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The Role of Artificial Intelligence in Supply Chain Operations in the Apparel Industry: A Systematic Literature Review

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A B S T R A C T

The integration of Artificial Intelligence (AI) in supply chain operations has emerged as a transformative force in the apparel industry, addressing key challenges related to sustainability, operational efficiency, and supplier selection. This systematic literature review (SLR) investigates the role of AI in enhancing these aspects of the apparel supply chain. A structured search was conducted across academic databases, including IEEE Xplore, SpringerLink, and Google Scholar, using predefined inclusion and exclusion criteria. From an initial pool of 188 studies, 15 were selected for in-depth analysis. The results highlight that AI-driven solutions such as machine learning, computer vision, and robotics significantly improve demand forecasting, quality control, and supply chain resilience. However, challenges such as high implementation costs and integration with legacy systems hinder widespread adoption, particularly for smaller firms. The review concludes that while AI offers substantial benefits, further research is required to develop more accessible AI tools and enhance the industry's sustainability efforts.

Keywords: Artificial Intelligence, Supply Chain, Apparel Industry

1. Introduction

The apparel industry, a cornerstone of the global economy, is characterized by its complex and dynamic supply chains. These supply chains, encompassing activities from raw material procurement to end-user delivery, are increasingly being challenged by demands for efficiency, sustainability, and responsiveness to market changes. The integration of Artificial Intelligence (AI) into supply chain management has emerged as a transformative force, promising to revolutionize operations within the apparel sector. This review explores the role of AI in optimizing supply chain operations in the apparel industry, with a particular focus on sustainability, operational efficiency, supplier selection, and future research directions.

AI technologies have rapidly evolved over the past decade, leading to their widespread adoption across various industries, including apparel. The application of AI in supply chain management is particularly significant due to the industry's inherent challenges, such as high inventory levels, long lead times, and the need for agile responses to fashion trends. As global sustainability concerns mount, AI offers the potential to significantly reduce the environmental impact of apparel supply chains through more efficient resource utilization and waste minimization (Ramos et al., 2023). The intersection of AI and sustainability within this industry is therefore a critical area of research, especially in light of the growing consumer demand for ethical and environmentally friendly products (Giri et al., 2019).

In addition to sustainability, the operational efficiency of apparel supply chains is a key focus of AI applications. Technologies such as machine learning, computer vision, and robotics are being leveraged to enhance various aspects of the supply chain, including demand forecasting, inventory management, and logistics optimization (Komal Dhiwar, 2024). These innovations are crucial for maintaining competitiveness in an industry where consumer preferences and market conditions are rapidly changing. The ability of AI to analyze large datasets and make informed predictions allows for more precise inventory control and efficient production planning, thereby reducing costs and increasing profitability (Noor et al., 2021).

Supplier selection and overall supply chain optimization are other critical areas where AI is making a significant impact. Traditional methods of supplier evaluation, often based on historical performance data, are being supplemented or replaced by AI-driven analytics that consider a wider array of factors, including real-time data on supplier performance, market conditions, and geopolitical risks (Chaimae Zouhri et al., 2023). This holistic approach to supplier management not only enhances decision-making but also improves the resilience and agility of supply chains in the face of disruptions (Guo et al., 2023). Furthermore, AI's ability to optimize supply chain networks by predicting and mitigating potential risks is increasingly recognized as a vital component of modern supply chain strategies (Rathore, 2023).

Despite the clear advantages of AI, the implementation of these technologies in the apparel industry's supply chain is not without challenges. Issues such as data privacy, the high cost of AI solutions, and the integration of new technologies with legacy systems present significant barriers to adoption (Chamathka Madushanka et al., 2023). Additionally, there is a need for more empirical research to understand the full impact of AI on smaller apparel

companies, which may lack the resources to implement these technologies effectively (Sachin & Bandara, n.d.). These challenges highlight the importance of ongoing research to develop more accessible and scalable AI solutions tailored to the needs of the apparel industry.

