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A systematic review of innovation and circular economy

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Abstract

The circular economy is often advocated as a more sustainable alternative to the prevailing linear production and resource management model, which has been found to have adverse impacts on economic, social, and environmental aspects. This article consolidates and analyzes existing literature on innovation within the circular economy context. The objective is to identify gaps or areas requiring more investigation to advance knowledge in this domain. Therefore, it has been determined that while being in the early stages of implementation, extensive research has already been conducted on the advantages, catalysts, problems, and impediments associated with the circular economy. It is important to note that investigating novel business models and operational approaches within supply chains necessitates the incorporation of ecological innovations. These innovations aim to diminish the environmental repercussions of production and consumption activities. Implementing such innovations makes it feasible to achieve a closed-loop system that effectively utilizes all waste materials. Examples of these ecological innovations include using product and service systems, dynamic capabilities, 3D printing, product life cycle analysis, and software recycling. To accomplish this objective, empirical research indicates that it is imperative to enhance knowledge of the issue, mainly through marketing initiatives, and for organizations, including small and medium-sized enterprises (SMEs), to demonstrate a willingness to collaborate and synchronize their interests.

Implications for Central European audience

The 2030 Agenda of the United Nations encompasses a set of 17 Sustainable Development Goals (SDGs), which outline the imperative for nations to adopt the principles of the circular economy to advance sustainability efforts. In the present environment, the European Union plays a pivotal role in this advancement, given its status as a prominent global force. The objective of this article is to consolidate and reveal the existing body of information about innovation within the context of the circular economy while also identifying areas that have not yet been thoroughly investigated or warrant further examination. Adopting this approach will facilitate other advancements within the circular economy paradigm, hence facilitating the Sustainable Development Goals (SDGs) attainment. Furthermore, a significant proportion of the articles examined are situated within the geographical boundaries of Europe

Keywords: Circular economy; Innovation; SDG

1. Introduction

The year 2015 witnessed the establishment of the 17 Sustainable Development Goals (SDGs) by the United Nations, which global leaders subsequently endorsed. These goals were formulated with the overarching objective of being accomplished by 2030. Although each objective has distinct purposes, they all share a common underlying idea: the adoption of the circular economy as a sustainable alternative to the prevailing model of production and resource management. This current model has detrimental effects on the economic, social, and environmental dimensions.

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The significance of SDG 9, which pertains to "Industry, Innovation, and Infrastructure," lies in its crucial role in fostering economic growth, promoting social advancement, and addressing climate change. These objectives are contingent upon substantial investments in infrastructure, the promotion of sustainable industrial development, and the rise of technology [1]. The rationale for undertaking this study is rooted in the imperative to investigate novel and advanced modes of industrial manufacturing within the context of the circular economy to facilitate the realization of Sustainable Development Goal (SDG) number 9, among others.

The primary aim of this article is to examine the existing evidence about innovation within the context of the circular economy. Additionally, it seeks to identify areas that have not been well examined or require further investigation to facilitate continued advancements in this domain. To achieve this objective, a comprehensive literature review has been conducted. This research approach involves the analysis and compilation of findings from all relevant publications about the topic at hand, specifically focusing on innovation and the circular economy. The provided text briefly summarizes the available material and presents a contemporary perspective on the topic under consideration.

This study comprises three primary sections. Firstly, the methodology section provides a comprehensive and detailed description of the sample that was chosen for the systematic literature review. Additionally, the findings encompass the foremost significant contributions of the examined publications, elucidating the existing state of innovation and the circular economy. Lastly, the results of this study explain the contributions made by this work, as well as the limits encountered. Additionally, prospective avenues of research on the subject matter are discussed.

2. Methodology

In this section, the methodology used is presented.

2.1. Sample selection

A comprehensive review of the literature was conducted to meet the desired objectives. This research method entails selecting and reviewing publications relating to the study's topic matter to synthesize the available evidence. It is a qualitative method extensively employed in academic literature that has been shown to facilitate conclusion. Several publications from other topic areas confirm this, as it is used for all types of knowledge development [2, 3].

A sample of 38 published articles on innovation and the circular economy were discovered and analyzed using this method to study the available literature and determine what has been researched and what remains untouched.

