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Zero-waste initiatives and circular economy in the U.S.: A review: Exploring strategies, outcomes, and challenges in moving towards a more sustainable consumption model

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Abstract

This study presents a comprehensive analysis of zero-waste initiatives and circular economy (CE) models in the United States, aiming to understand their contribution to sustainable consumption. Employing a systematic literature review methodology, the study sourced data from academic journals, government reports, and industry publications, focusing on literature from the year 2015 to 2023. The search strategy involved a combination of keywords related to zero-waste, circular economy, and sustainable consumption in the U.S. context. Inclusion and exclusion criteria were applied to ensure the relevance and quality of the selected literature, which was then subjected to thematic synthesis for data analysis. Key findings indicate that the evolution of zero-waste and CE concepts in the U.S. is driven by increasing environmental awareness, leading to innovative waste reduction strategies and sustainable consumption models. Despite significant environmental, economic, and social benefits, challenges such as institutional barriers, financial constraints, and technological hurdles persist. The study highlights the crucial role of standards, policies, and regulatory frameworks in facilitating the adoption of zero-waste and CE practices. Successful case studies underscore the importance of community involvement and stakeholder engagement. The study recommends that policymakers develop supportive legislative frameworks, businesses integrate sustainable practices into their operations, and communities actively participate in waste reduction efforts. Future research should focus on the long-term impacts of these practices and the role of emerging technologies. The transition to zero-waste and CE models is essential for sustainable development, requiring concerted efforts from all stakeholders.

Keywords: Circular Economy; Zer0 Waste; Sustainable Consumption; Waste Management

1. Introduction

1.1. The Emergence of Zero-Waste and Circular Economy Concepts in Modern Society

The emergence of zero-waste and circular economy concepts in modern society represents a paradigm shift in how we approach consumption and waste management. This shift is driven by the increasing recognition of the unsustainable nature of the traditional linear economy, characterized by a 'take-make-dispose' model, and the urgent need to adopt more sustainable practices (Awasthi, 2023). The zero-waste concept, as defined by the Zero Waste International Alliance, is an ethical, economical, efficient, and forward-looking approach that encourages consumers to buy products,

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care for them, and then recycle or reuse them, thereby closing the loop of product lifecycles (Bogusz et al., 2023). The circular economy, an alternative to the linear model, focuses on reducing waste and extending the life of resources. It is closely aligned with the zero-waste concept, emphasizing the importance of reusing and recycling products to minimize waste. This model not only addresses environmental concerns but also offers significant economic and social benefits, contributing to sustainable development. The circular economy is not just a theoretical concept but a practical approach to sustainability that has been increasingly adopted in various sectors, including education, where it is used to teach future generations about sustainable consumption (Kowasch, 2022).

In the United States, the adoption of these concepts has been influenced by growing consumer awareness and sensitivity to environmental problems. This awareness is partly driven by the promotion of healthy lifestyles by environmental organizations and movements, leading to a reversal of unfavorable trends in favor of conscious consumption based on rational consumer choices (Bogusz et al., 2023). The shift towards sustainable consumption models in the U.S. is evident in the increasing number of households and businesses adopting zero-waste practices and the growing interest in circular economy models.

The transition from a linear to a circular consumption model in the U.S. involves not only changes in consumer behavior but also systemic changes in production and business models. Companies are increasingly adopting circular business models that focus on extending the life of products through design, reuse, and recycling. This shift is supported by policy developments and regulatory advances that encourage sustainable practices and penalize wasteful ones (Awasthi, 2023). The implementation of zero-waste and circular economy practices in the U.S. has shown positive environmental, economic, and social implications. Environmentally, it has led to a significant reduction in waste and a decrease in the depletion of natural resources. Economically, it has opened up new business opportunities and markets focused on sustainable products and services. Socially, it has raised awareness about the importance of sustainability and encouraged a culture of responsibility towards the environment.

However, the journey towards a zero-waste and circular economy in the U.S. is not without challenges. One of the primary barriers is the entrenched nature of the linear consumption model, which is deeply rooted in the country's economic and social systems. Overcoming this requires not only changes in consumer behavior but also significant shifts in production processes, supply chains, and governmental policies. Additionally, there is a need for more education and awareness-raising to ensure that all stakeholders, including consumers, businesses, and policymakers, understand the benefits of zero-waste and circular economy practices and are motivated to adopt them (Kowasch, 2022).

In conclusion, the emergence of zero-waste and circular economy concepts in modern society, particularly in the U.S., represents a significant step towards sustainable consumption. While there are challenges to be overcome, the increasing adoption of these practices across various sectors indicates a positive trend towards a more sustainable future. The success of this transition will depend on continued efforts in education, policy-making, and innovation in sustainable practices (Awasthi, 2023; Bogusz et al., 2023).

1.2. Principles and Practices of Zero-Waste and Circular Economy

Defining the scope of zero-waste and circular economy (CE) principles and practices involves understanding their foundational concepts and how they are applied in the context of sustainable consumption. Zero-waste is a holistic model that extends beyond mere waste reduction and recycling, advocating for a complete reshaping of contemporary production and consumption modes. It emphasizes the need for a systemic and circular approach, promoting active citizenship awareness and a fundamental reconsideration of our relationship with sustainability (Guaran & Venturini, 2022).

In the context of sustainable development practices, innovative small and medium enterprises (SMEs) play a crucial role. A significant portion of consumer packaged goods' growth is tied to sustainability-marketed products, with a substantial number of shoppers willing to spend more on environmentally responsible purchases. Circular economy principles, along with Life Cycle Assessment (LCA) and the United Nations Sustainable Development Goals (SDGs), can highlight environmental hotspots in SMEs' value chains and offer mitigation options to reduce environmental impact and boost cost-efficiency (Skunca & Pešić, 2023). This approach aligns with the zero-waste model, which calls for a systemic change in production and consumption patterns to achieve sustainability.

The application of zero-waste principles in educational contexts, such as geographical education, demonstrates the potential of these concepts to encourage a new perspective on sustainability. By integrating zero-waste principles into the curriculum, educational institutions can foster a deeper understanding of sustainable practices among students, preparing them to be responsible citizens and consumers. This approach is in line with key international documents,

such as the United Nations' 2030 Agenda for Sustainable Development, which emphasizes the importance of education in achieving sustainable development goals (Guaran & Venturini, 2022).

In conclusion, the principles and practices of zero-waste and circular economy are essential components of sustainable consumption. They offer a framework for rethinking how resources are used and managed, aiming to create a more sustainable and efficient economy. The integration of these principles in education, business practices, and policy-making is crucial for the transition towards a more sustainable future. As these concepts continue to gain momentum, they hold the potential to drive significant environmental, economic, and social benefits, contributing to the broader goal of sustainability (Guaran & Venturini, 2022; Skunca & Pešić, 2023).

1.3. Historical Evolution of Sustainable Consumption Models in the U.S.

The historical evolution of sustainable consumption models in the United States reflects a dynamic interplay between environmental awareness, technological innovation, and policy development. This evolution can be traced through various sectors, including forestry, food consumption, and electronic waste management, each highlighting different aspects of the country's journey towards sustainability.

