DRIVING SUSTAINABLE INNOVATION IN THE TEXTILE INDUSTRY THROUGH CIRCULAR SUPPLY CHAIN MANAGEMENT

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Review paper
UDC: 677+338.1:005.3
DOI: 10.5937/tekstind2402036U

Abstract: *This study explores the integration of circular supply chain management (CSCM) principles within the textile industry to drive sustainable innovation. Through a systematic literature review, this paper aims to dissect the components of CSCM that contribute to sustainability, assess the practical outcomes of circular practices in textile companies, and identify the barriers and enablers affecting CSCM adoption. The research questions focus on understanding the characteristics of circular supply chains in the textile sector, the real-world application and outcomes of these principles, the factors influencing the adoption of circular practices, and the implications for sustainability metrics. This review aims to provide a comprehensive overview of how CSCM can foster environmental, economic, and social sustainability in the textile industry, offering insights for businesses, policymakers, and researchers seeking to promote a more sustainable future.*

Keywords: circular supply chain management, innovation, sustainability, textile industry, circular economy.

PODSTICANJE ODRŽIVOG RAZVOJA I INOVACIJA U TEKSTILNOJ INDUSTRIJI KROZ UPRAVLJANJE CIRKLULARNIM LANCIMA SNABDEVANJA

Apstrakt: *Ovaj literaturni pregled istražuje integraciju principa cirkularnog lanca snabdevanja (CLSN) unutar tekstilne industrije radi podsticanja održive inovacije. Kroz sistematski pregled literature, ovaj rad ima za cilj da razloži komponente CLSN-a koje doprinose održivosti, proceni praktične rezultate cikličnih praksi u tekstilnim kompanijama, i identifikuje prepreke i omogućivače koji utiču na usvajanje CLSN-a. Istraživačka pitanja fokusiraju se na razumevanje karakteristika cikličnih lanaca snabdevanja u tekstilnom sektoru, stvarnu primenu i rezultate ovih principa, faktore koji utiču na usvajanje cikličnih praksi, i implikacije za merenje održivosti. Ovaj pregled ima za cilj da pruži sveobuhvatan pregled kako CLSN može podstaći ekološku, ekonomsku i društvenu održivost u tekstilnoj industriji, nudeći uvide za kompanije, donosioce politika i istraživače koji teže promovisanju održivije budućnosti.*

Ključne reći: upravljanje cirkularnim lancima snabdevanja, inovacija, održivost, tekstilna industrija, cirkularna ekonomija.

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1. INTRODUCTION

The European Commission describes the textile and clothing industry as extensive and multifaceted, involving the production of fibers and their conversion into various textiles for a wide range of products, extending beyond clothing to other industries. In 2016, the industry, employing over 300 million people, was valued at $ 1.3 trillion, with clothing making up 60% of textile usage. The last decade has seen a doubling in production, driven by the expanding middle class, rapid fashion shifts, and increased per capita sales, all of which adversely affect Earth's ecological balance [1].

Fashion trends are evolving rapidly, with today's latest styles soon overtaking and discarding those of yesterday. Consumers skilled in compartmentalizing show no guilt or sense of contradiction in their dual desires. This raises the question: Can luxury fashion, which purportedly values authenticity, craftsmanship, and environmental respect, promote both quality and sustainability simultaneously? [2].

The textile industry stands at a crossroads between economic development and environmental sustainability. As one of the oldest and most globally integrated sectors, it plays a pivotal role in worldwide commerce, employment, and culture. However, the industry is also one of the leading contributors to environmental degradation, marked by excessive water consumption, pollution, and waste generation. In light of these challenges, the concept of sustainable innovation has emerged as a vital strategy to reconcile economic growth with ecological stewardship.

Circular supply chain management represents a transformative approach within this context, aiming to redesign the traditional linear model of "take, make, dispose" into a regenerative loop of "reduce, reuse, recycle". This approach not only addresses the environmental impact but also enhances resource efficiency and creates new economic opportunities. However, despite its potential, the adoption of circular principles in the textile industry is still in its nascent stages, with various barriers and enablers influencing its implementation.

This literature review seeks to explore the interplay between sustainable innovation and circular supply chain management within the textile industry. By synthesizing existing research, case studies, and industry practices, the review aims to shed light on how circular economy principles can drive sustainable innovation, address current challenges, and propose future directions for the industry. The objective is to provide a comprehensive overview that can inform researchers, practitioners, and policymakers about the potential pathways and pitfalls in transitioning towards a more sustainable textile industry.