Figure 1 depicts the search, screening, and selection of the sample of papers evaluated; the database used was Web of Science (WoS) and Google Scholar.

First, using the phrases 'circular economy' and 'innovate*,' the relevant search terms were established. The citation indexes 'Science Citation Index Expanded (SCI-EXPANDED) - 1900-present' and 'Social Sciences Citation Index (SSCI) - 1956-present' were chosen from Web of Science's primary collection. The search produced 503 results that matched the specified criteria.

Second, the accessible Google Scholar and Web of Science categories were filtered and refined using the phrases 'MANAGEMENT' and 'BUSINESS.' Only documents from specialized journals in these two fields of study would appear this way. The results were then filtered based on the year of publication, with a five-year window spanning articles published from 2016 to April 2020. The sample was cut from 503 to 43 findings.

Third, the type of document was determined to be an article, and the search was limited to those published in English to ensure the quality of the publications.

Finally, 38 publications were gathered and thoroughly read and analyzed to ensure they fit within the scope of the study.

Once the 38 articles were determined to be relevant to the framework under consideration, they were classified and grouped according to their central theme, one for each sub-chapter of the following section (CE paradigm, the road to CE, the importance of collaboration, eco-innovations, CE in SMEs, the importance of consumer awareness change, and CE in the textile industry). However, because they are linked, some publications contribute to other concerns even if they are not the primary research focus.

Finally, one disadvantage of this study is that it only used one methodology, a systematic literature review, which would have to be complemented with other ways to increase understanding of the subject.

Similarly, because only one database - Web of Science - has been used, it would be preferable to broaden the sample's scope using other databases.