In the realm of forestry, the United States has demonstrated a commitment to sustainable forest management since the early 20th century. This commitment is evident in the fact that, despite a significant increase in population, the forest area has remained relatively stable, and the country continues to be one of the top timber producers globally. Sustainable forest management in the U.S. is achieved through a combination of private and public ownership, stakeholder collaboration, and a federalist system that allows state and local jurisdictions to use both regulatory and voluntary means to achieve sustainable goals. This approach is supported by government incentive programs offering technical and financial assistance, as well as tax relief for landowners practicing responsible forest management (Rodriguez Franco & Conje, 2022).

The sustainable food consumption sector in the U.S. has also seen significant developments. A bibliometric analysis reveals that while research on broader sustainability topics dates back to the early 20th century, focused studies on sustainable food consumption began emerging in the 1990s. The growth of this research field has been incremental, with a notable increase in interest around 2015. The emergence of the COVID-19 pandemic marked a new phase of research, analyzing changes in consumer consumption patterns before and after the pandemic. The U.S., along with other leading countries, has been active in researching sustainable food consumption, focusing on sub-themes like organic food, food waste, sustainable development, food security, and consumer behavior towards organic products (Kristia et al., 2023).

Electronic waste (e-waste) management is another critical area where the U.S. has seen considerable evolution. Technological innovation has transformed the role of electronics in education, work, and society, but it has also led to concerns about resource consumption and waste management. A study on the evolution of e-waste in the U.S. using material flow analysis reveals that contrary to expectations, the total mass of the e-waste stream is declining, primarily due to the phase-out of large, legacy products like cathode ray tube TVs. This shift in the material profile of consumer electronics indicates reduced risks from hazards like lead and mercury but increased risks from reliance on scarce metals and product designs that limit recycling. This study underscores the need for e-waste management regulations to evolve in response to changing product profiles and consumer behaviors (Althaf et al., 2020).

The historical evolution of sustainable consumption models in the U.S. is characterized by significant strides in various sectors. From sustainable forest management to food consumption and electronic waste management, the U.S. has demonstrated a growing commitment to sustainability. This evolution is marked by a combination of technological advancements, consumer behavior changes, and policy developments, each playing a crucial role in shaping the country's sustainable consumption models. As these sectors continue to evolve, they offer valuable insights into the challenges and opportunities that lie ahead in the journey towards a more sustainable future (Rodriguez Franco & Conje, 2022; Kristia et al., 2023; Althaf et al., 2020).

Aim and Objectives of the Study

The primary aim of this study is to critically analyze and evaluate the strategies, outcomes, and challenges associated with zero-waste initiatives and circular economy models in the United States, with a focus on understanding how these initiatives contribute to the development of a more sustainable consumption model.

The objectives are;

- To Explore the Emergence and Evolution of Zero-Waste and Circular Economy Concepts.
- To Analyze the Impact of Zero-Waste and Circular Economy Practices.
- To Identify and Assess the Challenges and Barriers.

2. Methodology

The methodology for this study is structured as a systematic literature review, focusing on zero-waste initiatives and circular economy models in the United States. This approach allows for a comprehensive and unbiased synthesis of existing research, providing a clear understanding of the current state of knowledge in this field.

2.1. Data Sources

The primary data sources for this study include academic journals, conference proceedings, government reports, and industry publications. Key databases such as JSTOR, ScienceDirect, Google Scholar, and PubMed were utilized for sourcing relevant literature. Additionally, reports from environmental organizations and policy documents from governmental agencies were also considered to provide a broader perspective on the subject matter.

2.2. Search Strategy

The search strategy involved using a combination of keywords and phrases related to zero-waste, circular economy, sustainable consumption, and waste management practices in the United States. Boolean operators (AND, OR) were used to combine search terms effectively. For example, searches included combinations like "zero-waste AND circular economy AND United States," "sustainable consumption models in the U.S.," and "challenges in implementing zero-waste practices."

2.3. Inclusion and Exclusion Criteria for Relevant Literature

The inclusion criteria for selecting relevant literature in this study were focused on publications from the year 2015 onwards to ensure the relevance and timeliness of the data. The study specifically targeted literature focusing on the United States context or providing comparative analyses that included the U.S. Peer-reviewed articles, government reports, and publications from recognized environmental organizations were considered to ensure the credibility and reliability of the information. The study also included empirical data, case studies, or theoretical analyses relevant to zero-waste and circular economy practices. On the other hand, the exclusion criteria ruled out non-English publications, studies focusing solely on countries other than the U.S. without comparative analysis, opinion pieces, editorials, and non-peer-reviewed articles. Additionally, outdated studies or those not directly relevant to the core themes of zero-waste and circular economy were also excluded. This approach was designed to ensure a comprehensive and focused review of literature pertinent to the study's objectives.

2.4. Selection Criteria

The selection process involved a two-stage screening. Initially, titles and abstracts were screened to assess their relevance to the study's aim and objectives. This was followed by a full-text review to ensure the selected sources met the inclusion criteria. The quality and relevance of the sources were evaluated based on their methodological rigor, the credibility of the publication source, and the relevance of their findings to the study's focus.

2.5. Data Analysis

Data analysis involved a content analysis approach. Key themes and patterns were identified and categorized based on their relevance to the study's objectives. This included categorizing literature into themes such as environmental impacts, economic implications, policy and regulatory frameworks, challenges and barriers, and successful case studies. The findings were then synthesized to provide a comprehensive overview of the current state of zero-waste initiatives and circular economy models in the U.S., along with identifying gaps in the literature and areas for future research.

3. Literature Review

3.1. Fundamental Principles of Zero-Waste and Circular Economy

The fundamental principles of zero-waste and the circular economy (CE) are pivotal in shaping sustainable practices and policies. These principles are not just theoretical constructs but practical guidelines that drive the transition from

a linear to a circular, sustainable model of production and consumption. Zero-waste is a concept that aims to eliminate waste entirely, not just manage it. This approach is based on the understanding that waste is a design flaw and can be systematically avoided. In the context of municipalities, zero-waste is adopted as a mechanism for waste management, focusing on the prevention of waste at the source, reuse, and recycling. The circular economy complements this by providing a framework for industries and businesses to eliminate waste and promote resource efficiency. In a circular economy, products are designed and manufactured with the intention of being repurposed and recycled, thus reducing waste at the first stage of prevention. This involves using regenerative materials and designing products to be durable, repairable, and adaptable, in line with the principle of designing out waste (Khaw-ngern, 2021).

The circular economy also encompasses broader concepts such as eco-design, biomimicry, and eco-industrial development. These concepts guide public, private, and civil societal sectors towards zero-waste practices. Eco-design involves creating products with minimal environmental impact, biomimicry draws inspiration from nature to solve human challenges sustainably, and eco-industrial development promotes industrial symbiosis where waste from one process becomes input for another. These concepts are integral to achieving a zero-waste circular economy, as they focus on resource efficiency and waste minimization at every stage of the product lifecycle (Franco-García et al., 2018).