This systematic literature review aims to address several key research questions:

- **RQ1.** How has AI been applied in supply chain management within the apparel industry to enhance sustainability?
- **RQ2.** Which primary AI technologies are being utilized in the apparel industry's supply chain, and how do they impact operational efficiency?
- **RQ3.** In what ways does AI optimize supplier selection and overall supply chain performance in the apparel industry?
- **RQ4.** What are the key challenges and limitations faced by the apparel industry in implementing AI-driven solutions in supply chain management?
- **RQ5.** How can future research further the intersection of AI and supply chain management in the apparel industry?

By systematically reviewing the existing literature, this study seeks to provide a comprehensive understanding of the current state of AI applications in the apparel industry's supply chain. It also aims to identify gaps in the literature and propose directions for future research, ultimately contributing to the ongoing discourse on the role of AI in transforming the apparel sector.

2. Methodology

This systematic literature review was conducted using a structured, multi-stage process to ensure a transparent, replicable, and comprehensive review of relevant studies. The selection and screening process was designed to capture all relevant research that addresses the role of AI in supply chain operations within the apparel industry.

2.1 Eligibility criteria

To ensure that the review includes relevant and high-quality studies, strict eligibility criteria were established. These criteria were defined to identify studies that specifically address the research questions related to the integration of AI in supply chain operations within the apparel industry.

2.1.1 Inclusion criteria (IC)

To be included in this review, studies had to meet the following criteria:

IC1: The study must focus on the application of Artificial Intelligence (AI) within the supply chain operations of the apparel industry.

IC2: Only empirical studies, case studies, and systematic reviews were considered.

IC3: The research must have been published in a peer-reviewed journal or presented at a recognized conference within the last five years (2019-2024).

IC4: The study must be available in English to ensure consistency in data interpretation.

IC5: Full-text access to the study is required to allow for a comprehensive analysis of its methodologies, findings, and conclusions.

2.1.2 Exclusion criteria (EC)

An article was excluded from this review if it failed to meet any of the following criteria:

EC1: The study does not specifically address AI applications within the apparel industry's supply chain.

EC2: The paper lacks substantive discussion on the role of AI in the context of the specified research questions.

EC3: The research is not accessible in full text or is a non-peer-reviewed source such as an editorial, opinion piece, or promotional content.

EC4: The study is published outside the specified timeframe of 2019 to 2024.

EC5: The study is not available in English.

2.2 Information sources

For this review, information was sourced from a variety of academic databases and digital libraries to ensure a thorough and comprehensive search. The primary sources included recognized platforms, and other relevant academic databases, as detailed in Table 1.

Table 1 - Online sources used in this work

No.	Source	URL
1	IEEE Xplore	https://ieeexplore.ieee.org/
2	SpringerLink	http://www.link.springer.com/
3	Wiley	https://onlinelibrary.wiley.com/
4	Sage Journals	https://journals.sagepub.com/
5	Taylor & Francis	https://www.tandfonline.com/
6	Google Scholar	https://scholar.google.com/

2.3 Search strategy

To identify relevant articles for this systematic literature review, we developed a tailored search query aligned with our inclusion criteria. The search query used was: (((“Artificial Intelligence” OR “AI”) AND (“supply chain management” OR “supply chain operations”) AND (“apparel industry” OR “fashion industry” OR “garment industry”)) AND (“sustainability” OR “operational efficiency” OR “supplier selection”)). In each database, we utilized available filters to refine the search results, ensuring the retrieval of the most pertinent articles. The filters applied included restricting the publication years to 2019–2024, limiting the search to peer-reviewed journals and recognized conference papers, and setting the language to English. These filters were critical in aligning the results with the scope and timeframe of our review. Detailed information on the search process can be found in the Table 2. The final search was conducted on August 13, 2024.