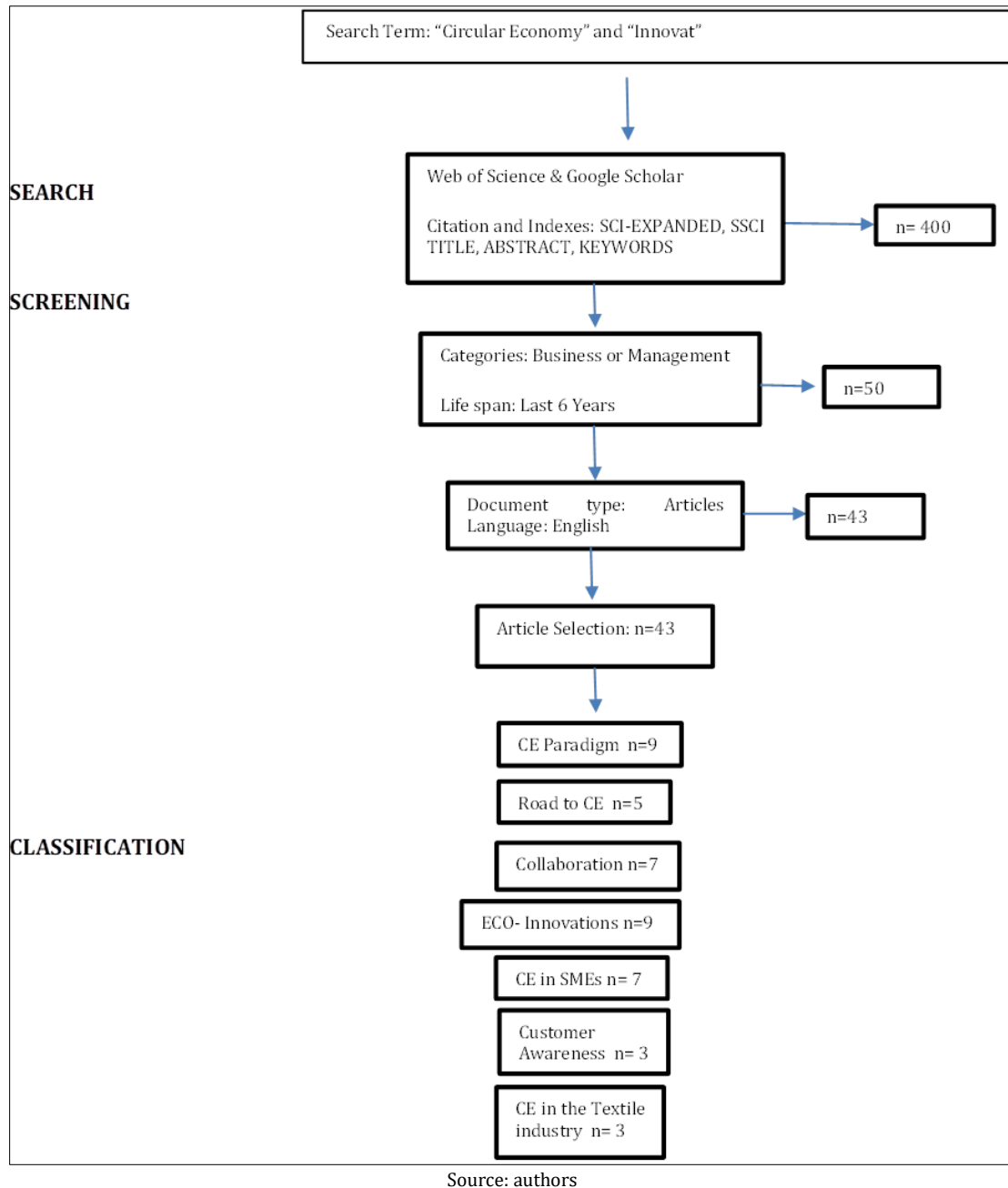


Figure 1 Search, Screening, and Selection of Samples

3. Results

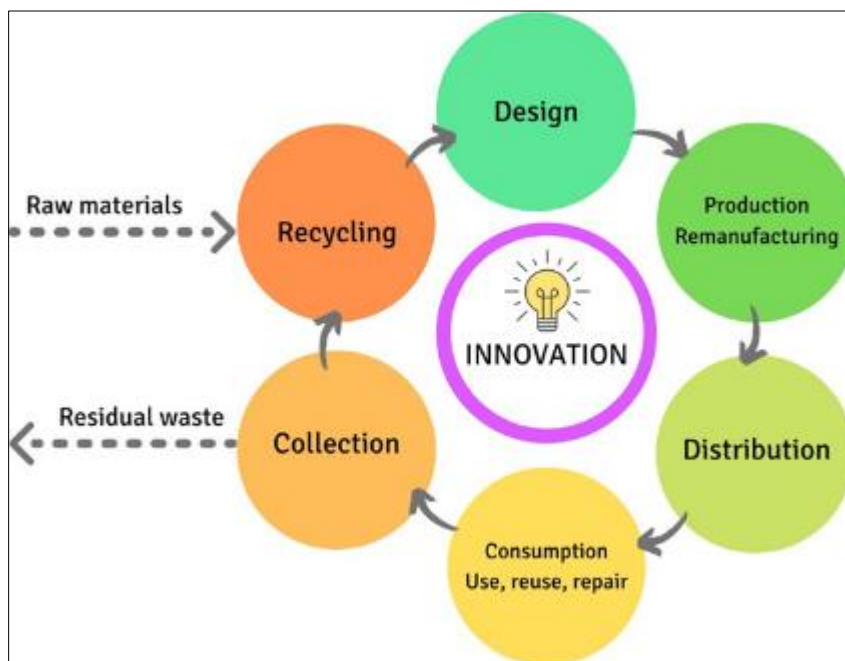
3.1. Circular economy paradigm

The circular economy (CE) refers to an economic system that employs business models that prioritize reducing, reusing, recycling, and recovering materials in various stages of production, distribution, and consumption. This system operates at multiple levels, including the micro level (involving products, companies, and consumers), meso level (involving ecological industrial parks), and macro level (involving cities, regions, nations, and the global scale). The ultimate goal

of the circular economy is to achieve sustainable development, which entails creating an environment characterized by high-quality standards, economic prosperity, and social equality. This is done to benefit both present and future generations [4].

The notion of corporate entrepreneurship (CE), initially articulated by Pearce and Turner in 1990, has gained significant importance in recent years, including corporate and societal domains. Presently, our society operates under a linear economic model that heavily relies on the extensive exploitation of natural resources. This approach has adverse environmental consequences, generating waste and rendering it unsustainable in the context of globalization. Certain scholars have designated the present epoch as the Anthropocene or the Age of Humans, denoting a period marked by extensive alterations to global social and ecological terrains, predominantly instigated or shaped by human endeavors, resulting in adverse ramifications. In light of the prevailing economic framework, it is incumbent upon enterprises to acknowledge and confront the present issues we encounter [5].

