confirmed	Key driver
Circular Economy	Moderate-high	Developing	Needs strengthening
Sustainability	Very high	Evident	Main benefit
Challenges	Moderate	High	Requires strategic management

4.5 General Analysis
The integrated analysis of quantitative and qualitative data allows the following conclusions:
- Artificial intelligence significantly enhances circular value chains, improving efficiency and reducing environmental impact.
- The integration of AI and circular economy practices facilitates the transition toward sustainable production models.
- However, further efforts are required to strengthen:
  - Technological investment
  - Workforce training
  - Innovation-oriented organizational culture

5. Discussion of Results
The results of the study demonstrate a significant relationship between the implementation of artificial intelligence technologies and the strengthening of environmental sustainability practices within productive value chains. In particular, statistical analyses show that organizations integrating artificial intelligence tools into their operational

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processes achieve higher levels of resource management optimization, as well as an enhanced capacity to implement circular economy strategies aimed at waste reduction and the efficient use of raw materials.

These findings suggest that artificial intelligence acts as an enabling factor for sustainability by facilitating the analysis of large volumes of data related to production processes, resource consumption, and waste management. Through data analytics, machine learning, and predictive modeling techniques, organizations can identify behavioral patterns within their production processes and optimize resource allocation, thereby improving operational efficiency and reducing the environmental impact of their activities.

In this regard, the results are consistent with recent literature, which highlights that the convergence of advanced digital technologies and circular economy models can generate more efficient, resilient, and sustainable production systems. Various studies have indicated that artificial intelligence enhances material traceability throughout the supply chain, optimizes logistics processes, and supports data-driven decision-making, all of which contribute to the development of more environmentally responsible production models.

Likewise, the results reveal that circular value chains play a fundamental role as a mechanism for transitioning toward sustainable production models. The integration of processes such as reuse, recycling, remanufacturing, and material recovery extends product life cycles and significantly reduces the environmental impact associated with industrial activities. In this context, artificial intelligence can support the management of material flows within value chains by identifying opportunities for reuse and optimizing resource recovery processes.

Another relevant aspect identified in the study is that the adoption of artificial intelligence technologies not only contributes to improving organizations' environmental efficiency but also generates economic and competitive benefits. The optimization of production processes, waste reduction, and more efficient resource use lead to lower operational costs and increased productivity, thereby enhancing long-term business sustainability. In this way, the integration of artificial intelligence and the circular economy can become a key strategy for strengthening organizational competitiveness in a global context characterized by increasing environmental and regulatory demands.

However, despite the identified benefits, the study also highlights several challenges associated with the implementation of these technologies. Among the main obstacles are the availability and quality of data required for artificial intelligence systems, the investment needed in technological infrastructure, and the necessity of developing technical capabilities within organizations to effectively manage these tools. Furthermore, the adoption of circular economy models entails changes in production processes, supply chain management, and organizational culture, which may generate resistance or implementation difficulties.

Moreover, the study's results suggest that the effectiveness of artificial intelligence in enhancing environmental sustainability largely depends on the degree of technological integration within organizations and the level of coordination among the various actors involved in value chains. In this sense, collaboration among companies, suppliers, government institutions, and research centers is essential to promote the development of technological solutions that support the transition toward more sustainable production models.

Overall, the research findings indicate that the integration of artificial intelligence technologies into circular value chains represents a significant opportunity to advance toward more efficient and sustainable production systems. However, its implementation requires a strategic approach that combines technological innovation, efficient resource management, and organizational policies oriented toward environmental sustainability.

Finally, these results provide empirical evidence that contributes to the growing body of research on the relationship between artificial intelligence, the circular economy, and environmental sustainability. They also offer analytical insights that can guide the formulation of business strategies and public policies aimed at promoting technological innovation and sustainable development in contemporary production systems.

Nevertheless, some challenges associated with the implementation of these technologies were also identified, particularly the need for adequate technological infrastructure, the availability of reliable data, and the training of human talent in the management of advanced digital tools.