The paper is structured as follows: after this introduction, the methodology section outlines the criteria and processes used to select and analyze relevant literature. The review results then present a thematic analysis of the findings, highlighting key strategies, outcomes, and gaps in the current body of knowledge. The discussion synthesizes these insights, examining their implications for theory, practice, and policy. Finally, the conclusion reflects on the overarching themes and suggests avenues for future research, aiming to contribute to the ongoing discourse on sustainable development in the textile industry.

As guidelines for research, this paper deals with four main research issues:

RQ1: What are the key components and characteristics of circular supply chain management as applied to the textile industry, and how do they contribute to sustainable innovation?

RQ2: How have textile companies integrated circular economy principles into their supply chains, and what outcomes have been observed?

RQ3: What barriers and enablers influence the adoption of circular supply chain practices in the textile industry?

RQ4: What are the implications of circular supply chain management for sustainability metrics in the textile industry, and how can they be measured and improved?

Four main sections, excluding the introduction and conclusion sections, are included in this paper. Firstly, more detailed explanations are given of the research methodology. The results of the review process will then be presented

2. METHODOLOGY

2.1 Review process

In order to do complete adequate literature review KoBSON and Google Schoolar were used. Search and download of scientific articles on circular supply chain management, supply chain practices in the textile industry, circular economy and sustainable innovation began the review. Subsequently, duplicate articles have been eliminated. In order to identify those articles that deal with the subjects concerned for systematic review, a detailed screening process has been carried out. Literature sources that were deemed not relevant have been ignored.

2.2 Literature eligibility criteria

For the review, consideration has been given to articles published between 2013 and 2023. All articles are published in respected scientific and peer reviewed journals. In these articles, the main topics are as follows:

- Circular supply chain management
- Supply chain practices in the textile industry
- Circular economy
- Sustainable innovation
- Sustainability.

Furthermore, articles involved in the review process are not taken into account, nor are those published in journals engaged in predatory practices. Most scientific journals primarily focus on supply chain, textile industry, innovation, circular economy and sustainability. The reference section for specific literature sources is provided below in section "References".

2.3 Data collection, search and study selection

Initially, articles were sought using Google Scholar. They were then acquired via KoBSON or directly from journal archives, based on their title and abstract if they were accessible. During this process, scrutiny was applied to determine if articles or conferences were labeled as predatory. Articles meeting review criteria were downloaded and stored on the author's personal computer.

Duplicates have been eliminated, and articles were examined. Those not aligned with the review paper's objective were excluded from further consideration. Articles containing data on circular supply chain management, textile industry, circular economy, innovation and sustainability were prioritized. The primary aim of the review is to address four key questions and offer guidance as outlined in the report's introduction.

3. REVIEW RESULTS

3.1 Qualitive analysis

1. CSCM has emerged as a cornerstone for fostering sustainable innovation within the textile industry. This approach, centered around the principles of the circular economy, aims to transform the traditional linear supply chain-characterized by a 'take-make-dispose' model—into a regenerative system that prioritizes the reuse, refurbishment, and recycling of materials and products [3]. CSCM INTRODUCTION AND PRINCIPLES

2. The adoption of CSCM practices within the textile sector has demonstrated significant environmental benefits. Companies that have integrated these circular principles effectively report substantial improvements in resource efficiency. This encompasses more judicious use of raw materials and energy, leading to a notable reduction in the overall environmental footprint of their operations. Moreover, these practices contribute to a substantial decrease in waste generation, aligning with global efforts to mitigate landfill growth and reduce pollution [4]. ENVIRONMENTAL BENEFITS AND RESOURCE EFFICIENCY

3. The implementation of CSCM also fosters improved product lifecycle management. By designing products with their end-of-life in mind, companies can ensure that garments are more easily disassembled, repaired, or recycled, thereby extending their lifecycle and reducing the demand for new resources. This approach not only conserves materials and energy but also opens up new business opportunities, such as product-as-a-service models, which further support sustainability objectives [5]. Technological advancements are shortening product life cycles (PLC), making rapid product development vital for companies' survival. The PLC concept allows for analysis of market influences, sales volumes, and profitability [6]. PRODUCT LIFECYCLE MANAGEMENT AND INNOVATION

4. However, the extent of CSCM implementation varies widely across the industry. Larger, more established firms often lead the way, adopting more comprehensive and integrated circular practices. These companies typically have greater access to financial and technological resources, enabling them to invest in advanced materials recovery processes, sustainable sourcing, and consumer take-back programs. Conversely, smaller firms may struggle to implement CSCM due to limited resources, lack of technical expertise, or constraints in their operational or supply chain capabilities [7]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