The objective of implementing a circular economy (CE) is to prolong the product's lifespan, thereby transforming a company's waste or outputs into inputs for subsequent manufacturing cycles, as seen in Figure 2. The procedure mentioned in Figure 2 results in the diminishment of waste and the preservation of a significant portion of the value of products, raw materials, or resources within the production cycle for an extended duration [6], serving as an additional revenue stream. The process of redefining garbage as a valuable resource entails the adoption of novel and inventive approaches inside established supply chains [7]. Consequently, there is a growing inclination to embrace and pursue a business excellence framework that integrates sustainability, adaptability, robustness, and innovation. [5] Companies must ascertain the specific challenges and issues they intend to address. Subsequently, they should consolidate their resources and align their organizational structure to tackle these identified concerns effectively.



Source: original work based on Volker et al. (2020).

Figure 2 The Circular Economy

The goal of CE is to extend the end of a product's useful life so that a company's trash or outputs become inputs for new production cycles, as illustrated in Figure 2. This procedure reduces waste and preserves the majority of the value of products, raw materials, or resources within the production circuit for a longer time [6], resulting in a new source of income. Rethinking garbage as a resource necessitates implementing new inventive solutions for existing supply chains [7]. This causes us to embrace and pursue a business excellence approach that encompasses sustainability, adaptability, soundness, and innovation concepts. Companies must determine the difficulties and concerns they will handle before pooling resources and aligning the organization to confront them [5].

The European Commission [6] envisions transitioning from a linear economy to a CE through numerous messages, papers, policies, and directives, such as the Paris Agreement and Agenda 2030 [8].

3.2. Pathway to Circular Economy

CE has numerous advantages for enterprises that use it and the country's economic development. [6] A study, in particular, demonstrates that measures linked with circular principles have a direct and positive impact on resource productivity and, hence, economic growth. Indeed, [9] forecasts that more effective resource use may save Europe 630 billion euros per year. It is important to remember that increasing resource productivity also means producing more jobs. According to the European perspective, boosting resource productivity by 30% by 2030 can result in a nearly 1% increase in green GDP. The importance of research and innovation in the transition from a linear economy to a CE has been emphasized in the European Union while adhering to the ideals of sustainable development. At the micro level, implementing circular business models would result in cost savings in manufacturing, increased differentiation potential, improved customer relations, higher marginal profits, lower environmental impact, and increased brand protection through CE-derived patents [10]. [11] A case study, in which a company developed a circular business model, supports the benefits of CE.

The CE additionally features a set of conductors that make it easier to use. [12] suggest a four-phase strategy for dominating firms to transition from a linear to a circular business model, which is difficult since they must change how they develop, deliver, and capture customer product value. Because of their large market share, these enterprises must shift toward sustainability. Even at a low level, they can have a substantial environmental impact.

[12] Studied a small business that built a circular business model and identified ten categories of problems and constraints (see Table 1).

Table 1 Challenges and limitations of CE identified by Linder and Williander (2017)

Challenge and limitation	Why is it a difficulty and limitation??
Clients	Not everyone is environmentally aware.
Experts of technology	The best technique to return the goods to their original or superior state.
Return of the flow	Not all products return to the supply chain.
Product classification	Not all can be reused.
Company's product decline	Possible sales decrease if the new product with a long lifetime duration decreases prior product sales.
Vulnerability to fashion	Inability to respond to changes in product design.
Fixed capital risk	When a product is rented rather than purchased, a financial risk is passed from the client to the producer.
Increased operational risk	Consequences of increased responsibility.
Policies and legislation	Lack of regulation, policies, and supporting legislation.
Partners	Your business models must be compatible with the main company.

Source: own elaboration based on Linder and Williander (2017)

The authors of this study have also demonstrated that the evaluation of linear models can be based on the number of items sold during a particular event, determining their success or failure. However, circular models cannot be deemed valid until several circular products have been effectively sold. Put simply, the business risk associated with verifying a circular model is consistently more significant than that of confirming the comparable linear model.