Table 2 - Search String for different Databases

Database	Search String
IEEE Xplore	((("All Metadata":"Artificial Intelligence" OR "All Metadata":"AI") AND ("All Metadata":"supply chain management" OR "All Metadata":"supply chain operations") AND ("All Metadata":"apparel industry" OR "All Metadata":"fashion industry" OR "All Metadata":"garment industry")) AND ("All Metadata":"sustainability" OR "All Metadata":"operational efficiency" OR "All Metadata":"supplier selection"))
SpringerLink	(((“Artificial Intelligence” OR “AI”) AND (“supply chain management” OR “supply chain operations”) AND (“apparel industry” OR “fashion industry” OR “garment industry”)) AND (“sustainability” OR “operational efficiency” OR “supplier selection”))
Wiley	(((AllField: “Artificial Intelligence” OR “AI”) AND (“supply chain management” OR “supply chain operations”) AND (“apparel industry” OR “fashion industry” OR “garment industry”)) AND (“sustainability” OR “operational efficiency” OR “supplier selection”))
Sage Journals	(((“Artificial Intelligence” OR “AI”) AND (“supply chain management” OR “supply chain operations”) AND (“apparel industry” OR “fashion industry” OR “garment industry”)) AND (“sustainability” OR “operational efficiency” OR “supplier selection”))
Taylor & Francis	(((“Artificial Intelligence” OR “AI”) AND (“supply chain management” OR “supply chain operations”) AND (“apparel industry” OR “fashion industry” OR “garment industry”)) AND (“sustainability” OR “operational efficiency” OR “supplier selection”))
Google Scholar	((“Artificial Intelligence” OR “AI”) AND (“supply chain management” OR “supply chain operations”) AND (“apparel industry” OR “fashion industry” OR “garment industry”) AND (“sustainability” OR “operational efficiency” OR “supplier selection”))

2.4 Selection process

The selection process involved multiple stages of screening and eligibility assessment. Initially, the titles and abstracts of all identified studies were reviewed to assess their relevance to the research questions. Studies that did not meet the inclusion criteria were excluded at this stage.

Full texts of potentially eligible studies were then retrieved and reviewed in detail. This detailed review ensured that the studies fully met the inclusion criteria and were directly relevant to the investigation of AI's role in supply chain management within the apparel industry. Only those studies that passed the full-text review were included in the final analysis. The entire selection process is visually represented in Figure 1.

2.5 Data collection process

Data collection was conducted systematically using a predefined data extraction form. The form was designed to capture key information from each study, including the title, authors, publication year, study objectives, AI technologies discussed, supply chain aspects covered, methodologies employed, key findings, strengths, weaknesses, and relevance to the research questions.

This process ensured that the data collected from each study was comprehensive and standardized, allowing for effective synthesis and comparison across studies. The extracted data was then tabulated to facilitate the analysis and discussion of findings in relation to the research questions.

