Kumara, C.H., Mallawaarachchi, H. and Jayakodi, J.A.D.K.S., 2025. Moving from linear to circular apparel economy in Sri Lanka: PRISMA-based analysis of circular economy and supply chain interactions. In: Waidyasekara, K.G.A.S., Jayasena, H.S., Wimalaratne, P.L.I. and Tennakoon, G.A. (eds). *Proceedings of the 13th World Construction Symposium*, 15-16 August 2025, Sri Lanka. pp. 1030-1042. DOI: https://doi.org/10.31705/WCS.2025.77. Available from: https://ciobwcs.com/papers/

MOVING FROM LINEAR TO CIRCULAR APPAREL ECONOMY IN SRI LANKA: PRISMA-BASED ANALYSIS OF CIRCULAR ECONOMY AND SUPPLY CHAIN INTERACTIONS

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ABSTRACT

The apparel industry is one of the largest and most resource-intensive industries in the world in terms of the resources necessary for the production process, as well as energy consumption, waste and carbon emissions. Circular economy (CE) can be considered as one of the critical success factors for developing the closed-loop supply chain. However, limited research that examines the applicability of CE to the apparel industry, this study aimed to address this gap by exploring the interactions between CE and apparel supply chain through PRISMA-based analysis of key literature. The systematic literature review procedure was adopted in this study, and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines were followed as the methodological basis. A total of 116 articles were included in the review and Scopus-based tools, VOSviewer, R-studio and Biblioshiny software were used for the bibliometric mapping. The results reveals that the number of journal publications has been increased throughout the past decade, and the "Journal of Cleaner Production" has emerged as the prominent journal in this research domain. Next, the interactions between CE and the apparel supply chain were reviewed as key implication of the research. Accordingly, this paper provides a comprehensive synthesis of existing literature on the interaction of circular economy and apparel supply chain and serves as a basis for future research in this field. Since this research is a primary step of a research project, a closed-loop apparel supply chain model will be developed as a way forward.

Keywords: *Apparel Industry; Circular Economy; Interactions; Supply Chain.*

1. INTRODUCTION

The apparel industry is one of the largest and most resource-intensive industries in the world in terms of the resources necessary for the production process, as well as energy consumption, water pollution and waste production (Gönlügür, 2019). Over the past few years, the industry has undergone significant shifts, which have developed due to the

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forthcoming of technology, globalization and transforming consumer trends (Lund et al., 2019). Due to increased awareness of people across the world on the effects of industrialization on the environment and people, there has been increasing emphasis on sustainability in the Apparel industry (Toprak & Anis, 2017). According to Payne (2015) A closed loop supply chain is therefore a concept whereby a product is taken throughout its life cycle from its manufacture until the materials used in its manufacture are reclaimed or recycled. This aimed at making the waste circulation to be in a closed-loop cycle system, hence reducing the utilization of virgin materials and having a lowered negative impact on the environment. Thus, necessary to note that a closed-loop supply chain in the apparel industry could greatly support the responsibility for minimizing net carbon emissions (Mishra et al., 2020).

According to Moktadir et al. (2020) the CE principles can be considered as one of the critical success factors for developing the closed-loop supply chain in the apparel industry. The circular economy is a concept that is aimed towards the reduction of wastage and more so the endless reuse of resources (Moktadir et al., 2020). In a circular economy, the products are developed for a long life, and the materials are kept in use for as long as possible by processes like recycling, remanufacturing, and refurbishing (Bakker et al., 2021). In the case of the Sri Lankan apparel sector, implementing circular economy within a closed-loop supply chain can be associated with significant environmental advantage. The integration of a closed-loop supply chain model in the Sri Lankan apparel industry offers a chance to contribute towards net-zero carbon emission and improves the sector's sustainability (Lakmali et al., 2020). Although there are issues and problems with the practical application of this model, the advantages of making changes for the better are huge and include improvement in such aspects as environmental preservation, economic efficiency, and customer desire (Gowsiga & Thayaparan, 2020). Apparently, there is a research gap concerning the methodology of managing the apparel supply chain with an aim of enabling the shift towards the circular economy. Current research has examined closed-loop systems mostly from the environmental perspective and some fundamental concepts of the CE (Manage & Dissanayake, 2021). Still, there is limited research that examines the applicability of CE for apparel supply chain. Therefore, this research aimed to address these gaps by exploring how the circular economy can be applied and implemented in apparel supply chain. Thus, as the initial step, the study presented in this paper sets outs to explore the interactions between CE and apparel supply chain through PRISMA-based analysis of key literature. Accordingly, two objectives are formulated as follows: (i) To review the evolution of publications, prominent journals, and authors who have made the most publications on the intersections of CE and apparel supply chain, and (ii) To recognise different interactions between CE and apparel supply chain.