[13] The World Economic Forum has also recognized that adopting a circular economy is a complicated endeavor due to factors such as the geographical dispersion of enterprises and suppliers, the growing complexity and diversity of materials, and the limitations imposed by the linear economic model.

[14] researched circular literacy, the knowledge-based ability to implement CE models to promote sustainable development. This paper contends that a particular sort of knowledge is required to fully use CE's revolutionary potential as a sustainable mode of production and consumption, as well as a solution to the myriad difficulties of global political relations and issues of an uncertain future. In this regard, the findings of [15] study indicate that CE results

from competing for market competitiveness rather than pursuing sustainable development; specifically, they argue that CE appears to be an economic rather than an environmental concern.

In conclusion, prior research indicates that while CE faces numerous obstacles and barriers to implementation, it also has benefits and drivers that can help it overcome its limits.

3.3. The significance of collaboration and interest alignment

CE implementation entails complexity and interconnectedness among the actors one corporation can achieve alone, necessitating collaborative action by a complete ecosystem [16]. This argument is supported by [17] textile industry analysis. [18] similarly found that the transition to CE depends on stakeholders recognizing that no single actor can address the central issue alone. To produce value in the context of the business ecosystem, collaboration is required. Information communication across firms in different business ecosystems is critical in CE [19].

This necessitates using an orchestrator, an actor capable of playing an integrative function [19]. These leaders must be from large corporations [16], share a common vision, establish trust-based connections, commit resources, and demonstrate transformational leadership in critical decision-making [20]. According to [21], larger organizations are more likely to implement CE because they obtain more economic and social benefits from sustainable practices, are often targeted by environmental regulations, have more resources, and are willing to risk investing in such activities.

[20] Work outlines a step-by-step approach for developing a circular business model with orchestrator support. It presents the necessity for circular business models to be built while keeping the dimensions of scalability (the model's ability to grow) and replicability (the ability to transfer the original model to different settings) in mind. According to this study, a circular resource model promotes sustainability and the company's economic profits. [21] Finally, it is critical to keep an eye on the Maker Movement. This approach promotes collaboration and involvement in reaching CE by integrating traditional processes with digital manufacturing technology and techniques such as 3D printing. Makers (people who take part in this movement) share their ideas and solutions in collaborative workspaces, always adhering to circular concepts, including repair and recycling. Furthermore, they bring production back to the cities where it is consumed, resulting in social, economic, and environmental benefits [22].

In short, while implementing CE at the corporate level, teamwork is critical. The alignment of interests, mainly through an orchestrator, increases the benefits of circularity and enables the resolution of any obstacles.

3.4. Reinventing the system through ecological innovations

Eco-inventions (EI), defined as innovations that lower the environmental impact of production and consumption activities, are essential in the pursuit of more sustainable societies since they transfer individual technologies. EIs necessitate greater collaboration than other innovations since they are characterized by new technologies that require more external sources of knowledge and information than different types of innovation.

[23] Research highlights two major EI pathways: cleaner production and eco-design of products. They also demonstrate that the favorable impact of innovations on businesses is influenced by their structure, attributes, unique innovation techniques, and industry context.

[24] Examined four types of EI related to CE in their study: investments in EI, eco-design, purchase and enhancement of novel and renewable equipment or processes for energy efficiency, and R&D investments. The findings show that the impact of informal, as opposed to formal, environmental management techniques extends beyond the level of circular EI and has an indirect effect on the company's circular activities, thereby strengthening the circular material cycle. They also recognized the growing necessity of new tools to assist with new EI developments, such as environmental management accounting, human ecological resources, and corporate governance. Enterprises that have previously exhibited EI-related talents can be used in new innovative circular business models and may be able to undertake CE-related activities more efficiently.

The following are many in-depth EIs that can be used to make progress toward the circular objectives.

The first is a product and service system, an innovative business concept. Separating economic development from consumption is perhaps the most complex sustainability challenge in the capitalist economy under the CE paradigm. Two types of novel models are utilized to address this.

