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Current Trends and Challenges in Green Apparel Supply Chain Management

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Abstract

The garment industry in India contributes considerably to industrial output and is the second most polluting sector. The research aims to identify trends in the green supply chain in the areas of green design, green innovation, LCA, green manufacturing, green marketing, and recycling in the Indian garment sector. The paper also analyses the various challenges faced by garment manufacturing companies globally. The review includes academic journal papers from March 2013 to March 2023 that were published in peer-reviewed publications in different databases in the aforementioned field of study. This study also gives a taxonomy of challenges based on various aspects of sustainability. Moreover, there is a dearth of study in the contexts of poor nations, where the majority of apparel manufacturing takes place, as well as in the upstream processes of garment production processes. By summarising green practices in apparel manufacturing, this review helps managers develop a firm's sustainability competency while also giving academicians inspiration for further scholarly research.

Keywords- green production, life cycle assessment, green branding, and green marketing

Introduction

The clothing manufacturing business has a significant negative influence on the environment due to the release of greenhouse gases, carbon dioxide, contaminated water, energy usage (Muthukumarana et al., 2018), resource consumption (Hiller Connell and Kozar, 2017), waste creation (Niinimaki et al., 2020), and the use of hazardous materials. According to Shen et al. (2021), garment manufacturing has adverse impacts

on the environment, including contamination of the water and air. A lot of used clothes are thrown away in landfills each year, causing significant environmental and chemical risks. Based on yearly estimates, the EU, China, and the United States wasted 29.3, 14.5, and 9.6 kg of textiles per person in 2016 (Bukhari et al., 2018). As a result, the clothing industry must embrace ecologically friendly ways to mitigate the adverse effects it has on the surroundings and the people.

New ecological restrictions have been put in place worldwide to reduce the waste of resources that come from nature. In response to "United Nations Climate Change," the fashion industry created the "Fashion Industry Charter for Climate Action (FICCA)," which seeks to clean up the apparel industry completely by the year 2050. The Worldwide Responsible Accredited Production (WRAP), "Leadership in Energy and Environmental Design" (LEED), and other international compliance standards have also been attained by several clothing manufacturers. The LEED and WRAP-certified companies are among the most environmentally responsible ones in the world. Well-known multinational fashion companies including H&M (Rahman and Gong, 2016), Patagonia, and Louis Vuitton have started a range of sustainable activities throughout their supply chains to meet recently increasing regulatory and environmental limitations.

He et al. (2017) claim that a study of the literature is an effective way to learn more about a certain field of study. It makes it easier for researchers to offer concise, reproducible methods for choosing, assessing, and summarising earlier studies on a certain subject (Yange et al., 2017). The majority of earlier studies have examined GSCM and green manufacturing practices or used case studies, each of which has examined a specific problem and offered a solution. It is difficult to understand the research focus and the present situation given the various studies done earlier. There is a substantial environmental effect, and there is a need for extensive studies on comprehensive literature in the apparel manufacturing sector. Therefore, it is important and relevant from both an academic and practical standpoint to conduct a systematic and thorough evaluation of the academic literature on current trends in sustainable production strategies in the apparel industry. The objective of this research is to map the Green Development Areas, Environmental Management Strategies, Green Innovation Strategies, Green Manufacturing Strategies, Green Consumer Behaviour, LCA etc about the apparel manufacturing industry based on a literature review. In addition, the study provides a taxonomy of drivers and challenges based on various aspects of sustainability.