2. LITERATURE REVIEW

2.1 THE CONCEPT OF CIRCULAR ECONOMY

CE is a regenerative system, with the intention of closing material loops by reducing resource use and the generation of waste. It supplants the conventional model 'take-make-dispose' with another model. Geissdoerfer et al. (2017) define the concept of CE as "an economic system that is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times,

distinguishing it from the traditional linear economy". Indeed, CE is intrinsic to reshaping the operational dynamics of industries by incorporating resource recovery and extending product life cycles. Nguyễn et al. (2023) highlighted the role of CE in promoting ideas of Corporate Social Responsibility (CSR) for corporate environmental management and supply chain development. Further to the authors, the conception of CE highlights the ecological and economic aspects of resilient supply chains. The principles of CE focus on creating sustainable systems that align economic activities with environmental conservation. Designing out waste and pollution, keeping products and materials in use and regenerating natural systems are the key circular economy principles according to Abdelmeguid et al. (2022). Designing out waste refers to reducing waste generation by innovating designs that promote reuse and recycling (Islam et al., 2020). Material in use can be considered as maximising resource utility by extending the lifespan of products through repair, refurbishment, and recycling (Wilson, 2022), while Regeneration of natural systems ensures industrial practices contribute to replenishing ecosystems and natural resources (Gazzola et al., 2020). These principles collectively foster a circular framework where industries, including apparel, move towards sustainability. Todeschini et al. (2017) highlighted in their study how these principles pave the way for innovative business models, offering economic opportunities and reducing environmental footprints. However, the application of circular economy in apparel industry still remains limited due to several reasons such as limited stakeholder engagement, policy and regulatory barriers (van Eeden et al., 2019; Fobbe & Hilletofth, 2022; Chhimwal et al., 2021).

2.2 CIRCULAR ECONOMY AND APPAREL SUPPLY CHAIN

Integrating circular economy practices into the apparel supply chain leads to numerous advantages, including cost saving, reducing the dependency on raw materials, maximising resource usage through material recovery processes and reducing environmental impact (Gazzola et al., 2020; Sudusinghe & Seuring, 2020; Dissanayake & Weerasinghe, 2020; Gebhardt et al., 2022). Further, Su et al. (2023), noted that the CE implementation in supply chain meant that there were low greenhouse gas emissions as it aimed at managing material flow much better and also reducing landfill waste. Over the last couple of decades, the Sri Lankan apparel industry being one of the largest export markets around the globe there is a growing trend to implements CE practices in the country (Manage & Dissanayake, 2021). Efforts to recycle, use environmentally friendly products in production processes, and encourage change in consumer practices are pushing manufacturers towards compliance with international benchmark sustainability. Collaborative consumption models, as explored by Chowdhury et al. (2022), emphasise shared usage of resources and align seamlessly with CE principles to reduce the overall carbon footprint in apparel supply chains.

3. RESEARCH METHODOLOGY

The systematic literature review procedure was adopted in this study to explore the prominent literature related to the circular economy, apparel supply chain and their interactions. As claimed by (Denyer & Tranfield, 2009), the systematic review is a structured approach to identifying existing literature, synthesising data and presenting findings on established knowledge and gaps in a particular research domain. Accordingly, the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA)

guidelines were followed as the methodological basis in this systematic literature review (SLR). Figure 01 illustrates the PRISMA guideline-based SLR procedure graphically.

Initially, a literature search was conducted in the Scopus database to identify the key publications related to the circular economy and apparel supply chain. In this regard, the search was limited to titles, keywords, and abstracts and the used search string was: (TITLE-ABS-KEY ("circular economy" OR "closed-loop economy") AND TITLE-ABS-KEY ("apparel" OR "fashion industry" OR "textile industry" OR "garment sector" OR "clothing industry") AND TITLE-ABS-KEY ("supply chain" OR "value chain")). From the initial search, the Scopus database identified 278 articles. Out of these, 03 articles were excluded due to duplication. Subsequently, article screening was conducted in two phases.