- First, there is the user-oriented business model, in which the company owner rents or leases a product but keeps ownership.
- Second, the results-oriented business model, in which the lead company gives a set outcome to the consumer [12].

These are included in the so-called system of products and services, which proposes a shift in the business model from offering a manufactured product with a profit based on the number of units sold to providing a combination of products and services that meet the needs of the consumer with a profit based on the number of service units delivered [10]. [13] investigated this unique concept from the standpoint of servicing (service-based growth) in their article.

Second, there are dynamic capabilities that must be developed to attain long-term competitive advantage. Several authors examine this concept, which implies a long-term competitive advantage [24]. These include the ability to detect needs, capitalize on opportunities, and reconfigure the system based on the concept of micro-foundations comprised of various talents, processes, and business activities. They are also envisioned in remanufacturing, a type of sustainable manufacturing that involves recycling the remaining value in obsolete products rather than disposing of them in landfills. They are known as dynamic remanufacturing capabilities (DRC) in this scenario. They are defined as the ability to optimize and apply variations to production lines by adjusting individual component manufacturing process timeframes. This necessitates, on the one hand, systems of flexibility that allow changes to the structure based on the volume of products recovered and end-customer requests and, on the other hand, control systems that will enable cost-effective supervision of operations while reducing associated risks.

Enterprises that use multiple micro-foundations can successfully discover and respond to circular possibilities. According to the findings of this study, dynamic capabilities make it easier for a corporation to integrate, produce, and rearrange resources for long-term sustainability in a dynamic business environment.

[24] Discovered a favorable relationship between a company's circular scope and its environmental capabilities, confirming that adopting environmental management accounting tools can be linked to the management of CE in businesses.

A look at dynamic capabilities to assist organizations in developing a sustainable competitive advantage will depend on whether the goal is to make sense of and shape opportunities and threats, reach scale opportunities, or retain competitiveness. On the other hand, investigated remanufacturing in the automotive sector in terms of the circular flow of products via old components or reverse logistics. Several difficulties were discovered, and e-procurement is recommended as a solution.

A third EI is 3D printing, which promotes recycling through its manufacturing process. In 2018, investigate 3D printing's involvement in CE implementation was investigated. Thus, 3D printing is regarded as a disruptive emerging technology capable of allowing and facilitating the transition to CE by introducing new capabilities and altering the underlying economy of numerous manufacturing sectors. It promotes recycling through product design that extends product life and builds a local supply chain, utilizing economies of scope rather than economies of scale, resulting in significant cost savings.

However, several difficulties could be overcome in the short or medium term. These include economic, technological, social, organizational, and legislative barriers. The most important of these are the current low quality or defects in 3D printed products, for which more significant technological innovation is required, and the low economic attractiveness of storing plastics due to regulation, for which the value generated by the new product made from recycled plastics would have to be increased. All in all, IE will be the means through which the implementation of CE will be possible in the industries. Precisely, the system of products and services, dynamic capabilities, 3D printing, the biography of the product, and software recycling are the main EI for which the CE will be supported.

3.5. The circular economy in SMEs and other enterprises

SMEs account for over 90% of global business, employ 50-60% of the workforce, and are responsible for more than 70% of industrial pollution. These facts highlight the importance of achieving sustainability in SMEs to ensure the sustainability of the entire ecosystem; however, adhering to social and economic objectives makes it difficult for them to maintain their competitiveness, as many social and environmental projects are costly [4], in addition to receiving limited government support. [4] identifies numerous hurdles, benefits, and opportunities for SMEs to embrace CE in their study. Also, it suggests that the industry may accomplish CE by turning linear business activities (take, make, distribute, use, and recover) into circulars (p.2). [25] Identify a series of strategies, internal factors, resources,

capacities, and competencies in each of the five phases that can favor the circular paradigm in SMEs to assist them in determining which combination of the factors mentioned should be used to advance their environmental management.

[23] Investigated SMEs in a circular framework as well. They emphasized the significance of eco-design as the only EI that has a positive impact on the growth of this type of company since it saves energy and material costs owing to better eco-efficient design. However, they added that this would necessitate the investigation of alternate funding sources, such as government subsidies because limited external money is insufficient to support corporate expansion.