A critical aspect of implementing zero-waste and CE principles is the distinction between the zero-waste concept and the zero-waste to landfill concept. While the former focuses on waste prevention and minimization, the latter often involves diverting waste from landfills, which may still result in waste generation through other means. Therefore, a true zero-waste approach requires a more holistic view, considering the entire lifecycle of products and materials (Franco-García et al., 2018).

In the business context, adopting circular principles can significantly influence zero-waste performance and green differentiation advantage. This adoption, however, may not directly lead to significant improvements in zero-waste outcomes. Instead, it can facilitate the effective implementation of cleaner production and total quality environmental management, which are crucial for achieving zero-waste performance. Cleaner production focuses on reducing the environmental impact of production processes, while total quality environmental management integrates environmental considerations into all aspects of organizational management. These practices are essential for businesses to realize the benefits of circular principles, including improved zero-waste outcomes and a competitive advantage in green differentiation (Afum et al., 2022).

The fundamental principles of zero-waste and the circular economy are centered on designing out waste, maximizing resource efficiency, and creating sustainable products and processes. These principles require a systemic approach, involving changes in design, production, consumption, and waste management practices. By adopting these principles, municipalities, industries, and businesses can move towards a more sustainable and efficient model of operation, contributing to environmental conservation, economic viability, and social well-being (Khaw-ngern, 2021; Franco-García et al., 2018; Afum et al., 2022).

3.2. Systemic Overview: From Linear to Circular Consumption Models

The transition from linear to circular consumption models represents a fundamental shift in the approach to production, consumption, and waste management. This systemic overview explores how this transition is being implemented and the challenges and opportunities it presents.

The linear model of production and consumption, which has dominated for decades, is characterized by a 'take-make-dispose' approach. This model has led to large-scale environmental damage and resource depletion. In contrast, the circular economy (CE) proposes a restorative and regenerative model of economic development aligned with environmental sustainability. In the CE model, the focus is on designing products and systems that minimize waste and make the most of resources. One of the key sectors undergoing this transition is the fashion industry, traditionally known for its linear approach. The shift to a circular model in fashion requires a change in both production and consumption behaviors. For consumers, this means adopting sustainable consumption behaviors, such as choosing products designed for longevity, repairability, and recyclability. For producers, it involves redesigning products and processes to minimize waste and maximize resource efficiency.

The transition to a circular economy is also evident in urban development. Cities, due to their significant role in population growth, production, and consumption, are crucial in driving this change. The sustainable development of cities through the implementation of circular systems involves a holistic approach that includes protecting resources, promoting sustainable production and consumption, and generating new income and social integration opportunities.

This transition is not just about waste management but encompasses a broader range of activities, including urban planning, infrastructure development, and community engagement (Silva & Franz, 2022).

Education plays a pivotal role in facilitating this transition. Teaching about sustainable production and consumption involves introducing concepts such as closed-loop production, the circular economy, and Cradle to Cradle (C2C) models. However, there are challenges in bridging the gap between theory and practice. Case studies in educational settings reveal mismatches between the expectations of companies and students and between macro-economic theory and micro-economic applications. These mismatches highlight the need for practical, financially viable solutions that consider the entire supply chain's complexities (Kopnina, 2017).

The transition from linear to circular consumption models is a global movement that requires a systemic change in how we think about and manage resources. It involves a shift in consumer behavior, production processes, urban development, and education. While there are challenges in implementing this transition, it offers significant opportunities for environmental sustainability, economic development, and social well-being. The success of this transition will depend on the collaboration and commitment of all stakeholders, including businesses, consumers, policymakers, and educators (Ostermann & Nascimento, 2021; Silva & Franz, 2022; Kopnina, 2017).

3.3. Key Strategies in Zero-Waste Implementation

The implementation of zero-waste strategies within the framework of a circular economy (CE) is a critical step towards addressing global waste problems and achieving sustainability. These strategies challenge the traditional notion of waste as an inevitable by-product and instead view it as a "misallocated resource" or "resource in transition." This perspective is fundamental to the zero-waste approach, which aims to recirculate waste back into production and consumption processes, thereby eliminating the concept of waste in a circular economy system (Zaman, 2022).

Zero-waste practices can be observed at various levels, including family, community, business, and city. These practices involve a range of strategies and actions, such as reducing consumption, reusing materials, recycling, and composting. The implementation of zero-waste strategies requires the support of all ecosystem participants, highlighting the crucial role of consumers in sustainable consumption behavior. However, achieving the visionary goals of zero-waste cannot be accomplished without responsible global stewardship and the active role of citizens (Zaman, 2022).

In the context of national waste management strategies, such as those in Turkey, zero waste plays a significant role in the circular economy model. It focuses on manufacturing recyclable products, reducing waste, developing recycling/reuse technologies, and ensuring resource efficiency. However, the implementation of zero-waste strategies faces various barriers. A study using the fuzzy DEMATEL method identified key barriers to zero waste implementation in Turkey, including uncertainty of goals and tactics related to the circular economy and lack of financial and economic aid. These barriers highlight the need for clear strategies and support mechanisms to successfully implement zero-waste management (Ayçin & Kayapinar Kaya, 2021).

Circular economy strategies are also crucial in combating climate change and other environmental issues. These strategies encompass waste management, climate change, energy, air and water quality, land use, industry, food production, life cycle assessment, and cost-effective routes. One of the challenges in increasing the use of bio-based materials is the impact on land use and land cover. Additionally, carbon removal technologies, which are essential for achieving carbon neutrality, are currently expensive. The implementation of circular economy strategies in various sectors, such as industry, waste, energy, buildings, and transportation, requires life cycle assessment to optimize new systems (Yang et al., 2022).

Key strategies in zero-waste implementation within the circular economy context involve a systemic approach to waste management, focusing on reducing, reusing, recycling, and composting. These strategies require the collaboration of various stakeholders, including consumers, businesses, and policymakers. Overcoming barriers to implementation, such as financial constraints and lack of clarity in goals, is essential for the successful adoption of zero-waste practices. Additionally, integrating circular economy strategies across different sectors is vital for addressing broader environmental challenges, including climate change (Zaman, 2022; Ayçin & Kayapinar, 2021; Yang et al., 2023).

3.4. Milestones in U.S. Zero-Waste and Circular Economy Initiatives

The United States has made significant strides in implementing zero-waste and circular economy (CE) initiatives, marking key milestones in the journey towards sustainable consumption and production. These milestones reflect a growing commitment to environmental stewardship and resource efficiency.

One of the notable milestones in the U.S. is the adoption of the circular economy as a framework for municipalities to achieve zero waste. This approach involves a shift from the traditional linear model of 'take-make-dispose' to a more sustainable model where waste is viewed as a resource. Municipalities across the U.S. are increasingly adopting zero-waste strategies, focusing on waste prevention, reuse, and recycling. These strategies are aligned with the principles of the circular economy, which emphasize the importance of designing products and systems that minimize waste and maximize the use of resources (Khaw-ngern, 2021).