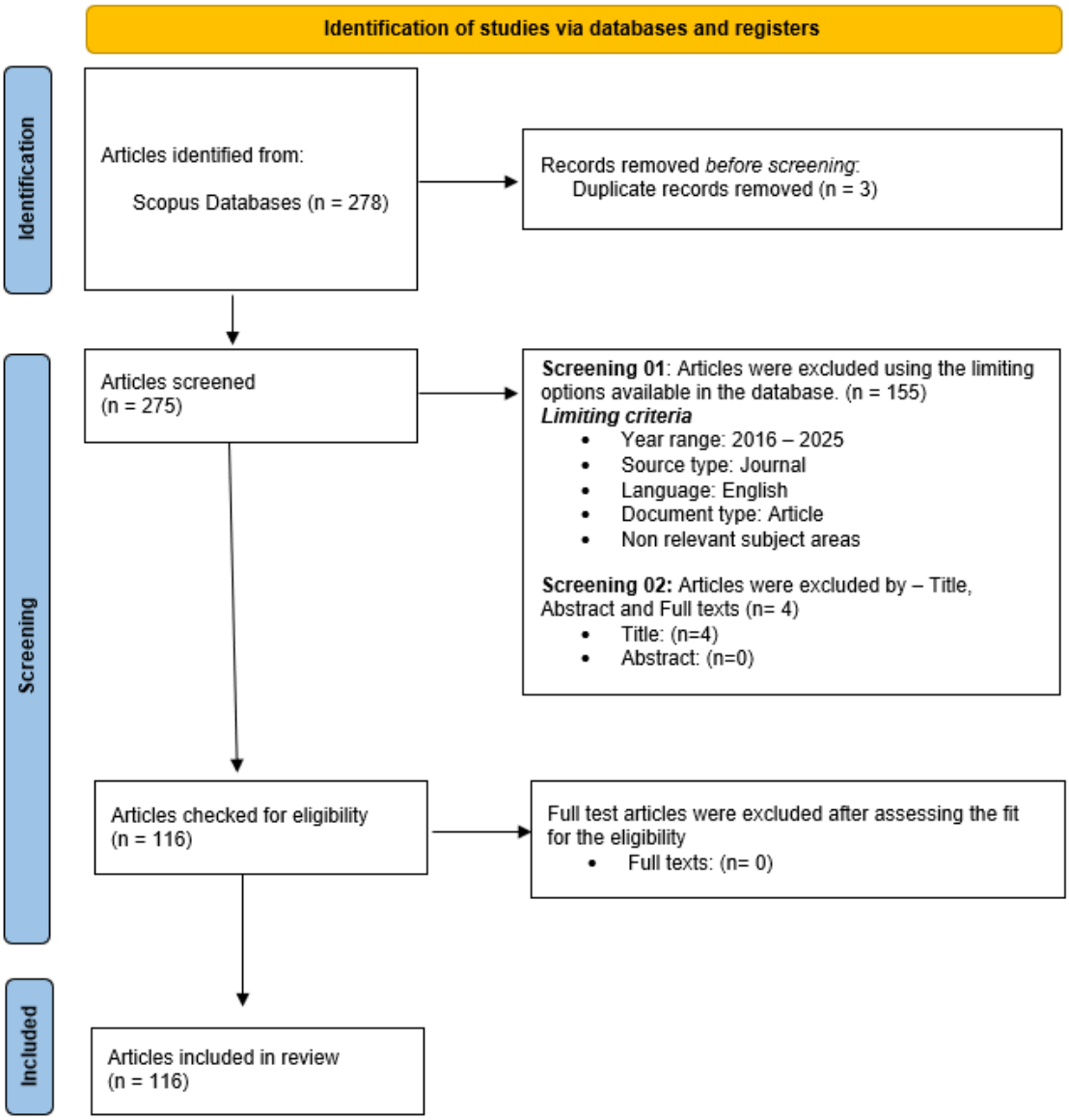

Figure 1: PRISMA guideline-based SLR procedure

In Screening 01, the articles were screened by several restricting criteria in the database as: year range: 2016 – 2025; Source type: Journals; Document type: Articles; Language:

English. Further, excluded subject areas were Earth and Planetary sciences, Computer science, Physics and Astronomy, Agriculture and Biological science, Biochemistry, Genetics and Molecular biology, Medicine, Immunology and Microbiology and Health professions and articles were excluded based on the title and abstract in the second screening phase. Subsequently, 120 articles were selected for assessing the eligibility. Subsequently, articles were further screened by reviewing the title and abstract, and 4 articles were excluded. Accordingly, 116 articles were selected to check the eligibility. Subsequently, the articles were further assessed for eligibility by reviewing the full text and no articles were excluded; a total of 116 articles were included in the review.