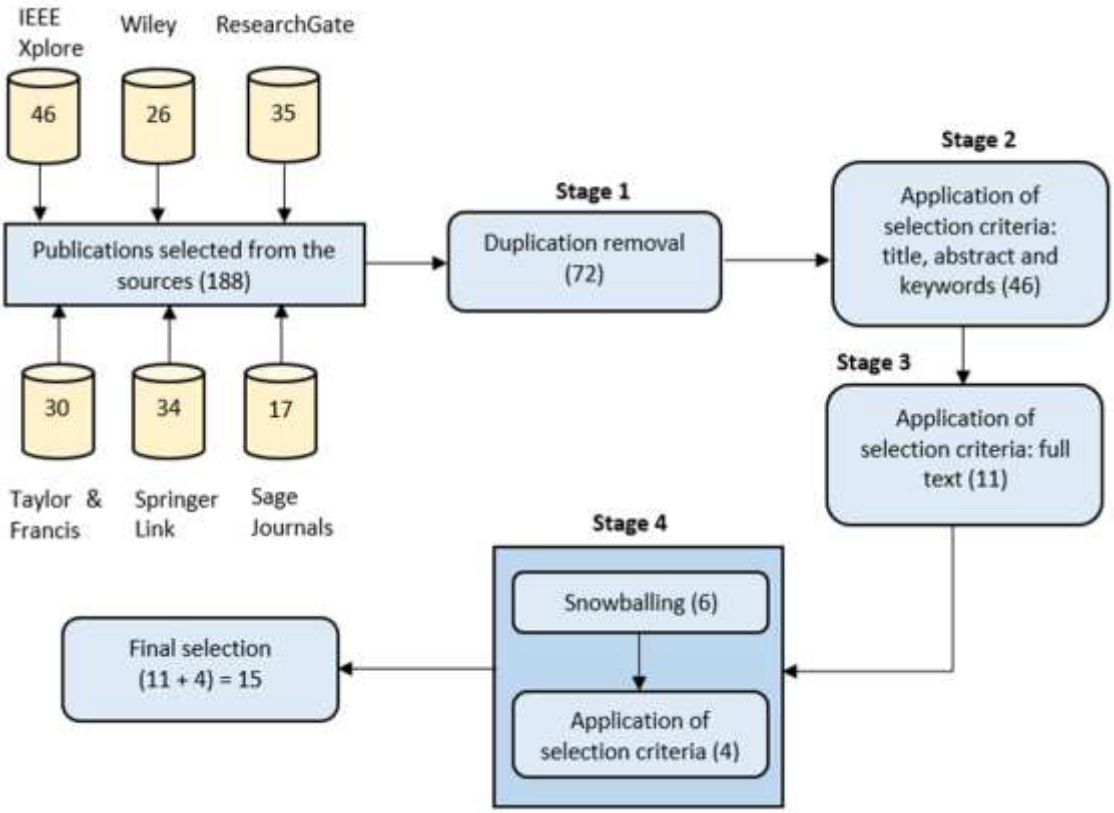

Fig. 1 - Data Extraction - Selection process

2.6 Data extraction and synthesis

The information extraction process focused on identifying and summarizing the key contributions of each study to the understanding of AI applications in the apparel industry's supply chain. The extraction process was guided by the research questions, ensuring that all relevant information was captured and categorized appropriately.

For each study, detailed notes were taken on the AI technologies applied, the specific supply chain functions addressed (e.g., sustainability, operational efficiency, supplier selection), the outcomes reported, and any challenges or limitations noted by the authors. This information was then synthesized to provide a coherent narrative that addresses the research questions posed in the introduction.

3. Results and Discussion

This section presents the findings of the systematic literature review (SLR) and addresses the research questions (RQs) on how Artificial Intelligence (AI) has been applied in supply chain management within the apparel industry. The discussion is organized according to each research question and provides an analysis of the findings from the reviewed literature.

RQ1: How has AI been applied in supply chain management within the apparel industry to enhance sustainability?

AI has been widely applied in the apparel industry to address sustainability concerns, particularly through resource optimization, waste reduction, and enhancing transparency in supply chains. Studies show that AI-driven demand forecasting tools are helping companies predict consumer demand more accurately, minimizing overproduction and reducing inventory waste (Ramos et al., 2023, Giri et al., 2019).

Moreover, AI-based algorithms can optimize production processes by reducing energy consumption and waste generation in textile manufacturing, thereby improving the overall environmental footprint of apparel supply chains (Noor et al., 2021). AI's integration into circular supply chains also facilitates recycling processes by identifying reusable materials, thereby supporting more sustainable fashion practices (Ramos et al., 2023).

RQ2: Which primary AI technologies are being utilized in the apparel industry's supply chain, and how do they impact operational efficiency?

The reviewed studies identify several AI technologies that are significantly enhancing operational efficiency in the apparel industry's supply chains. These include:

- **Machine Learning (ML)**: Used extensively for demand forecasting and production planning, ML algorithms improve decision-making by analyzing large volumes of historical data and consumer behavior trends (Komal Dhiwar, 2024, Chaimae Zouhri et al., 2023)
- **Computer Vision**: Applied in quality control and inventory management, computer vision systems are being used to automatically detect defects in fabrics and garments, ensuring consistency and reducing production delays (Guo et al., 2023, Nair & trivedi, 2024).
- **Natural Language Processing (NLP)**: NLP helps in automating supplier communication and streamlining order management processes by analyzing and responding to supplier inquiries, reducing lead times (Chaimae Zouhri et al., 2023).
- **Robotics and Automation**: Automated robotic systems are being integrated into logistics and warehousing operations, which significantly reduces manual labor and accelerates order fulfillment processes (Noor et al., 2021, Rathore, 2023).