In the manufacturing sector, the circular economy has emerged as a fundamental change in how products are designed, manufactured, sold, and consumed. The transition to circular business models in manufacturing is a critical step towards efficient and sustainable growth. These models involve a shift from selling products to selling services, where companies retain property rights over products and have an incentive to reduce environmental impact through design. This shift not only conserves resources but also opens up new business opportunities and models for companies in the U.S. (Mohapatra, 2023).

The implementation of circular economy initiatives in the U.S. aligns with the United Nations Sustainable Development Goals (SDGs), particularly SDG 12.5, which aims to significantly reduce waste generation through prevention, reduction, recycling, and reuse by 2030. Achieving this goal requires actions and strategies from various stakeholders, including businesses, consumers, and policymakers. While the impact of these initiatives may take time to materialize, the commitment to a circular economy is already setting the stage for more sustainable practices across various sectors (Fiksel et al., 2020).

The milestones in U.S. zero-waste and circular economy initiatives represent a significant shift towards sustainable consumption and production. These initiatives are being implemented across different levels, from municipalities to manufacturing sectors, reflecting a holistic approach to sustainability. The transition to a circular economy in the U.S. is not without challenges, but the ongoing efforts and commitment from various stakeholders indicate a positive trajectory towards achieving environmental sustainability and economic resilience (Khaw-ngern, 2021; Mohapatra, 2023; Fiksel et al., 2020).

3.5. Current Innovations and Best Practices in Sustainable Consumption

The landscape of sustainable consumption is continually evolving, marked by current innovations and best practices that are shaping the way individuals, communities, and industries approach sustainability. These developments are crucial in meeting the challenge of sustainable development and consumption, which aims to satisfy current needs without compromising the ability of future generations to meet their own needs.

A systematic review of recent trends in consumers' sustainable consumption reveals a growing focus on the environmental impact of sustainability, with an emerging interest in the social perspective. This shift is evident in consumers' increasing preference for eco-friendly food products, as well as growing awareness and practices in sectors like tourism, commerce, and clothing. The review suggests that future research should explore less examined frameworks, particularly those that consider the economic and social sides of sustainability in various contexts. Moreover, it emphasizes the need to view consumers' sustainable behavior holistically, considering its impacts from the perspectives of planet, people, and profit (Sesini, Castiglioni, & Lozza, 2020).

Innovations in sustainable consumption are also being driven by new economic models, socio-technical transitions, and social practices. These innovations are part of a broader paradigm shift in how companies interact with society and the environment. The circular economy, for instance, is redefining traditional business models by emphasizing the importance of product design, process design, service design, and production design in minimizing waste and maximizing resource use. This shift is not only environmentally beneficial but also offers new opportunities for economic growth and social development.

The transition to sustainable production and consumption also involves overcoming various challenges and leveraging best practices. Recent advances in areas such as eco-efficiency, waste management, and the use of renewable resources are indicative of progress in sustainable production. On the consumption side, the role of consumers is critical, with increasing emphasis on sustainable consumption practices. Supporting actions, such as advances in design and innovation for sustainability and the role of assessment and benchmarking, are also contributing to this transition. However, to achieve a more sustainable future, it is essential to connect production with consumption and integrate consumer and user perspectives into innovation and design processes. This approach can help overcome hindering factors like rebound effects and ensure the scalability and transferability of successful sustainable practices to different contexts and settings (Blok et al., 2015).

Current innovations and best practices in sustainable consumption are shaping a more sustainable future. These developments are characterized by a holistic approach that considers environmental, economic, and social aspects of sustainability. The ongoing efforts in various sectors, coupled with the integration of consumer perspectives and innovative business models, are key to advancing sustainable consumption and production globally (Sesini, Castiglioni, & Lozza, 2020; Blok et al., 2015).

3.6. Emerging Trends and Future Directions

The evolving landscape of zero-waste strategies and the circular economy (CE) is increasingly influenced by emerging trends and technologies. These developments are shaping the future directions of sustainable practices, offering innovative solutions to environmental challenges.

One of the significant trends in the circular economy is the integration of emerging technologies. Technologies such as artificial intelligence (AI), the Internet of Things (IoT), and advanced data analytics are playing a pivotal role in optimizing circular economy systems. These technologies enable data-driven design and innovative information and communication technologies (ICTs), which are crucial for efficient process management and adaptation to the unique attributes of circular economy systems. The potential of these technologies in the circular economy extends to various sectors, including energy, policy, models, and global systems. The integration of these technologies is expected to lead to the emergence of new approaches and systems in the circular economy, enhancing resource efficiency and sustainability (Kio, Anumba, & Ali, 2022).

The intersection of the circular economy and digital technologies is also a growing trend in environmental research. The COVID-19 pandemic, which led to lockdowns and travel restrictions, highlighted the impact of reduced anthropogenic activities on environmental sustainability. The circular economy model, which involves reusing, recycling, refurbishing, leasing, and sharing existing materials and products, is increasingly being recognized as a viable solution for improving environmental sustainability without compromising financial performance. Technological innovation plays a crucial role in this context, influencing the triple bottom line (social, economic, and environmental) performance at micro, meso, and macro levels. This technological revolution is creating new patterns in environmental research, contributing to the achievement of sustainable development goals (Khan, 2022).

Another emerging trend in the circular economy is the focus on food waste management. Food waste represents one of the most significant economic and environmental challenges of the 21st century, but it also offers a vast array of valuable resources. The circular economy approach to food waste involves resource recovery to close the supply chain loop. A bibliometric review of trends and patterns in food waste and circular economy research reveals eight broad themes, including anaerobic digestion of food waste, life cycle assessments, bio-based circular economy approaches, and consumer behavior towards circular economies. These themes underscore the need for collaboration among governments, the private sector, educational institutions, and researchers to promote and integrate circularity, potentially mitigating greenhouse emissions associated with food loss and waste (Tamasiga et al., 2022).

Emerging trends and future directions in zero-waste strategies and the circular economy are being shaped by technological advancements and innovative approaches to resource management. The integration of digital technologies, the focus on sustainable food waste management, and the exploration of new models and systems in the circular economy are key to advancing sustainable practices. These developments offer promising pathways for addressing environmental challenges and achieving sustainability goals (Kio, Anumba, & Ali, 2022; Khan, 2022; Tamasiga et al., 2022).

3.6.1. Technological Innovations and Their Role in Zero-Waste Strategies

Technological innovations play a crucial role in advancing zero-waste strategies, offering new ways to manage waste and promote sustainability. These innovations are transforming traditional waste management approaches, enabling more efficient and effective practices that align with the principles of a circular economy.

One significant area of innovation in zero-waste strategies is the development of sustainable waste management systems. These systems are designed to minimize waste generation and maximize resource recovery. For instance, Turkey's Zero Waste Project represents a comprehensive approach to waste management, focusing on recycling and recovery processes to prevent resource losses. This project demonstrates how technological advancements can support the transition from a linear 'take-use-waste' production model to a more sustainable 'zero waste' model. By rethinking traditional waste management practices, these technologies enable the treatment of all materials as valuable resources, contributing to a more sustainable and efficient material management system (Burcu, 2021).