As the next step, articles were analysed in terms of the evolution of the number of publications, leading journals, leading countries, leading authors, co-occurrence of keywords and thematic map. In this regard, Scopus-based tools, VOSviewer, R-studio and Biblioshiny software were used for the bibliometric mapping.

4. KEY RESEARCH FINDINGS

This section discusses the key research findings gained through the systematic review under two major areas: (i) Outcomes of bibliometric analysis, and (ii) Circular economy and supply chain interactions in the apparel industry.

4.1 OUTCOMES OF THE BIBLIOMETRIC ANALYSIS

4.1.1 Evolution of the number of Journal Articles Published on Circular Economy and Apparel Supply Chain

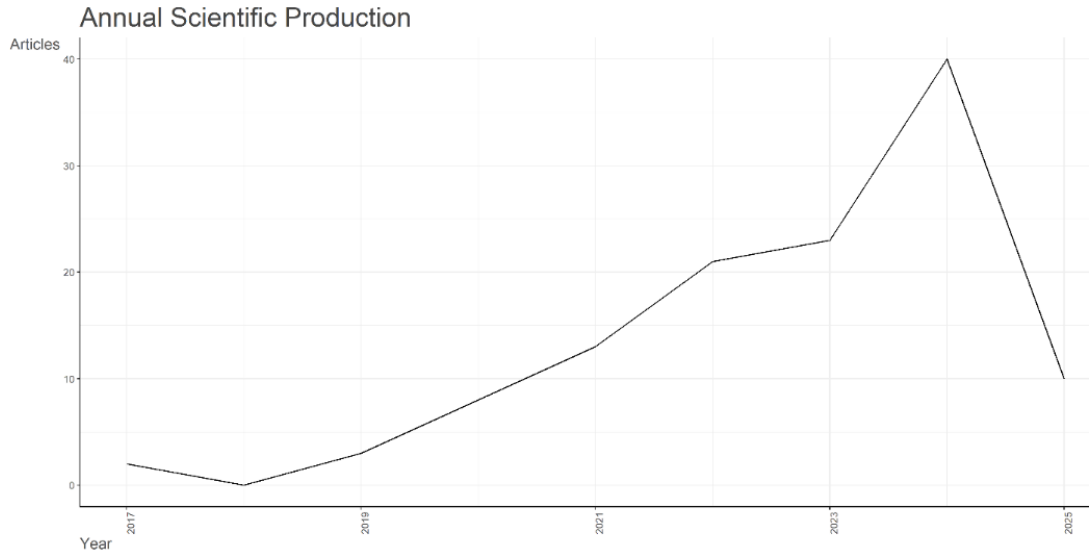

Figure 2: Evolution of the number of journal articles

As per the result of this PRISMA-based systematic literature review, 116 journal articles have been published from 2016 to the first three months of 2025 related to the circular economy and apparel supply chain. Figure 02 graphically represents the evolution of the number of journal articles published on this research domain.

Upon the analysis, no publications related to the circular economy and apparel supply chain existed in 2016. There were only 2 publications in 2017, and again, the number of publications sharply declined to zero in 2018. However, the graph shows an upward

trajectory of the annual scientific production from 2019 onwards. This upward trend may be attributed to the global shift towards and policy enhancements such as the European Union Circular Economy Action Plan 2020. Accordingly, the number of publications has increased to 3, 8, 13, 21, and 23 in 2019, 2020, 2021, 2022, and 2023, respectively. Notably, this ascending trend peaks in 2024, with 40 publications. Further, 10 publications were identified in the first three months of 2025. Overall, the graph portrays positive growth of the scholarly focus on the topic of circular economy and apparel supply chain within the past decade, elaborating the significance of integrating circular economy principles into the apparel supply chain.