5. A critical factor in the success of CSCM adoption is the level of stakeholder engagement. Companies that actively involve suppliers, customers, and other partners in their circular initiatives tend to experience better outcomes. This collaborative approach helps ensure that all elements of the supply chain are aligned with circular principles, from the sourcing of sustainable materials to the end-of-life management of products [8]. STAKEHOLDER ENGAGEMENT AND SUPPLY CHAIN TRANSPARENCY

6. Transparency within the supply chain processes is another key element linked to successful CSCM integration. Companies that maintain open communication channels and share information freely with stakeholders can build trust and foster cooperative efforts towards sustainability goals. This transparency is often facilitated by technological tools such as blockchain, which can provide a secure and immutable record of the origin, movement, and disposal of materials and products [9]. STAKEHOLDER ENGAGEMENT AND SUPPLY CHAIN TRANSPARENCY

7. CSCM in the textile industry presents a pathway to significant environmental and economic benefits, its success is contingent upon a variety of factors. These include the scale of implementation, the level of stakeholder engagement, and the transparency of supply chain processes. Addressing these factors effectively can help overcome barriers to CSCM adoption and drive more widespread and impactful sustainable innovation in the industry [10]. ENVIRONMENTAL BENEFITS AND RESOURCE EFFICIENCY

8. Implementing CSCM practices often requires significant upfront investment. This includes costs associated with acquiring new technologies for recycling, redesigning products for easier disassembly, and developing more sustainable supply chains. These initial costs can be particularly prohibitive for smaller firms or those with tight budgets, making the shift towards circular practices challenging [11]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

9. Consumer demand plays a crucial role in driving industry practices. Currently, there is a lack of widespread awareness and understanding among consumers regarding the benefits of circular textiles. This translates to less market demand for sustainably produced or circular products, thereby reducing the incentive for companies to invest in CSCM practices. Additionally, consumers may not be aware of how to properly return or recycle textile products, which further undermines the effectiveness of circular systems [12]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

10. While some regions have started to introduce policies aimed at promoting sustainability in the textile industry, overall, regulatory incentives remain insufficient globally. Without stringent regulations or incentives to adopt sustainable practices, companies may not feel compelled to shift away from the conventional linear model. Effective policy measures, such as tax breaks, subsidies for sustainable practices, or penalties for excessive waste, are crucial for encouraging more businesses to adopt CSCM [13]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

11. The textile industry features highly complex and globalized supply chains, involving numerous stages from raw material extraction to garment production and distribution. This complexity poses significant challenges in tracking and managing the lifecycle of materials, which is a fundamental aspect of CSCM. Ensuring transparency and accountability at every stage of the supply chain requires concerted efforts and collaboration among all stakeholders, which can be difficult to achieve [14]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

12. Smaller enterprises, in particular, face challenges in accessing the capital needed to invest in sustainable technologies and practices. This is compounded by a lack of access to the necessary technological resources and expertise required to implement CSCM effectively. Smaller firms may also struggle to engage with larger supply chain actors, making it harder to integrate into sustainable networks or access sustainable materials and processes [15]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

13. Inherent resistance to change within the industry can also be a significant barrier. This can stem from a lack of knowledge about circular practices, uncertainty regarding the return on investment, or a preference for sticking with established, linear business models. Overcoming this resistance requires education, demonstration of the economic benefits of CSCM, and leadership committed to sustainable practices [16]. CHALLENGES AND BARRIERS TO CSCM IMPLEMENTATION

14. Fast paced technological advancements play crucial role in enabling CSCM. Blockchain technology, for instance, offers a transparent and secure way to track the lifecycle of textiles from production through to recycling or disposal. This can help verify the sustainability credentials of products and processes, enhancing consumer trust. The Internet of Things (IoT), on the other hand, allows for real-time tracking and management of resources, reducing waste and improving efficiency. Innovations in material science, such as the development of more easily recyclable or biodegradable fabrics, also support the shift towards circular models by addressing the issue of textile waste at its source [17]. TECHNOLOGICAL AND POLICY ENABLERS

15. Government policies and regulations are critical in shaping the business environment and encouraging the adoption of CSCM. Policies that impose stricter regulations on waste and pollution can drive companies to

adopt circular practices to comply with legal standards. Conversely, incentives such as tax breaks, subsidies, or grants for companies engaging in sustainable practices can provide a financial boost that helps offset the initial costs of transitioning to CSCM. Additionally, government-led initiatives or standards for sustainability in the textile industry can set a clear benchmark, guiding companies in their circular journey [18]. TECHNOLOGICAL AND POLICY ENABLERS