The role of technology in zero-waste strategies is also evident in the transformation of social practices related to waste management. The 'Zero Waste' strategy, which has been gaining global attention, proposes an alternative model of waste governance that challenges the conventional reliance on incinerators and landfills. This strategy encompasses symbolic, technological, and organizational elements, highlighting the importance of integrating technology with social movements and local administrations. Technological innovations in this context facilitate knowledge exchange, support the remunicipalization of local public services, and contribute to the institutionalization of political ecology in policy-making. These technological interventions are crucial in enabling communities and organizations to adopt more sustainable waste management practices (Marcianò, 2021).

Furthermore, the transition to circularity in waste management is increasingly influenced by design strategies such as Design for Longevity and Design for Deconstruction. These strategies emphasize the role of designers in reducing environmental pressure not just through recycling but also through reusing and avoiding waste production. Technological innovations in design tools and decision-making processes are essential in supporting designers to adopt a Zero Waste Strategy effectively. These tools enable designers to evaluate waste implications during the design phase and guide them towards sustainable design practices that align with zero-waste principles (Baratta, 2021).

Technological innovations are pivotal in advancing zero-waste strategies and facilitating the transition to a circular economy. These innovations are transforming waste management systems, reshaping social practices related to waste, and influencing design strategies to reduce environmental impact. The integration of technology with sustainable practices is key to achieving zero-waste goals and promoting a more sustainable future (Burcu, 2021; Marcianò, 2021; Baratta, 2021).

3.6.2. Policy Developments and Regulatory Advances

Policy developments and regulatory advances play a pivotal role in shaping zero-waste strategies and the circular economy (CE). These policies and regulations are essential for creating an enabling environment that promotes sustainable practices and resource efficiency.

One significant area where policy plays a crucial role is at the local and regional government levels. Municipalities are increasingly using waste as a resource to inform circular economy policies. This approach is particularly effective at the city level, where the majority of global resources are used and waste is produced. Successful precedents for municipal governments adopting the CE as a development strategy could serve as a global model and catalyze a paradigm shift. Key factors contributing to CE implementation success include identifying and incentivizing waste as a resource, multi-governmental efforts, partnerships within government and with external partners, dedicated funding, and metrics to quantify CE impacts. Governments that adopt the CE as a formal, holistic economic development strategy with supporting frameworks at multiple scales have seen greater success in implementing these initiatives (Rico, 2019).

In the Australian built environment sector, the development of circular economy design guidelines represents a significant policy advancement. These guidelines, which focus on the construction and demolition waste stream, aim to achieve CE goals by reviewing issues related to "Design for Zero Waste" (DfZW) and "Design for Recycling" (DfR). The guidelines draw on circularity practices, resource management, innovation, and optimization, bridging the gap between theory and practice. They enable industry practitioners to keep products and materials in use for a longer period and develop strategies to regenerate natural systems. Future research should focus on measuring emissions reductions linked to the strategies shown in the proposed guidelines (Zaman et al., 2023).

The CE also plays a crucial role in addressing climate change in developing economies. CE practices can help reduce greenhouse gases to net zero emissions by 2050 through efficient resource use, product lifetime elongation, recycling, recovery, reuse, materials substitution, efficient waste reduction and management, and sharing services. Developing countries should align CE strategies with climate change mitigation and the achievement of Sustainable Development Goals (SDGs), synergizing CE practices with existing national policies. Mainstreaming CE across sectoral strategy and policy development is essential for resilient growth in both developed and developing economies (Odia, 2021).

Policy developments and regulatory advances are critical in advancing zero-waste strategies and the circular economy. These policies and regulations provide the necessary framework for implementing sustainable practices, promoting resource efficiency, and addressing environmental challenges. The success of zero-waste and CE initiatives depends on the commitment and collaboration of governments at various levels, industry practitioners, and other stakeholders (Rico, 2019; Zaman et al., 2023; Odia, 2021).

4. Discussion of Findings

4.1. Impact Analysis of Zero-Waste and Circular Economy Practices

The impact of zero-waste and circular economy (CE) practices is increasingly becoming a focal point of environmental and economic discussions. These practices aim to create a sustainable balance by minimizing waste and maximizing resource efficiency. The analysis of their impact reveals significant implications for environmental, economic, and social domains.

One study examines the relationship between institutional pressures (IP), zero waste practices, and circular economy target performance (CETP). It finds that IPs play a crucial role in explaining CETP and zero waste practices. Zero waste practices directly affect CETP and also act as a mediator between IP and CETP. The study also highlights the moderating role of enviropreneurship in the relationship between zero waste practices and CETP. This indicates that zero waste practices, influenced by institutional pressures and supported by enviropreneurship, can significantly contribute to achieving circular economy targets. These findings underscore the importance of institutional frameworks and entrepreneurial initiatives in promoting zero waste and circular economy practices (Nassani et al., 2023).

The concept of zero waste is closely linked to the broader framework of the circular economy. Zero waste strategies are essential in transitioning from a linear to a circular economic model. These strategies involve reducing waste generation, enhancing recycling and reuse technologies, and ensuring resource efficiency. The distinction between zero waste and zero waste to landfill concepts is critical in understanding the full scope of CE practices. Zero waste strategies are not just about diverting waste from landfills but about rethinking and redesigning products and processes to eliminate waste altogether. This approach is fundamental in guiding public, civil societal, and private sectors towards sustainable practices (Franco-García et al., 2018).

The impact of CE measures in the European Union's built environment sector, particularly concerning CO2 emissions, is another area of interest. Studies have quantified CO2 emissions associated with CE measures, ranging from individual construction elements to the entire construction sector. These studies highlight the need for a synthesis and comparison of CE strategies to the EU's CO2 emission reduction targets. The findings suggest that CE strategies targeting construction elements can significantly contribute to managing the EU's remaining carbon budget. However, caution is advised in evaluating the performance and trade-offs of CE strategies, considering wider sustainability concerns beyond material and waste considerations (Sharmina et al., 2023).

The impact analysis of zero-waste and circular economy practices reveals their significant contributions to environmental sustainability, economic viability, and social responsibility. Institutional pressures, enviropreneurship, and innovative strategies play pivotal roles in enhancing these practices. The transition to a circular economy, particularly in sectors like construction, is crucial in achieving broader sustainability goals, including reducing CO2 emissions and preserving natural resources (Nassani et al., 2023; Franco-García et al., 2018; Sharmina et al., 2023).

4.1.1. Environmental, Economic, and Social Implications

The environmental, economic, and social implications of zero-waste and circular economy (CE) practices are multifaceted, impacting various aspects of society and the environment. These practices aim to create a sustainable balance by minimizing waste and maximizing resource efficiency, leading to significant benefits and challenges.

The circular economy plays a key role in sustainable economic growth by saving resources, minimizing waste, reducing environmental degradation, and achieving beneficial economic and social results. The transition to a global circular economy has gained political attention, with the aim of promoting material circularity and decoupling resource use from macroeconomic growth. Research reveals synergies between the circular economy and sustainable economic growth, indicating that the circular economy can lead to sustainable well-being. However, these positive effects at the global level cannot be generalized to individual economies due to sector-specific differences and varying degrees of harmonization with circular economy practices (Ocolișanu, Dobrotă, & Agârbiceanu, 2022).