4.1.2 Leading Journals Published on Circular Economy and Apparel Supply Chain

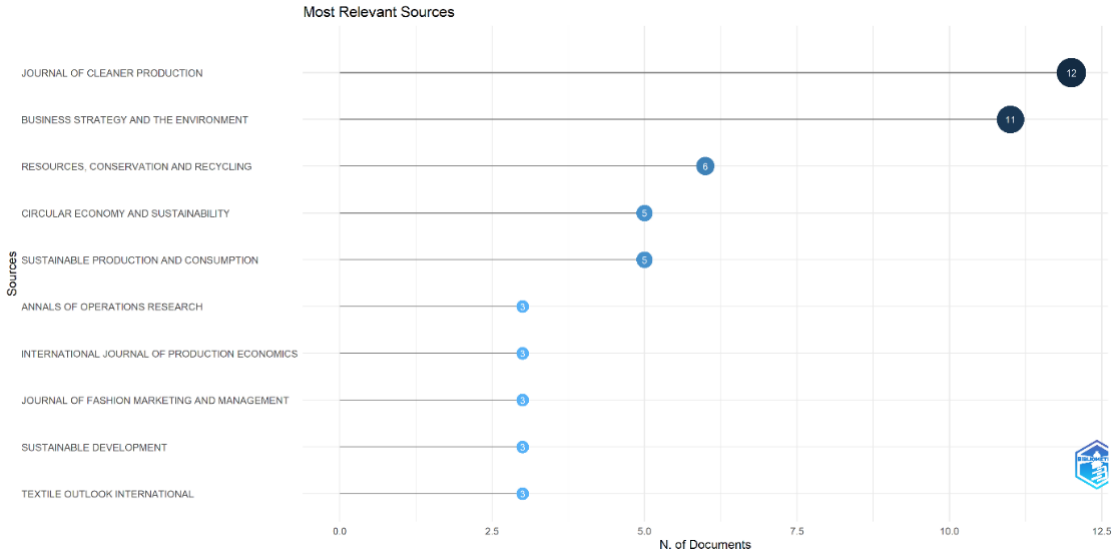

Figure 3: Leading journals published on circular economy and apparel supply chain

Figure 03 illustrates the leading journals published on the intersection of circular economy and apparel supply chain. Here, the x-axis represents the number of publications, while the y-axis lists the names of journals and sources contributing to this research area. Further, the number of publications associated with each journal is presented within a dot, and the dot size is correlated with the number of documents published.

Upon the analysis results, the "Journal of Cleaner Production" was the leading journal in this research domain, contributing the highest number of publications with 12 articles. Further, the "Business Strategy and the Environment" journal has also provided a significant contribution to scholarly publications in the past decade, with 11 journal articles. The "Resources Conservation and Cleaning", "Circular Economy and Sustainability" and "Sustainable Production and Consumption" are some other remarkable journals in this research domain with 6, 5, and 5 publications respectively. Additionally, "Analysis of Operation Research", "International Journal of Production Economics", "Journal of Fashion Marketing and Management", "Sustainable Development", and "Textile Outlook International" have also contributed to this research although there are fewer publications. In conclusion, this distribution of journals illustrates that a wide range of journals has addressed this research area, reflecting the emerging scholarly interest and the significance of this research domain.