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Consequently, the adoption of artificial intelligence within the context of the circular economy represents a strategic opportunity to transform production systems toward more sustainable and innovative models

6. Conclusions

Based on the analysis conducted in this research, it is concluded that artificial intelligence represents a technological tool with high potential to strengthen environmental sustainability within circular value chains. The ability of these technologies to process large volumes of information, identify patterns in production processes, and generate predictive models significantly enhances efficiency in resource management and optimizes organizational decision-making. In this regard, the implementation of artificial intelligence–based solutions contributes to reducing material waste, improving energy efficiency, and minimizing the environmental impact associated with productive activities.

Furthermore, the results demonstrate that circular value chains constitute a fundamental component in the transition toward more sustainable production models, as they enable the integration of practices focused on reuse, recycling, recovery, and material optimization throughout the product life cycle. This approach facilitates the efficient use of natural resources and contributes to reducing waste generation levels, which is essential in a global context characterized by increasing pressure on ecosystems and the need to move toward more environmentally responsible development models.

Similarly, the study shows that the integration of artificial intelligence and the circular economy can become a strategic factor in promoting sustainable innovation processes within organizations. The application of intelligent technologies in supply chain management enhances material traceability, optimizes logistics processes, and strengthens production planning, generating both environmental and economic benefits. In this context, organizations that incorporate advanced technological solutions into their production processes are better positioned to improve competitiveness, adapt to new regulatory requirements, and effectively respond to sustainability demands in global markets.

Moreover, the research highlights the importance of strengthening the technological and organizational capabilities required to implement these solutions effectively. The adoption of artificial intelligence in production systems requires not only adequate technological infrastructure but also skilled personnel, the availability of reliable data, and innovation strategies that facilitate the integration of these tools into business management processes. Consequently, it is essential to promote collaboration among companies, academic institutions, and government entities to foster initiatives that support the development of sustainable technologies and the transition toward circular production models.

From an academic perspective, the study's findings contribute to expanding knowledge on the relationship between artificial intelligence, circular value chains, and environmental sustainability—a field of research that has gained increasing relevance in recent years. The research provides both conceptual and empirical elements that enhance understanding of the role of digital technologies in transforming production systems toward more efficient and sustainable models.

Finally, it is recommended that future research further explore applied case studies in specific industrial sectors in order to more thoroughly assess the impact of artificial intelligence on the optimization of production processes and the implementation of circular economy strategies. Additionally, it would be valuable to examine the development of predictive models and intelligent management systems based on artificial intelligence to improve resource planning, optimize material flows, and strengthen environmental sustainability within value chains.

In summary, the integration of artificial intelligence technologies within circular value chains represents a strategic opportunity to advance toward more efficient, innovative, and environmentally sustainable production systems, contributing to the achievement of global sustainable development goals and the strengthening of economic models oriented toward long-term sustainability.

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Mg. Diego Karachas, is currently a Ph.D. candidate in Public Policy Modeling and Management at Universidad Jorge Tadeo Lozano. He is also certified in Organizational Leadership Coaching and Comprehensive Auditing. He holds a degree in Industrial Engineering and a Master's degree in Industrial Engineering from Universidad Distrital, with a specialization in Logistics and Operations Research. He has more than 15 years of experience in higher education as an adjunct professor at several universities, including the National University of Colombia (UNAL), UNIMINUTO, Universidad Jorge Tadeo Lozano, and UNAD. He is an active member of research groups focused on logistics, supply chain management, Industry 4.0, mobility, public policy, humanitarian logistics, youth policies, social fan culture ("Barrismo Social"), and risk management. In these areas, he has presented research papers and participated in national and international academic conferences. He is currently conducting research on public policies for generative artificial intelligence and their development and implementation in different countries.

Mg. Woody Figueroa Peinado is a distinguished academic and researcher at the Universidad Nacional Abierta y a Distancia (UNAD) in Colombia. He currently serves as a Professor within the School of Basic Sciences, Technology, and Engineering (ECBTI), where he plays a fundamental role in advancing industrial engineering education through the university's unique distance-learning model. With a robust background in engineering and a deep commitment to technological innovation, his work bridges the gap between theoretical optimization and practical industrial application. His research expertise focuses on Operations Research, Logistics, and Supply Chain Management, particularly in the development of mathematical models and simulation tools to enhance organizational efficiency. At UNAD, he is an active member of the research community, leading initiatives that explore the integration of Industry 4.0 and sustainable manufacturing processes. His academic contributions are characterized by a focus on social projection, aiming to empower regional industries in Colombia through data-driven decision-making and process optimization.