These technologies collectively improve efficiency by optimizing production schedules, reducing waste, and enhancing the speed of operations across the supply chain.

RQ3: In what ways does AI optimize supplier selection and overall supply chain performance in the apparel industry?

AI is revolutionizing supplier selection by enhancing the decision-making process. Traditional methods relied on historical performance data, whereas AI allows for the analysis of real-time data, which includes supplier reliability, market trends, and geopolitical risks (Chaimae Zouhri et al., 2023). Advanced AI algorithms use predictive analytics to forecast potential disruptions in the supply chain and provide recommendations for alternative suppliers, improving resilience and agility (Guo et al., 2023). Studies also indicate that AI-driven systems can evaluate supplier performance by analyzing various metrics such as quality, lead times, and pricing, helping apparel companies select the most reliable partners (Zeleke & Hailemariam, 2023).

RQ4: What are the key challenges and limitations faced by the apparel industry in implementing AI-driven solutions in supply chain management?

Despite the numerous benefits of AI, its implementation in the apparel industry faces several challenges. One of the primary challenges is the high cost of AI technologies, which can be a significant barrier for small and medium-sized enterprises (SMEs). (Rathore, 2023, Chamathka Madushanka et al., 2023). Additionally, integrating AI systems with existing legacy infrastructure in supply chain operations poses significant technical difficulties, particularly for companies that have not yet digitized their processes (Liang et al., 2019). Another key limitation is data privacy and security concerns, especially when handling sensitive supplier and customer information. There is also a skills gap in the industry, with a lack of adequately trained personnel who can develop, implement, and manage AI-driven solutions (Chamathka Madushanka et al., 2023).

RQ5: How can future research further the intersection of AI and supply chain management in the apparel industry?

Future research should focus on making AI more accessible to SMEs in the apparel industry by developing cost-effective AI solutions and improving user-friendliness. There is also a need for research into improving AI integration with legacy systems, allowing for a more seamless transition to AI-driven operations. Furthermore, as sustainability continues to grow in importance, future research could explore AI’s role in driving circular economy practices, such as developing more efficient textile recycling processes (Ali & Yousef, 2022). Lastly, research should aim to bridge the skills gap by focusing on AI education and training programs for industry professionals (Rani et al., 2023).

4. Conclusion

In conclusion, this systematic literature review highlights the transformative role of Artificial Intelligence (AI) in enhancing supply chain operations within the apparel industry, particularly in areas such as sustainability, operational efficiency, and supplier selection. AI-driven technologies, including machine learning, computer vision, and robotics, are being effectively applied to streamline processes, reduce waste, and improve decision-making. However, despite these advancements, challenges such as the high cost of implementation, integration with legacy systems, and data privacy concerns remain significant barriers, particularly for smaller firms. Future research should focus on addressing these challenges by developing more accessible AI solutions and exploring AI's potential in driving sustainable practices, such as in the circular economy, to further revolutionize the apparel industry's supply chain operations.

References

1. Ali, R., & Yousef, H. (2022). *Amany Ismaiel & Rasha Yousef 203 International Design Journal*, *12*(3). https://idj.journals.ekb.eg/article_234807_0e56a5f50673e607bdcb3cdcec992dfe.pdf

2. Chaimae Zouhri, Faouzi Khedher, Mustapha Ahlaqqach, Amel Babay, Mustapha Hlyal, & Jamila El Alami. (2023). *Application of Artificial Intelligence for Improving Internal Logistics in the Garment Industry: A Literature Review*. https://doi.org/10.1109 /icoa58279.2023.10308836