4.1.3 Leading Authors Published on Circular Economy and Apparel Supply Chain

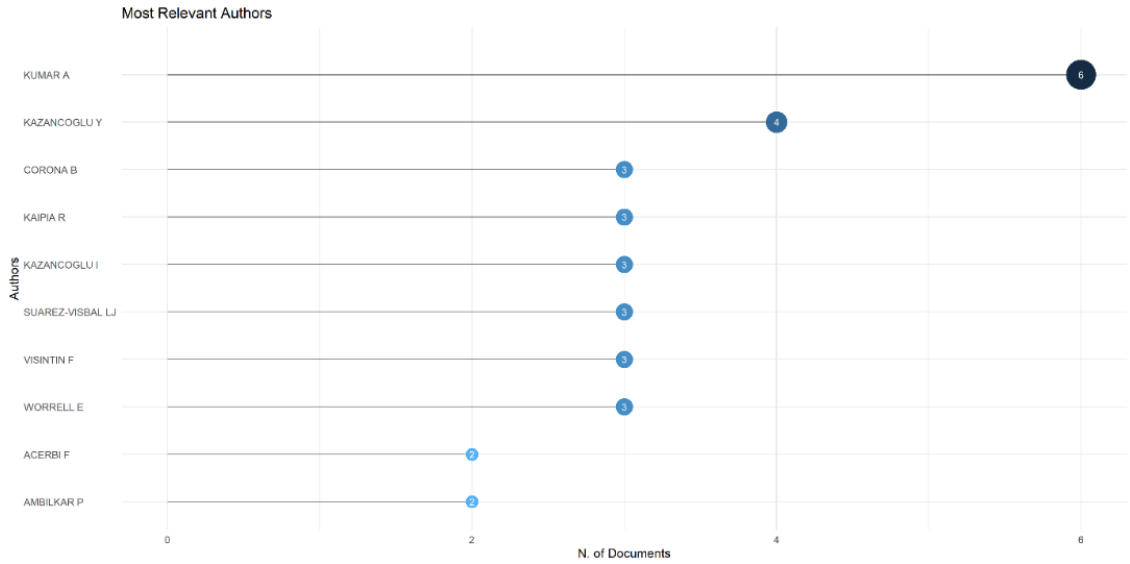

Figure 4: Leading authors published on circular economy and apparel supply chain

Various scholars have contributed to investigating the adoption of the circular economy concept for the apparel supply chain. Accordingly, Figure 04 illustrates the leading authors who have published the highest number of articles in this research area. The vertical axis indicates the authors, while the horizontal axis indicates the number of articles published. Similar to the graph in Figure 03, the number of publications of each author is presented within a dot, and the dot size is correlated with the number of documents published.

Upon the analysis, Kumar A stands out as the leading author in the circular economy and apparel supply chain, who has 6 publications within the past decade. Following closely, Kazancoglu Y has published 4 journal articles reflecting the strong research presence and ongoing contribution to this specific academic discipline. Several notable authors, Corona B, Kaipia R, Kazancoglu I, Suarez-visbal L. J., Visintin F, and Worrell E has published in 3 journals by each demonstrating the consistent involvement in advancing this scholarly field. Further, Acerbi F and Ambilkar P have also contributed to investigate the intersection between circular economy and apparel supply chain within past decade. Additionally, analysis results reveal that there are many authors who have actively been involved in this study area, even though with a smaller number of publications. Overall, the distribution of authorship indicates that there are a number of scholars who are actively contributing to the growth of this evolving academic discipline while a few scholars are taking the leading role.