16. Increasing consumer awareness and demand for sustainable and ethical fashion significantly drive the adoption of CSCM. As consumers become more conscious of the environmental and social impacts of their purchases, they are more likely to seek out and prefer brands that align with their values. This shift in consumer behavior encourages companies to adopt circular practices not only as a moral imperative but also as a competitive advantage in the market [19]. Implementing quality management systems lowers manufacturing costs and leads to better-quality products, which attract customers and promote positive word-of-mouth. As consumer awareness about environmental protection grows, companies are increasingly promoting their products or services with environmental labels. The term "environmentally friendly" describes goods, services, legislation, guidelines, and policies that purportedly have little to no environmental impact. The clothing industry, a fundamental aspect of daily life, is seeing a rising relevance of environmental or green considerations within the textile sector [20]. Additionally, the reduced costs allow for competitive pricing, offering customers greater value at lower prices than competitors. Thus, quality significantly influences business performance and competitiveness [21]. CONSUMER DEMAND AND MARKET DYNAMICS

17. The complexity of textile supply chains means that no single company can transition to a circular model in isolation. Collaborations across the industry, including partnerships between manufacturers, suppliers, designers, recyclers, and even competitors, can facilitate the sharing of resources, knowledge, and best practices. Collaborative initiatives can lead to the development of shared standards and processes that make it easier for the entire industry to move towards circularity. Furthermore, partnerships with governments, NGOs, and academic institutions can provide additional support and resources for companies looking to adopt CSCM practices [22]. Merging companies has emerged as a novel strategy for achieving competitive advantages in the global market. Small and medium-sized enterprises (SMEs) are crucial for economic development across all market economies. Given that SMEs often operate with limited resources, their management practices are distinctively unique. In situations where resources are constrained, the management of small and medium-sized enterprises becomes particularly critical [23]. COLLABORATION AND PARTNERSHIPS

18. Access to finance and technical expertise is a crucial enabler for many companies, particularly small and medium-sized enterprises (SMEs), looking to transition to CSCM. Financial support, whether through loans, grants, or investment, can help businesses overcome the initial barrier of high setup costs. Technical support, on the other hand, can come in the form of guidance, training, or access to technology, helping companies to implement circular practices effectively and efficiently [24]. ECONOMIC BENEFITS AND MARKET OPPORTUNITIES

19. The adoption of Circular Supply Chain Management (CSCM) practices within the textile industry has been instrumental in advancing sustainability metrics. These practices lead to considerable reductions in water and energy consumption, which are critical in a sector known for its intensive resource use. By implementing water recycling systems, energy-efficient processes, and more sustainable raw materials, companies can significantly diminish their environmental impact [25]. ENVIRONMENTAL BENEFITS AND RESOURCE EFFICIENCY

20. Furthermore, CSCM contributes to lowering carbon footprints. By optimizing logistics, reducing material waste, and leveraging renewable energy sources, textile companies can mitigate their greenhouse gas emissions, aligning more closely with global climate targets. The reduction of textile waste is another significant outcome, as CSCM encourages the reuse, refurbishment, and recycling of materials, thereby extending product lifespans and minimizing landfill contributions [26]. The global economy has faced stagnation and crisis due to the rapid consumption of natural resources beyond their regeneration capacity, causing ecological strain, environmental damage, and reduced quality of life. The Green Economy concept aims to address these socio-economic issues, promoting a swift transition towards sustainable development. However, implementing this concept, especially in less developed countries, presents significant challenges [27]. ENVIRONMENTAL BENEFITS AND RESOURCE EFFICIENCY

21. Despite these positive outcomes, accurately measuring the full impact of CSCM practices presents challenges. The lack of standardized sustainability metrics across the textile industry complicates efforts to quantify improvements comprehensively.

Additionally, inconsistent data collection and reporting methods can hinder the evaluation of CSCM's effectiveness. Establishing universal, industry-wide sustainability metrics and improving data collection methodologies are essential steps toward addressing these challenges [28]. MEASUREMENT AND STANDARDIZATION CHALLENGES

22. Moreover, companies embracing circular practices often experience economic benefits alongside environmental gains. Cost savings arise from reduced material and energy expenses, lower waste disposal fees, and minimized water usage. Efficient resource utilization and the minimization of waste contribute to these savings, improving the overall financial health of adopting companies [29]. ECONOMIC BENEFITS AND MARKET OPPORTUNITIES