3. Chamathka Madushanka, Hakeem, A., Chamodani Uththarangi, Janama Rupigeena, Colinie Wickramaarachchi, Sandali Ehalapitiya, & W.D.N. Madhavika. (2023). *The Impact of Industry 4.0 on Supply Chain Integration in Apparel Sector, Sri Lanka*. https://doi.org/10.1109/scse59836.2023.10215014

4. Giri, C., Jain, S., Zeng, X., & Bruniaux, P. (2019). A Detailed Review of Artificial Intelligence Applied in the Fashion and Apparel Industry. *IEEE Access*, *7*(7), 95376–95396. https://doi.org/10.1109/access.2019.2928979

5. Guo, Z., Zhu, Z., Li, Y.-Z., Cao, S., Chen, H., & Wang, G. (2023). AI Assisted Fashion Design: A Review. *IEEE Access*, *11*, 1–1. https://doi.org/10.1109/access.2023.3306235

6. Komal Dhiwar. (2024). *Artificial Intelligence and Machine Learning in Fashion: Reshaping Design, Production, Consumer Experience and Sustainability*. https://doi.org/10.1109/icetsis61505.2024.10459436

7. Liang, Y., Lee, S.-H., & Workman, J. E. (2019). Implementation of Artificial Intelligence in Fashion: Are Consumers Ready? *Clothing and Textiles Research Journal*, *38*(1), 0887302X1987343. Sagepub. https://doi.org/10.1177/0887302x19873437

8. Nair, G. G., & trivedi, V. (2024). Application of AI And ML in Quality Control Department of Textile and Apparel Industry. *INTERNATIONAL CONFERENCE on SUSTAINABLE DESIGN PRACTICES*. https://www.researchgate.net/publication/379987927_ Application_of_AI_And_ML_in_Quality_Control_Department_of_Textile_and_Apparel_Industry

9. Noor, A., Saeed, M. A., Ullah, T., Uddin, Z., & Ullah Khan, R. M. W. (2021). A review of artificial intelligence applications in apparel industry. *The Journal of the Textile Institute*, *113*(3), 1–10. https://doi.org/10.1080/00405000.2021.1880088

10. Ramos, L., Francklin Rivas-Echeverría, Anna Gabriela Pérez, & Casas, E. (2023). Artificial intelligence and sustainability in the fashion industry: a review from 2010 to 2022. *SN Applied Sciences*, *5*(12). https://doi.org/10.1007/s42452-023-05587-2

11. Rani, S., Minakshi Memoria, Kumar, R., & Tanupriya Chaoudhary. (2023). *Role of Fashion in Artificial Intelliegence in Digital Age*. https://doi.org/10.1109/cisct57197.2023.10351465

12. Rathore, D. B. (2023). Integration of Artificial Intelligence& It's Practices in Apparel Industry. *International Journal of New Media Studies (IJNMS)*, *10*(1), 25–37. https://ijnms.com/index.php/ijnms/article/view/40

13. Sachin, K., & Bandara, A. (n.d.). Exploring the Diffusion of Industry 4.0 Technologies in Apparel Supply Chains of Sri Lanka Exploring the Diffusion of Industry 4.0 Technologies in Apparel Supply Chains of Sri Lanka Exploring the Diffusion of Industry 4.0 Technologies in Apparel Supply Chains of Sri Lanka supply chain performance. The study offers managers insights into the potential of Industry 4.0 technologies. *Peradeniya Management Review*, *03*, 2021. https://mgt.pdn.ac.lk/peradeniya_management_review/assets /uploads/vol03_issue02/7.pdf

14. *View of THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN THE SUPPLY CHAINS OF TEXTILE INDUSTRIES*. (2024). Csrpublisher.com. https://journals.csrpublisher.com/index.php/jbem/article/view/64/104

15. Zeleke, R. E., & Hailemariam, S. S. (2023). Drivers for Sustainable Supply Chain Management and the Practices in Ethiopian Apparel Industries. *Journal of Engineering*, *2023*, 1–15. https://doi.org/10.1155/2023/2625998