4.1.4 Co-occurrence of Keywords on Circular Economy and Apparel Supply Chain Publications

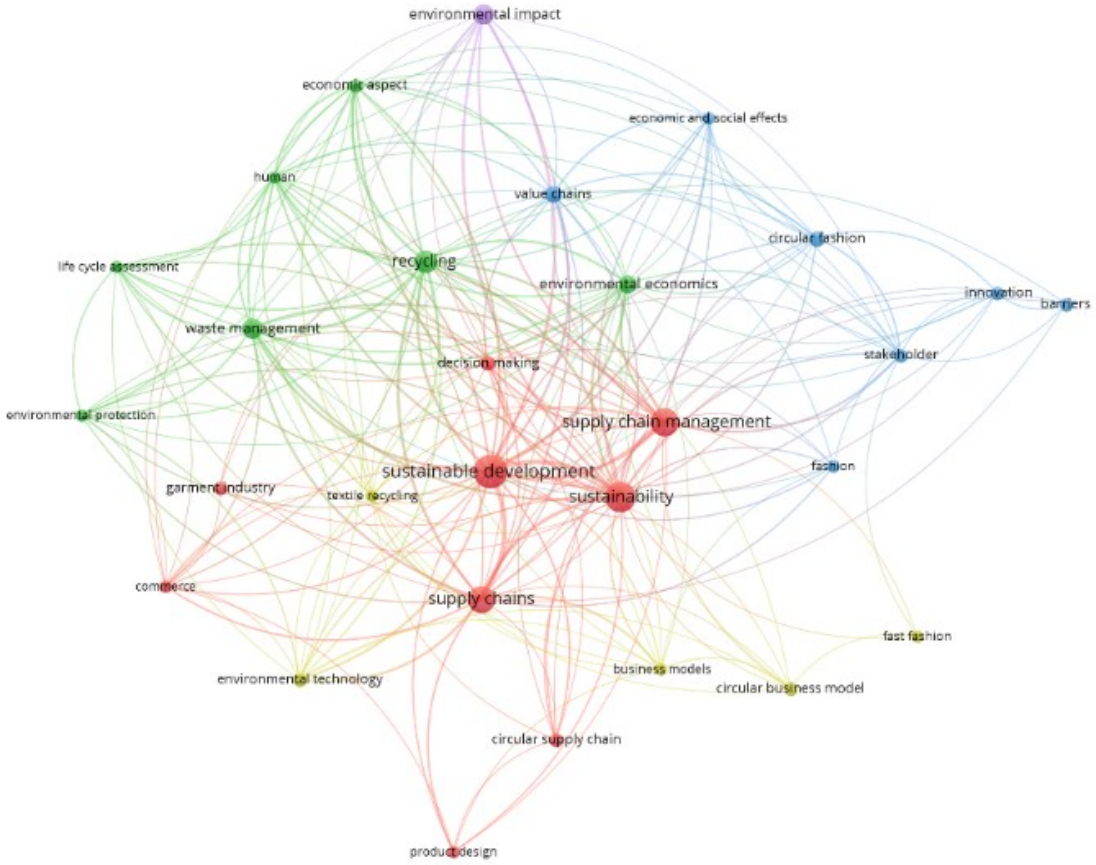

Figure 5: Co-occurrence of keywords on circular economy and apparel supply chain publications

This graph demonstrates the co-occurrence of keywords of publications related to the circular economy and apparel supply chain. The co-occurrence analysis was conducted using VOSviewer software to identify the research trends within this research area. The unit of analysis was selected as the author keywords to identify the frequently co-occurring terms used by authors, and the minimum occurrence threshold level was set at ten (10). Further, the modularity-based clustering algorithm was applied to group keywords. According to the results, the graph illustrates five major thematic research domains, each represented by a different colour, and their interrelationships among key topics.

The red colour cluster indicates the sustainable development and circular concepts, while the green colour cluster includes keywords related to supply chain management and operations. The key aspects related to environmental assessment and tools are represented by the blue colour cluster. Additionally, research domains related to governance and stakeholder engagement are presented in the yellow colour cluster while resource management aspects are indicated in the purple colour cluster. While this thematic clustering reveals the interrelationship in current literature in the intersection of apparel supply chain and circular economy, it also uncovers some critical research gaps. For instance, although governance and stakeholder engagement aspects were discussed in literature, it lacks the interrelationship with supply chain management and operations

clusters, which represents a literature gap in studies of combining policy frameworks with supply chain practices. Further, the disconnection between waste management and stakeholder aspects underscores the necessity of exploring stakeholder engagement strategies for waste management within circular apparel industry.

4.2 CIRCULAR ECONOMY AND APPAREL SUPPLY CHAIN INTERACTIONS TOWARDS CIRCULAR APPAREL ECONOMY

The following literature synthesis elaborates the key aspects related to the research problem on "how the circular economy can be applied and implemented in the apparel supply chain. It discussed several subtopics: benefits of adopting CE, approaches for CE implementation, barriers, and future research directions in the intersection of circular economy and apparel supply chain. Benefits of integrating the circular economy with apparel supply chain

The apparel industry can be considered one of the most ecologically harmful industries in the world due to the intensive consumption of natural resources and the complexity inherent in its supply chain (Boström & Micheletti, 2016; Denizel & Schumm, 2024). According to Niinimäki et al. (2020), the apparel industry contributes to 8% – 10% of global carbon emissions, which equals 4 – 5 billion tonnes per year, while 20% of global wastewater. Further, the apparel industry accounts for 20% of global waste, even though only 20% of waste is collected for circular use (Papamichael et al., 2023). Accordingly, the concept of "Circular Economy" (CE) has emerged as a promising solution for mitigating these adverse environmental impacts of the industry (Wiegand & Wynn, 2024). Accordingly, many research scholars have drawn their attention to incorporating CE in the apparel industry, owing to its numerous advantages. CE promotes an economic paradigm that continuously regenerates itself while minimising reliance on finite natural resources and mitigating ecological degradation (Hvass & Pedersen, 2019). Further from the environmental perspective, CE helps to reduce waste generation, minimise the extraction of virgin natural resources, maximise the production from resources, optimise the usage of natural resources, minimise waste generation and enhance the product life cycles (Lenka et al., 2010; Kayikci et al., 2022; Salmi & Kaipia, 2022).