In summary, it is imperative to consider small and medium-sized enterprises (SMEs) in implementing circular economy (CE) initiatives, given their significant contribution to employment, their substantial presence in the market, and their impact on environmental damage.

3.6. The need for a change in consumer awareness

Customers play an essential role in the deployment of CE. They are becoming more concerned with where items come from and how businesses work. As a result, companies are being compelled to include CE and sustainability in their business strategies. In this way, environmental knowledge is critical for customer decision-making on sustainable purchase behavior. [22] consumers are eager to pay a premium for sustainable products, but there is a shortage of sufficient and accurate data. They suggest that information about sustainability should be displayed systematically and clearly to encourage the purchasing of greener products. Thus, [11] demonstrates that marketing can influence consumer behavior significantly. Consumers have been trained to believe that what is new is superior. The impact of advertising and media on programmed obsolescence and perceived obsolescence influences individuals to discard products that are still entirely usable. Branding and marketing, on the other hand, can re-educate consumers on the value of items created using a CE process [11]. To summarize, consumers play an essential role in the deployment of CE. As a result, change must begin with them to compel companies to implement more sustainable solutions in their products and services.

3.7. The textile industry: From fast fashion to slow fashion

The textile sector demands special attention because it is one of the world's most polluting industries. One of the primary issues of CE in fashion is the increase in the volume of clothing that winds up in landfills or is burnt, which stems from the industry's core problem: the fast fashion phenomenon or disposable fashion. The rapid production and consumption of clothing has developed a consumer notion that clothing is disposable. By recycling the trash, it is possible to use textile waste as a resource with CE. [26] demonstrated that consumers are eager to recycle existing garments to manufacture new ones. As a result, [17] stated that CE in fashion could only become a reality if garment collection mechanisms and effective sorting methods were in place.

Identifying numerous drivers, difficulties, and opportunities as an alternative to the rapid fashion paradigm. CE, veganism, adopting Corporate Social Responsibility (CSR) through fair trade and free production, shared economy and collaborative consumption, technological innovation, and a shift in consumer awareness were mentioned as drivers.

However, various obstacles stand in the way of the industry's sustainability development. For starters, there are technical difficulties in the product design phase approach. Second, it is difficult to change consumer education, as consumers must be convinced of the benefits of circularity. Third, a shift in customer perceptions of the company's activities and intentions toward sustainability is required. Fourth, it is challenging to align values throughout the supply chain.

4. Conclusion

Finally, for many years, CE has been offered as the solution to humanity's environmental problems. Although it is still in its early stages of implementation, its benefits and drivers, as well as its obstacles and barriers to implementation, have previously been examined. As evidence, the European Union has begun to implement sustainable growth policies that support CE.

The goal was to gather all relevant evidence on CE innovation. The findings indicate that this is a critical component in achieving the circular aims. Thus, collaboration and interest alignment among all enterprises, particularly SMEs, and all sectors, including the textile industry, may aid in achieving this sustainable development. The EI must abandon the current linear economic model in favor of new business models and ways of functioning in supply chains that allow the cycle to be closed and all waste to be exploited. All of the proposals studied, namely the system of products and services, dynamic capabilities, 3D printing, product biography, and software recycling, have already been put into practice to

varying degrees, owing to the growing awareness among businesses and consumers of the importance of participating in the fight against climate change.

Furthermore, it would be interesting to investigate the effects of trade dynamics, including recycling and secondary raw materials, on various macroeconomic variables. Additionally, exploring the influence of the circular economy on social, political, economic, and technical dimensions will contribute to a better understanding of the road towards achieving a circular economy.

The 2035 strategy represents a significant strategic initiative with substantial academic, managerial, and public ramifications for all stakeholders engaged in innovation systems. Its objective is to reduce landfill disposal of municipal waste to 10% or less of the total municipal waste generated within a specific year by 2035 (Zero Waste Europe, 2020). In this context, future research endeavors may examine the effects of this particular strategy across several industrial sectors, both at the organizational level and on a national scale. Additionally, it would be valuable to explore the environmental and economic implications of its implementation. An additional area of inquiry that warrants investigation is the examination of the consequences stemming from the obligatory alterations in manufacturing procedures and environmental regulations.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declared no conflict of interest.

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