23. Furthermore, CSCM opens up new market opportunities. Consumer demand for sustainable and ethically produced textiles is growing, and companies that can demonstrate genuine circular practices gain a competitive edge. This consumer interest can translate into higher sales, increased brand loyalty, and access to new markets focused on sustainability. Additionally, circular business models, such as product leasing or take-back schemes, offer novel revenue streams and business opportunities [30]. ECONOMIC BENEFITS AND MARKET OPPORTUNITIES

24. Industry 5.0 emphasizes the importance of catering to individual customer needs and preferences. In the textile industry, this can lead to more demand-driven production models, reducing overproduction and waste. CSCM complements this by enabling the return and reuse of products, thus closing the loop and minimizing waste, which aligns with personalized consumption and production trends [31]. INDUSTRY 5.0 IN CSCM

25. One of the core pillars of Industry 5.0 is enhancing sustainability and focusing on human well-being. CSCM in the textile industry embraces these values by promoting eco-friendly materials, ethical labor practices, and waste reduction. By integrating CSCM principles, the textile industry can move towards a more sustainable model that prioritizes environmental health and social equity, resonating with the goals of Industry 5.0[32]. INDUSTRY 5.0 IN CSCM

26. Industry 5.0 leverages advanced technologies such as AI, IoT, and robotics, not just for efficiency but also for enhancing sustainability and human-machine collaboration. In the context of the textile industry, these technologies can optimize resource use, improve recycling processes, and enable better tracking and tracing of materials throughout the supply chain. CSCM benefits from these technological advancements, leading to more transparent, efficient, and circular supply chains[33]. INDUSTRY 5.0 IN CSCM

27. Industry 5.0 promotes collaboration between different stakeholders, including businesses, consumers, and governments. This collaborative approach is essential for CSCM, as it requires coordination across the entire supply chain—from raw material suppliers to retailers and consumers. By fostering a collaborative ecosystem, Industry 5.0 can enhance the implementation of circular practices in the textile industry. Industry 5.0 encourages innovation that leads to new business models and economic opportunities. In the textile industry, this can manifest as innovative circular business models, such as clothing-as-a-service, that challenge traditional consumption patterns. CSCM supports this innovation by providing the framework for reducing waste, extending product lifecycles, and creating value from used textiles [34]. INDUSTRY 5.0 IN CSCM

28. For textile and clothing companies, prioritizing sustainability in their supply chains is crucial. Strategies for achieving sustainable supply chain management in these sectors involve sustainable product strategies, investments, performance evaluations, corporate social responsibility, and implementing environmental management systems [35]. SUSTAINABLE INNOVATION IN TEXTILE INDUSTRY

29. The textile industry, characterized by its extensive supply chain from the procurement of raw materials to the production and distribution of clothing, is a significant contributor to pollution and waste. As sustainable development gains traction, there is a pressing need for companies to adhere to environmental standards within the clothing supply chain to maintain their brand reputation and remain competitive. However, the challenge lies in balancing cost reduction, decreasing production and distribution times, and adapting to fast-evolving fashion trends in an unpredictable market [36]. SUSTAINABLE INNOVATION IN TEXTILE INDUSTRY

30. The textile sector is considered one of the most challenging industries to integrate sustainability into its operational practices. Various sustainability innovation practices within the textile industry have been recognized. Product innovations for sustainability encompass eco-design, eco-labeling, life cycle assessments, as well as innovations in materials and packaging. In terms of process innovation, practices include adopting cleaner production methods, enhancing eco-efficiency, managing waste effectively, implementing sustainable supply chain management, and utilizing

enzymatic processes in textile manufacturing [37]. SUSTAINABLE INNOVATION IN TEXTILE INDUSTRY

31. The textile industry was at the forefront of the industrial revolution, significantly influencing the economic and political landscapes globally for an extended period. This chapter delves into the critical role of innovation-focused research and development in the sustainable advancement of the textile and clothing sector. It explores the concept of innovation, reviews major innovations within the industry over the past six decades, and examines the unparalleled scientific and technological progress made during this era. [38]. The clear conflict between fashion culture and sustainability highlights significant challenges for the clothing industry. Public comprehension is vital for the success of strategies aimed at steering the industry towards a more sustainable path. Consumer studies reveal that while some consumers are knowledgeable and worried about sustainability issues, others exhibit little interest in sustainable fashion practices [39]. SUSTAINABLE INNOVATION IN TEXTILE INDUSTRY

32. The textile industry has notable environmental impacts throughout the lifecycle of its products. This chapter outlines strategic approaches to enhance environmentally sustainable consumption and production within the sector. Specifically, it concentrates on five phases of environmental sustainability: materials, manufacturing, retail, consumption, and disposal. Key concepts such as corporate social responsibility, green supply chain management, and eco-design are proposed as essential for fostering environmentally sustainable business practices. Accent is on the importance of collaboration among all stakeholders in the textile industry, including consumers, manufacturers, supply chain actors, and retailers, to foster environmental protection in the production and consumption of textile products [40]. The significance of green innovation management has grown both practically and academically [41]. SUSTAINABLE INNOVATION IN TEXTILE INDUSTRY

Furthermore, in Table 1. a concise overview of the analyzed studies is presented.