4.2.1 Approaches for Adopting Circular Economy into Apparel Supply Chain

Saha et al., (2022) claimed that CE offers diverse business opportunities across various domains, including improving sustainability, enhancing brand reputation, increasing long-term shareholder value and profitability. However, the implementation of the circular apparel economy requires considerable attention due to the presence of various challenges and scholars have explored different methods for implementing CE in the apparel supply chain (Zaidi & Chandra, 2024). Accordingly, Agent-Based Models (AGM), Entrepreneurial Business Models, Lifecycle Assessment and Plan-Do-Act-Check (PDCA) framework are some examples of those methods (Todeschini et al., 2017; Hazen et al., 2021; Rivera et al., 2021; Wilson, 2022). Among these methods, PDCA can be considered a robust framework for the systematic incorporation of CE into the apparel supply chain because its iterative nature assures continuous improvement (Hazen et al., 2021). Here, the "Plan" phase provides a clear objective in terms of setting achievable aims for CE implementation; the "Do" phase involves the implementation of planned activities including buying recycling machinery, training employees and developing consumer engagement; the "Check" phase incorporates the impact assessments of the implemented CE practices and the "Act" provides feedbacks and enhancements for the

identified gaps in the check phase (Mendoza et al., 2017; Hazen et al., 2021; Walzberg et al., 2021).

4.2.2 Barriers to Implementing Circular Economy in Apparel Supply Chain

Nevertheless, the practical implementation of CE principles in the apparel supply chain remains limited due to the presence of numerous barriers despite the existence of certain enablers. (Saha et al., 2022; Salmi & Kaipia, 2022) identified limited government support, managerial reluctance, company culture and obtaining necessary technologies are some barriers that against the CE implementation in the apparel supply chain. Further, Lewandowski (2016) and Freund et al. (2019) claimed that consumer demand and the market for circular apparel products remain underdeveloped. However, digitalisation, supportive regulatory frameworks and increased customer awareness of environmental considerations serve as the key enablers that motivate the transition towards a circular apparel economy (Wójcik-Karpacz et al., 2023).

4.2.3 Future Research Directions in the Interaction of Circular Economy and Apparel Supply Chain

In recent years, scholarly studies related to the circular economy and the apparel supply chain have broadened to diverse research domains. Accordingly, researchers attempt to integrate the circular apparel supply chain into novel digital technologies, including blockchain technology, robotics, artificial intelligence, Internet of Things and digital fabrication (Wiegand & Wynn, 2024). Correspondingly, blockchain technology ensures reliable, decentralised data transmission through the partners in the supply chain; robotics allows autonomous operation in apparel production and logistics processes; the Internet of Things supports real-time monitoring throughout the apparel life cycle, and digital fabrication allows for computer-controlled modelling and manufacturing (Agrawal et al., 2022; Bressanelli et al., 2022; Alves et al., 2023; Rusch et al., 2023; Hassan et al., 2024).

5. CONCLUSIONS AND A WAY FORWARD

The circular economy concept is a transformative model that fosters sustainability in various industries, including the apparel industry. Incorporating the circular economy in the apparel industry leads to waste minimisation, increases resource efficiency, reduces carbon footprint, and enhances product lifecycle. Hence, this study focused on investigating the intersection of the concept of circular economy and apparel supply chain through a systematic review as a basis for future research. A bibliometric analysis was conducted to identify key literature publications in the Scopus database between 2015 to 2024. Accordingly, this study provides a unique contribution to the existing knowledge by providing a consolidated overview of research trends in the intersection between circular economy and apparel supply chain. The bibliometric analysis outcomes significantly contribute to identifying the number of published journals, leading journal authors, countries active in this field, and the co-occurrence of keywords on circular economy and apparel supply chain publications. The analysis results are evident that this field of study is an evolving research domain over the past decade and continues to exhibit growth, reflecting its contribution to achieving global sustainability goals within the apparel industry. Notably, analysis reveals that the concept of CE is transferring to the concept of digital circular economy with the current technological advancements. Accordingly, the apparel industry is progressing towards more sustainability and efficiency by striving to balance all environmental, social, and economic dimensions. As

future research directions, "A closed-loop apparel supply chain model for achieving net zero goals of the apparel industry" will be developed considering the intersection of CE and apparel supply chain as a way forward for this research.

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