Institutional pressures (IP) and zero waste practices are also crucial in achieving circular economy target performance (CETP). A study examining the relationship between IP, zero waste practices, and CETP found that IPs play an essential role in explaining CETP and zero waste practices. Zero waste practices directly affect CETP and act as a mediator between IP and CETP. Furthermore, the moderating role of enviropreneurship in the relationship between zero waste practices and CETP highlights the importance of entrepreneurial initiatives in promoting zero waste and circular economy practices (Nassani et al., 2023).

The optimization of solid waste management in the context of the circular economy also has significant economic, environmental, and social implications. A study examining the feasibility of circular economy in municipal solid waste (MSW) management proposes a concept for utilizing collected organic MSW by converting it into biogas for use in thermal power plants. This approach reduces the burden on coal mines and minimizes environmental and social costs. The study's findings indicate that the proposed system reduces the total cost of the present system significantly, contributing to a reduction in carbon emissions. This highlights the potential of circular economy strategies in addressing environmental challenges while optimizing economic and social outcomes (Rathore & Sarmah, 2020).

The environmental, economic, and social implications of zero-waste and circular economy practices are significant. These practices contribute to sustainable economic growth, optimize resource use, and reduce environmental degradation. The success of zero-waste and CE initiatives depends on institutional frameworks, entrepreneurial initiatives, and innovative strategies that promote sustainability across various sectors (Ocolişanu, Dobrotă, & Agârbiceanu, 2022; Nassani et al., 2023; Rathore & Sarmah, 2020).

4.1.2. Challenges and Barriers in Implementing Sustainable Practices

Implementing sustainable practices in zero-waste and circular economy (CE) initiatives is fraught with challenges and barriers, particularly in developing regions and specific industries. Understanding these challenges is crucial for developing effective strategies to overcome them and achieve sustainability goals.

In Sub-Saharan Africa (SSA), managing waste has become a significant challenge due to the continued practice of the traditional linear waste economy, which involves taking, making, and disposing methods of management. This approach poses a threat to global environmental sustainability. Despite the need to shift to the circular economy model, several factors restrict its realization in practice, especially in developing countries. Key challenges include the absence of educational programs and public awareness of waste management activities, lack of political will, funding, and national policies on waste management. These barriers highlight the need for policymakers, entrepreneurs, and relevant groups to commit resources to sustainable waste management services, aiming to advance the circular economy in SSA countries (Debrah, Teye, & Dinis, 2022).

In emerging countries, implementing CE practices is particularly challenging due to problems in the supply chain network and the financial constraints exacerbated by the COVID-19 pandemic. A study focusing on the leather products industry identified several barriers to implementing CE, including unavailability of initial funding capital, long-term investment needs, lack of integrating production systems using advanced technology, and lack of strategic planning. The study suggests strategies such as integrated design facilities for CE and ensuring large-scale funding for CE facilities as potential solutions. These findings are crucial for managers in the industry to implement CE practices effectively and gain competitive advantages (Maliha, Moktadir, Bag, & Stefanakis, 2023).

In Turkey, the implementation of zero-waste management strategies referring to the circular economy faces its own set of challenges. A study using the fuzzy DEMATEL methodology identified key barriers, including uncertainty of goals and tactics relevant to the circular economy and lack of financial and economic aid. These barriers affect the success of zero-waste management in Turkey, underscoring the need for clear strategies and support mechanisms to successfully implement zero-waste management (Ayçin & Kayapinar Kaya, 2021).

The challenges and barriers in implementing sustainable practices in zero-waste and circular economy initiatives vary across regions and industries. Addressing these challenges requires a comprehensive approach that includes enhancing public awareness, political commitment, strategic planning, and financial support. Overcoming these barriers is essential for the successful adoption of zero-waste and circular economy practices, contributing to environmental sustainability and economic development (Debrah, Teye, & Dinis, 2022; Maliha, Moktadir, Bag, & Stefanakis, 2023; Ayçin & Kayapinar Kaya, 2021).

4.1.3. Evolution of Strategies and Techniques in Waste Reduction

The evolution of strategies and techniques in waste reduction within the frameworks of zero-waste and circular economy (CE) has been significant, especially in urban settings and manufacturing sectors. These strategies are increasingly focusing on reuse, resource conservation, and sustainable supply chain management. In New York City (NYC), the aspiration of achieving zero waste to landfills has robustly engaged the solid waste management technique of reuse. The reuse activities in NYC, which include furniture, appliances, and automobile accessories, among others, are quantitatively assessed using the Reuse Impact Calculator (RIC) based on the Waste Reduction Model (WARM). This assessment shows that reuse activities in NYC account for a significant reduction in net CO2-eq emissions. The study highlights that the maximum recycle potential is saturated at 66%, and only auxiliary strategies like reuse can achieve

the zero waste to landfill ambitions. This approach emphasizes the role of reuse in the circular economy, wherein the resource utilization is maximized by increasing the shelf life of the product, thereby enabling maximum reuse potential (Lugo, Ail, & Castaldi, 2020).

The concept of the circular economy is also a critical step toward net-zero manufacturing. In developing economies, which rely on linear practices and traditional resources, the adoption of CE practices is essential for achieving self-sustainability in materials and energy. A study focusing on Indian small and medium enterprises (SMEs) identified critical success factors (CSFs) for implementing the circular economy. The study used Fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) techniques to categorize and establish a structural model among the identified CSFs. The findings suggest that government policies and regulations on CE, consumer awareness and demand for CE products, economic incentives available for CE products, and new global business opportunities due to CE are the leading cause groups of CSFs. This analysis provides a pathway for SMEs to adopt CE practices effectively, contributing to a more sustainable economy (Kumar, Gupta, & Rehman, 2023).

In the agri-food industry, managing food loss is critical for creating a world with zero hunger and achieving the Sustainable Development Goals. A study analyzing food loss in the agri-food industry supply chain used bibliometric techniques to analyze publications on this topic. The results show a growing interest in managing and preventing food loss, with a focus on stakeholder collaboration, the circular economy, and related regulatory changes. This holistic approach from a supply chain perspective is needed to devise food loss reduction strategies, highlighting the effect that a reduction in food loss has on business strategies and policymaking (Sánchez-Teba, Gemar, & Soler, 2021).

The evolution of strategies and techniques in waste reduction in zero-waste and circular economy practices is marked by a shift towards reuse, resource conservation, and sustainable supply chain management. These strategies are essential for achieving environmental sustainability, economic viability, and social responsibility. The success of these initiatives depends on the commitment and collaboration of various stakeholders, including governments, businesses, and consumers (Lugo, Ail, & Castaldi, 2020; Kumar, Gupta, & Rehman, 2023; Sánchez-Teba, Gemar, & Soler, 2021).