3.2 Developed model

Based on the thorough literature analysis a model for improving sustainable innovation in textile industry through circular supply chain is presented in the Figure 1. below.

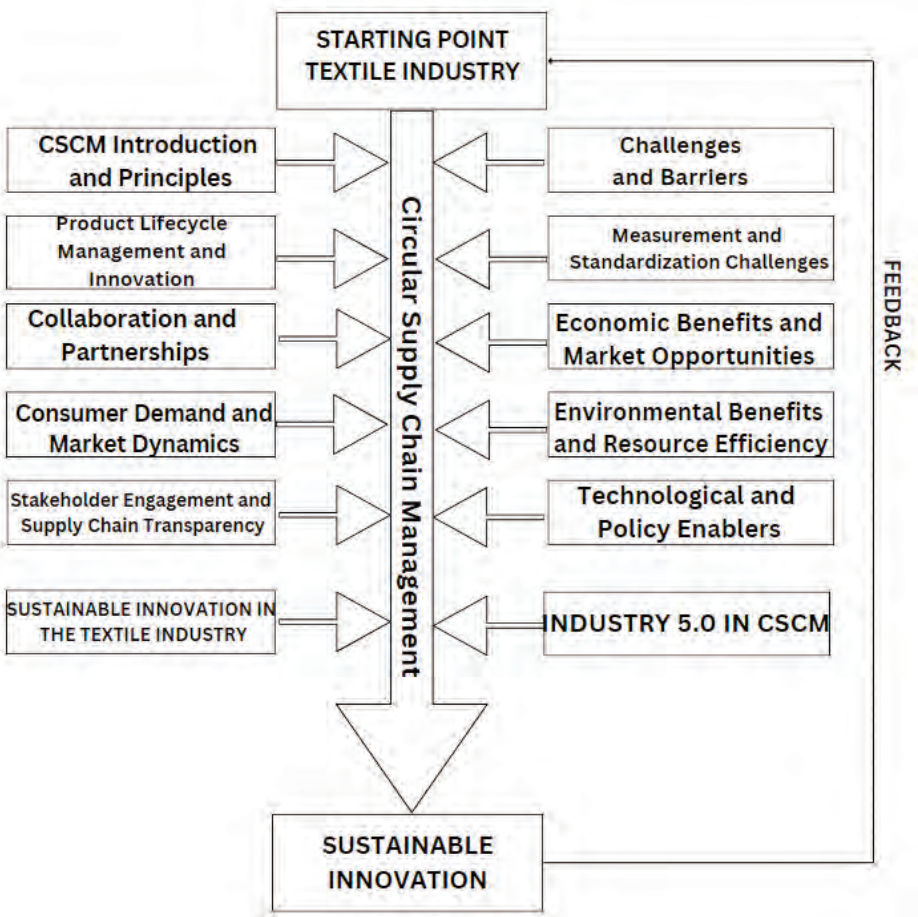

Figure 1: Circular Supply Chain Management

Table 1. Literature overview

Category	Author	Year Published	Description
CSCM Introduction and Principles	Khompatraporn	2021	INNOVATION
Environmental Benefits and Resource Efficiency	Niinimäki, K., et al. França, C. L., et al. Lieder, M., & Rashid, A. Li, X., et al.	2020 2017 2016 2021	ENVIRONMENTAL FOOTPRINT SUSTAINABILITY METRICS REDUCING MATERIAL WASTE REDUCING WASTE IN TEXTILE INDUSTRY
Product Lifecycle Management and Innovation	Demarcq, B., et al. Vorkapić, M., et al	2022 2017	CIRCULAR PRODUCT DESIGN PLC
Challenges and Barriers to CSCM Implementation	Masi, D., et al. Kirchherr, J., et al. Fletcher, K., et al Govindan, K., & Hasanagic, M. Winter, S., & Knemeyer, A. M. Bocken, N. M., et al. Lüdeke-Freund, F., et al.	2017 2017 2018 2018 2018 2016 2019	CHALLENGES FOR CSCM IMPLEMENTATION UPFRONT INVESTMENT CONSUMER DEMAND PROMOTING SUSTAINABILITY IN THE TEXTILE INDUSTRY TRANSPARENCY AND ACCOUNTABILITY CHALLENGES IN ACCESSING CAPITAL
Stakeholder Engagement and Supply Chain Transparency	Menke, C., et al. Saberi, S., et al.	2021 2019	STAKEHOLDER ENGAGEMENT COMMUNICATION CHANNELS
Economic Benefits and Market Opportunities	Bocken, N. P., et al. Pieroni, M. P., et al.	2014 2019	RESOURCE UTILIZATION MARKET OPPORTUNITIES
Technological and Policy Enablers	Ailane, A., et al. Rizos, V., et al.	2014 2016	BLOCKCHAIN TECHNOLOGY GOVERNMENT POLICIES AND REGULATIONS
Consumer Demand and Market Dynamics	Davé, D., et al. Bakator, M., et al. Eryuuk, H,. et al.	2018 2019 2012	CONSUMER AWARENESS QMS ECO FRIENDLY
Collaboration and Partnerships	Zhuravleva & Aminoff Đorđević, D., et al.	2021 2011	PARTNERSHIPS SME
Industry 5.0 in CSCM	Yang, Q., et al. Juzer & Sri Darma Pal & Yasar Santos, L., et al.	2023 2019 2020 2020	INDIVIDUAL CUSTOMER NEEDS AND PREFERENCES GOALS OF INDUSTRY 5.0 IoT,AI AND ROBOTICS ENHACMENT
Sustainable innovation in textile industry	Shen, B., et al. Negrete & López Harsanto, B., et al. Lee, K., et al. Schiederi, T., et al.	2017 2020 2023 2017 2012	RESPONSIBILITY ENVIRONMENTAL STANDARDS ECO FRIENDLY FIVE PHASES OF ENVIRONMENTAL SUSTAINABILITY GREEN INNOVATION
Measurement and Standardization Challenges	Genovese, A., et al	2017	STANDARDIZATION

This model visually represents the integration of Circular Supply Chain Management (CSCM) within the textile industry, emphasizing its role in driving sustainable innovation. Here's a breakdown of its components and their significance.