4.1.4. Future Prospects and Potential Developments in Sustainable Consumption

The future prospects and potential developments in sustainable consumption within the frameworks of zero-waste and circular economy (CE) are shaped by evolving strategies, technological advancements, and a growing global commitment to sustainability.

A comprehensive bibliometric mapping analysis of zero-waste management and sustainable consumption reveals a growing trend in the number of publications and citations related to these topics. The analysis, which examined 2534 publications from the Web of Science core collection from 2011 to 2021, highlights the increasing global interest in zero-waste management. The most relevant journals, authors, and regions contributing to this field were identified, with China, the USA, and Italy being the principal regions. The study underscores the importance of waste management, sustainability, circular economy, and sustainable development as key areas of focus. This growing body of research provides a collaborative network for future knowledge generation in zero-waste management and sustainable consumption (Valenzuela-Fernández & Escobar-Farfán, 2022).

The transition to a sustainable circular economy requires a transformation that redefines growth and progress, redesigning economies to decouple prosperity from material consumption, carbon emissions, and waste. Dematerialization, servitization, collaborative consumption, and a shift from ownership to access are potential strategies to restructure the economics of consumption, accelerate decoupling, and create a circular economy that delivers benefits for all. However, their deployment without policy steer, public support, and appropriate technology developments could be a missed opportunity for ensuring sustainable economic growth aligned with environmental stewardship and social development (Voulvoulis, 2022).

The future prospects and potential developments in sustainable consumption in zero-waste and circular economy practices are marked by a shift towards innovative strategies, global collaboration, and a commitment to sustainability. These developments are essential for achieving environmental sustainability, economic viability, and social responsibility. The success of these initiatives depends on the commitment and collaboration of various stakeholders, including governments, businesses, and consumers (Valenzuela-Fernández & Escobar-Farfán, 2022; Zamlynskyi et al., 2023; Voulvoulis, 2022).

4.2. The Role of Standards, Policies, and Regulatory Frameworks

The role of standards, policies, and regulatory frameworks is crucial in shaping the success of zero-waste and circular economy (CE) initiatives. These regulatory instruments guide the development of infrastructure, finance research, support market growth for secondary raw materials, and regulate information flows, thereby facilitating sustainable waste management and circular practices. In the European Union (EU), waste policies play a pivotal role in orienting integrated strategies for waste management within the circular economy. The Waste Framework Directive 2008/98/EC, considered the fundamental legal framework for treating waste in the EU, is a prime example. This directive outlines strategies for applying the waste hierarchy to various sectors, including construction, in the perspective of the circular economy. The EU's approach to waste and CE policies highlights the importance of regulatory and procedural instruments in developing sustainable production models and improving waste management practices (Migliore, Talamo, & Paganin, 2020.).

Globally, solid waste management (SWM) challenges are driven by growing populations and consumption patterns. The Waste Hierarchy (3Rs) and Circular Economy concepts have been updated in a Conceptual Waste Framework used by international organizations to evaluate SWM practices. This framework identifies key steps, important factors, and stakeholders essential for effective SWM. Despite some countries exhibiting zero waste compliance, most face challenges in waste generation, incineration, and disposal. The Global North relies on technologies, economic tools, regulatory frameworks, education, and social engagement, while the Global South often sees governments taking sole legal responsibility for SWM. The study emphasizes the need for improved Waste Hierarchy and CE compliance and enhanced stakeholder partnership and awareness across nations (Awino & Apitz, 2023).

In developing countries, transitioning toward smart waste management within the context of the circular economy requires a facilitating framework. A study focusing on Pakistan identified 16 critical facilitators for adopting smart waste management. The study employed a fuzzy hybrid multi-criteria decision-making approach, suggesting that before applying smart waste technologies, countries should focus on devising regulations for waste management. Industries should adopt environmental management systems that foster waste minimization, and digitalization should be applied in ICT and IoT for effective waste data collection, sharing, and receiving. This approach highlights the importance of regulatory frameworks in facilitating the adoption of smart waste management practices in developing countries (Khan & Ali, 2021).

Standards, policies, and regulatory frameworks play a vital role in the successful implementation of zero-waste and circular economy practices. These regulatory instruments guide the development of sustainable waste management systems, support market growth for secondary raw materials, and facilitate the transition to a circular economy. The success of these initiatives depends on the commitment and collaboration of various stakeholders, including governments, businesses, and consumers (Migliore, Talamo, & Paganin, 2020; Awino & Apitz, 2023; Khan & Ali, 2021).

4.3. Implications for Stakeholders: Government, Industry, and Community Perspectives

The implications of zero-waste and circular economy (CE) practices for stakeholders, including government, industry, and community, are multifaceted and critical for achieving sustainable development goals. These stakeholders play distinct yet interconnected roles in promoting and implementing sustainable practices.

In Central Taiwan Science Park (CTSP), sustainable development initiatives have been assessed through the perspectives of residents living around the park. The study aimed to understand how technology parks can promote circular economy and waste reduction, as well as their potential impact on the environment and neighboring communities. The CTSP has established advanced recycling facilities and green infrastructure to promote waste reduction. Residents' opinions were crucial in understanding the current situation and the way forward, helping the CTSP design effective green infrastructure for the urban ecosystem. This study underscores the importance of involving local communities in sustainable development initiatives and highlights the role of technology parks in advancing zero-waste and circular economy practices (Chen, 2023).

The international community's response to climate change, particularly after the adoption of the Paris Agreement in 2015, has significant implications for countries like Korea. The urgency of mitigating greenhouse gas emissions and the call for wider and more decisive actions have led to the review of nationally determined contributions and the submission of long-term low greenhouse gas emission development strategies. Many countries are seeking sustainable economic recovery plans that reflect climate change and environmental considerations. The involvement of major greenhouse gas emitters in the declaration of carbon neutrality vision and plans to introduce carbon border tax indicates that greenhouse gas reduction will affect not only domestic economic and industrial policies but also

diplomatic and international trade sectors. This research highlights the need for countries to strengthen greenhouse gas reduction targets and assess the economic impact of policies like the EU's Carbon Border Adjustment Mechanism.

The current multifactorial and pervasive crisis, exacerbated by the COVID-19 pandemic, imposes a deep review of current unequal development models. This crisis highlights the need for a transition to sustainable and circular economic models. The pandemic has accelerated dynamics related to climatic, environmental, social, and economic crises, leading to significant changes in various sectors. The role of public institutions, the redesign of the built environment and landscape, and the promotion of sustainable, intelligent, and ethical cities and territories are crucial in this transition. The crisis presents an opportunity for stakeholders to enable forms of citizenship and communities capable of inhabiting more sustainable environments (Mussinelli, 2021).

The implications for stakeholders in zero-waste and circular economy practices are significant and require a collaborative approach. Governments, industries, and communities must work together to promote sustainable practices, mitigate environmental impacts, and achieve economic and social benefits. The success of zero-waste and CE initiatives depends on the commitment and collaboration of all stakeholders (Chen, 2023; Moon et al., 2020; Mussinelli, 2021).

4.4. Exploring Strategies, Outcomes, and Challenges in Moving Towards a More Sustainable Consumption Model

The movement towards a more sustainable consumption model, particularly within the frameworks of zero-waste and circular economy (CE), involves exploring various strategies, understanding their outcomes, and addressing the challenges they present. A study focusing on circular consumption in Portugal evaluated the influence of environmental concerns and the search for pro-sustainable information on Portuguese consumers' circular habits and their impact on circular consumption choices. The study, which collected 826 valid responses using a non-probabilistic convenience sampling technique, found that environmental concerns and the search for pro-sustainable information positively impact circular habits, emphasizing energy and water saving, and zero plastic use. Additionally, these factors directly correlate with circular consumption decisions, although this relationship is less intense when mediated by circular habits. The study proposes a model of consumer participation in the circular economy, suggesting that adherence to responsible circular consumption habits can transform traditional corporate business models into circular models, accelerating more efficient management of natural resources and ensuring global sustainability (Gomes & Lopes, 2023).

The intersection of the circular economy and digital technologies is an evolving trend in environmental research. The COVID-19 pandemic, which led to lockdowns and travel restrictions, highlighted the impact of reduced anthropogenic activities on environmental sustainability. The circular economy model, which involves reusing, recycling, refurbishing, leasing, and sharing existing materials and products, is increasingly recognized as a viable solution for improving environmental sustainability without compromising financial performance. Technological innovation plays a crucial role in this context, influencing the triple bottom line (social, economic, and environmental) performance at micro, meso, and macro levels. This technological revolution is creating new patterns in environmental research, contributing to the achievement of sustainable development goals (Khan, 2022).

The transition from a linear to a circular economic model involves profound changes in a company's core values and strategic risk management. This transition implies new challenges, such as managing strategic risk in an integrated way. The circular economy requires a systemic and integrated vision of economic, social, and environmental dimensions to guarantee effective corporate governance sustainability strategy. The study provides theoretical considerations about this transition, highlighting the need for companies to rethink their business strategies and adapt their management models inspired by sustainable development (Gennari & Cassano, 2020).

Moving towards a more sustainable consumption model in zero-waste and circular economy practices involves a multifaceted approach. It requires understanding consumer behavior, leveraging technological innovations, and rethinking business strategies and risk management. These strategies are essential for achieving environmental sustainability, economic viability, and social responsibility. The success of these initiatives depends on the commitment and collaboration of various stakeholders, including governments, businesses, and consumers (Gomes & Lopes, 2023; Khan, 2022; Gennari & Cassano, 2020).

4.5. Comparative Study of Circular Economy Models in Different States

The comparative study of circular economy (CE) models in different states in the U.S. reveals diverse approaches and challenges in implementing sustainable practices. These models are influenced by various determinants, including economic, social, and environmental factors.

A quantitative study assessing the factors supporting the circular transition in the U.S. highlighted the importance of the circular economy in addressing resource consumption. The study employed time series analysis based on the Autoregressive Distributed Lag (ARDL) model to analyze the impact of Gross Domestic Product (GDP) per capita, Research and Development expenses, and Renewable Energy consumption on circular economy in the U.S. from 1971 to 2017. The findings indicated a long-run relationship between GDP per capita and renewable energy consumption, but no relationship was observed between research and development expenses and the circular economy. This study emphasizes the need for policy interventions to enhance awareness regarding the circular economy, increase consumption of renewable energies, and steer investments in research and development activities to support CE activities in the U.S. (Upadhayay et al., 2023).

In the context of the European Union (EU), a multidimensional comparative analysis of the implementation of circular economy by EU countries was conducted. This analysis used CE indicators proposed by the European Commission and created a relevant index of development of circular economy (IDCE). The classification of EU countries according to their advancement in the concept of CE was adopted as the main research task. The comparative analysis conducted by statistical methods concluded that among all EU countries, those of the old EU are the most advanced in terms of CE. This analysis provides insights into the spatial differentiation of advancement in implementing CE and identifies CE implementation leaders and countries particularly delayed in this regard (Mazur-Wierzbicka, 2021).

Another study focused on innovative projects connecting the circular economy with sustainable territorial development. The research analyzed the levers and barriers to developing new business models built on circular economy principles. The study, based on primary and secondary sources, applied causal approach, analysis, synthesis, and survey to derive common features and develop a typology for successful realization of similar projects. It also provided recommendations concerning the necessary support from national and local public authorities for such projects. This study highlights the importance of understanding the requirements, conditions, and factors for successful implementation of CE-based projects (Ivanova, 2020).

The comparative study of circular economy models in different states in the U.S. and other regions reveals the complexity of implementing sustainable practices. The success of these initiatives depends on various factors, including economic indicators, policy interventions, and the development of innovative business models. Understanding these factors is crucial for advancing circular economy practices and achieving sustainable development goals (Upadhayay et al., 2023; Mazur-Wierzbicka, 2021; Ivanova, 2020).

5. Conclusion and Recommendations

The systematic review of literature on zero-waste initiatives and circular economy models in the United States has yielded several key findings and insights. Firstly, the evolution of zero-waste and circular economy concepts in the U.S. reflects a growing awareness and sensitivity towards environmental issues, leading to innovative strategies in waste reduction and sustainable consumption. The impact analysis revealed that these practices have significant environmental, economic, and social implications, contributing to sustainable development. However, challenges and barriers such as institutional constraints, financial limitations, and technological hurdles persist in implementing these practices effectively.

The role of standards, policies, and regulatory frameworks emerged as crucial in facilitating the adoption and effectiveness of zero-waste and circular economy practices. Successful case studies highlighted the importance of community involvement, stakeholder engagement, and the adaptation of strategies to local contexts. The study also underscored the potential for technological innovations in enhancing the efficiency and effectiveness of zero-waste strategies. For policymakers, it is recommended to develop clear and supportive legislative frameworks that encourage zero-waste and circular economy practices. This includes providing incentives for sustainable practices, investing in research and development, and enhancing public awareness and education on environmental sustainability.

Businesses are advised to integrate zero-waste and circular economy principles into their operational and strategic planning. This involves adopting sustainable production methods, investing in renewable energy, and engaging in responsible supply chain management. Businesses should also explore new market opportunities arising from sustainable practices and collaborate with stakeholders to enhance their sustainability efforts. Communities play a vital role in the success of zero-waste initiatives. Community engagement in waste reduction efforts, participation in recycling programs, and support for local sustainable businesses are crucial. Education and awareness campaigns can empower communities to make informed decisions and adopt sustainable lifestyles.

Future research should focus on exploring the long-term impacts of zero-waste and circular economy practices on environmental sustainability and economic growth. There is a need for more empirical studies to assess the effectiveness of different strategies and models in diverse contexts. Research should also investigate the role of emerging technologies in enhancing the efficiency of waste management and resource utilization.

Finally, the transition to zero-waste and circular economy models is essential for achieving sustainable development. While challenges exist, the potential benefits for the environment, economy, and society are significant. Continued efforts from all stakeholders, including policymakers, businesses, and communities, are crucial in moving towards a more sustainable and resilient future.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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