Circular Supply Chain Management positioned at the center, it highlights CSCM as the core mechanism through which the textile industry can achieve sustainability. It represents the overarching strategy that encompasses various practices and principles aimed at minimizing waste, maximizing resource efficiency, and creating a regenerative loop within the supply chain. The model outlines key components of CSCM on the left side and outcomes/enablers on the right, showing a balanced approach to implementing CSCM in the textile industry.

On the left side of the presented model we can see fundamentals of CSCM, emphasizing the shift from a linear to a circular model. This foundational aspect emphasizes transitioning from a linear "take-make-dispose" model to a circular one, where waste is minimized, and resources are reused or recycled. Rethinking the entire lifecycle of textile products from design to disposal, with a view to ensuring that each phase is consistent with sustainability principles. Focus is mostly on designing products for longevity, recyclability, and minimal environmental impact. It also encompasses the development of new services, such as leasing or take-back schemes, to encourage prolonged use and value retention. Collaboration and partnerships highlights the necessity of collaborative efforts across the entire supply chain, including suppliers, manufacturers, retailers, consumers, and recycling entities. Successful CSCM requires a collective approach, where shared values and goals drive the adoption of circular practices. It also involves engaging with policymakers, NGOs, and industry groups to foster an enabling environment.

On the right side of the model we can see different outcomes and enablers. We must acknowledge the obstacles to implementing CSCM, such as high initial costs, technological limitations, and resistance to change. It recognizes that overcoming these challenges is essential for the successful integration of circular principles in the textile industry. We can also face the problem in addressing the difficulties in quantifying the impact of CSCM practices and the lack of standardized metrics for sustainability. This component emphasizes the need for industry-wide benchmarks and methodologies to accurately assess and communicate the benefits of CSCM. It is of utmost importance to highlight the potential economic advantages of adopting CSCM, including cost savings from resource efficiency, revenue from new circular business models, and competitive differentiation in the marketplace. It also points to the opportunity to tap into growing consumer segments that value sustainability. Outcome of implementation of circular supply chain can be seen in positive environmental outcomes such as reduced resource consumption, lower greenhouse gas emissions, and decreased waste generation. It underscores the contribution of CSCM to broader environmental goals, like mitigating climate change and preserving natural ecosystems.

Sustainable Innovation is the end goal. Positioned at the bottom, it indicates that the ultimate goal of integrating CSCM in the textile industry is to achieve sustainable innovation. This involves creating new products, processes, and business models that not only generate economic value but also protect the environment and society.

At the end we have feedback loop. It suggests that the process is iterative. Implementing CSCM practices lead to continuous improvements, adjustments, and innovations in response to challenges, stakeholder feedback, and evolving market demands.

4. DISCUSSION

The four research questions (RQs) serve as a structural backbone for the literature review, guiding the exploration of Circular Supply Chain Management (CSCM) within the textile industry and its contribution to sustainable innovation. Their impact on the literature review is profound, as they direct the thematic analysis of existing research, case studies, and industry practices. Each question opens up a critical area of inquiry, allowing the review to dissect the multifaceted nature of CSCM and its implications. Here's how each RQ contributes to the literature review and the broader understanding of CSCM in the textile industry:

RQ1: What are the key components and characteristics of circular supply chain management as applied to the textile industry, and how do they contribute to sustainable innovation? This question lays the foundation for understanding CSCM by identifying its essential elements and how they foster sustainability. It helps structure the literature review around the core principles of circularity, such as waste minimization, resource efficiency, and the lifecycle approach to product design. By dissecting these components, the literature review illuminates how CSCM differs from traditional supply chain management, providing a theoretical framework that underpins the entire discussion on sustainable innovation.

RQ2: How have textile companies integrated circular economy principles into their supply chains, and what outcomes have been observed? In addressing the second research question, the analysis shows that companies integrating circular economy principles into their supply chains witness notable environmental and economic benefits. This integration, as depicted in the model, fosters improved product lifecycle management and innovation. However, the extent of implementation varies significantly across the industry, with larger firms often leading the way due to their better access to financial and technological resources. This disparity underscores the need for broader industry collaboration and stakeholder engagement to ensure more widespread adoption of CSCM practices.

RQ3: What barriers and enablers influence the adoption of circular supply chain practices in the textile industry? The third research question explores the barriers and enablers affecting the adoption of CSCM in the textile industry. The discussion acknowledges the challenges highlighted in the model, such as high upfront costs, technological limitations, and resistance to change. At the same time, it emphasizes the critical role of technological and policy enablers in facilitating this transition. Innovations like blockchain and IoT, alongside supportive government policies and regulations, are identified as key drivers that can overcome these barriers, underscoring the necessity for a conducive regulatory and technological ecosystem for CSCM to thrive.

RQ4: What are the implications of circular supply chain management for sustainability metrics in the textile industry, and how can they be measured and improved? Finally, the fourth research question examines the implications of CSCM for sustainability metrics within the textile industry. Despite the positive environmental and economic outcomes of CSCM practices, the model points to significant challenges in measuring the full impact due to the lack of standardized metrics and comprehensive data. This discussion stresses the importance of developing universal, industry-wide sustainability metrics to accurately assess and communicate the benefits of CSCM. It calls for concerted efforts to improve data collection methodologies and establish clear benchmarks for sustainability in the textile industry.

5. CONCLUSION

This study embarked on a journey to uncover the intricacies of integrating CSCM in the textile industry, motivated by the pressing need for sustainable innovation in one of the world's oldest and most impactful sectors. Through a systematic literature review, we dissected the components of CSCM, examined the practical outcomes of circular practices in textile companies, and identified the barriers and enablers influencing CSCM adoption. Our investigation was guided by four research questions, each contributing to a comprehensive understanding of how CSCM can foster environmental, economic, and social sustainability.

CSCM emerges as a transformative approach, shifting from a linear to a circular model. It underscores the importance of redesigning the supply chain to prioritize reuse, refurbishment, and recycling, thereby contributing significantly to sustainable innovation. He integration of CSCM in the textile industry has demonstrated notable environmental and economic benefits. It underscores the potential of circular practices to reduce waste, enhance resource efficiency, and open new business opportunities, despite varying degrees of implementation across the sector. The adoption of CSCM is influenced by a range of barriers, including technological limitations, high upfront costs, and resistance to change. Conversely, technological advancements, supportive policies, and consumer demand for sustainable products emerge as key enablers, highlighting areas for strategic focus to overcome these challenges. The study highlights the need for standardized sustainability metrics and methodologies to accurately assess and communicate the impacts of CSCM. This is crucial for tracking progress, demonstrating value, and informing circular strategies in the textile industry.

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Primljeno/Received on: 03.04.2024.
Revidirano/ Revised on: 24.05.2024.
Prihvaćeno/Accepted on: 26.05.2024.