Method

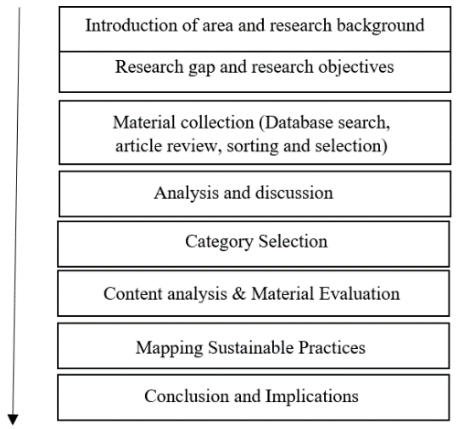

FIG.1. Overview of Research Methodology

The approach of secondary research that involves a systematic evaluation of the literature and its analysis (Koberg and Longoni, 2019) entails locating, evaluating, and interpreting research that is important to a certain subject or phenomenon of interest. Planning, implementing the review, analysing the results, and concluding the outcomes are the main elements of the process, according to Denyer and Tranfield (2006) and Karaosman et al. (2016). Figure 1 depicts the methodology of the systematic review of the research conducted. Before starting to collect information and resources, the researcher first conducted an analysis and established the standards for the inclusion and exclusion of the article. The choice of March 2013 to March 2023 as the study's timeframe was supported by the considerable volume of academic literature on the topic that was created during this period. Academic journal articles provide extensive literature on a variety of topics, which is required for achieving the study's goal, and peer review ensures that a certain standard of quality is met. The search terms "fashion," "apparel," "garment," and "clothing," among others, were used to locate the articles. To guarantee full coverage of key articles for inclusion, logical operators (such as OR, AND), wildcards (such as *), and synonyms of words were used. Each entry in a bibliography also includes a title, an abstract, a list of keywords, and references in addition to the list of authors. Every reference comes with the original author's name, the year it was published, the origin type, the volume it was published in, and a DOI reference. Based on the aforementioned retrieval criteria, the search produced published papers from Web of Science, Scopus, Science Direct, Emerald Insight, Springer Link, and MDPI yielding a preliminary sample of 10,225 articles. When the study's focus keyword, garment/apparel/clothing, was searched, 338 results were returned. After additional screening, the study included 212 peer-reviewed complete texts that were published in English-language scholarly journals over the prior 10 years. After carefully reading their titles and abstracts, the papers were then thoroughly analysed using Denyer and Tranfield's (2006) standards to determine conformance with the field of research. To assess internal validity, prior studies in the area (Barnett and Thomas, 2009; Yang et al., 2017) provided guidance.

After carefully reading the articles' titles and abstracts, Denyer and Tranfield's (2006) evaluation standards were used to decide whether or not they met the investigation's purview. Prior studies in the area (Barnett and Thomas, 2009; Yang et al., 2017) served as a guide for the examination of internal validity. Duplicate or irrelevant articles were eliminated based on sound logic and persuasive justifications (such as not coming inside the scope of the study, not meeting set quality requirements, not being relevant to the clothing sectors, and not being fully accessible). Following this procedure, 138 very relevant papers were ultimately chosen for evaluation. To make data administration easier, all the research papers were saved in the Mendeley software. References from earlier literature studies (Islam et al., 2021; Wu et al., 2022) were utilized as a reference model to categorise and retrieve data. The green practices in the research papers were mapped for Green Development Areas, Environmental Management Strategies Green Innovation Strategies, Green Manufacturing Strategies, Green consumer behaviour and LCA, etc.

Results and Discussion

Green manufacturing is a sustainable method of producing goods and providing

services without harming the environment. Douglas, 2009 (IPCC). Cay A. (2018) asserts that employing more environmentally friendly or green manufacturing practices is essential for sustainable production. Findings from past studies indicate that the fashion industry has embraced the concept of green production more frequently. Several studies have assessed the pertinent literature on green or sustainable manufacturing were reviewed. (Fig. 2.)

Author	Area of review
Luo et al. (2021)	Environmental sustainability assessment methodologies and addressed their shortcomings in the TAI
Mukendi et al. (2020)	Management approaches for sustainable fashion and noted societal implications and potential areas for further study
Islam et al. (2021)	Environmentally responsible manufacturing practises used in a range of TAI manufacturing processes and created a conceptual framework to offer recommendations for sustainable practise
Thorisdottir and Johannsdottir (2020)	Effect of CSR on the sustainability of the fashion industry
Köksal et al. (2017)	Social issues in the TAI on sustainable supply chain management
Jia et al. (2020)	Drivers, obstacles, practises, and metrics of circular economy in the TAI,
Tey et al. (2018)	Key drivers that affect consumers' willingness to pay more when purchasing sustainable clothing products.
Koberg, E., & Longoni, A. (2019).	A systematic review of sustainable supply chain management in global supply chains
Köksal, D., Strähle, J., Müller, M., & Freise, M. (2017).	Social sustainable supply chain management in the textile and apparel industry-a literature review.

FIG 2. Literature Review on Textile and Apparel

Structural Dimension and Analysis

To study the topic and possible directions for more research, the structural dimensions were determined. The components within each dimension were then further ranked using analytical categories.

1. *Distribution of Research articles:* The distribution of the paper publications from March 2013 to March 2023 is shown in Figure 3. From 2013 to 2016, there was a slow increase in research on green practices in apparel manufacturing, followed by an acceleration in 2017 as academic understanding and interest in the topic developed. Since there are still many unanswered research questions, a continued growing research trend may be projected. A persistently expanding research trend may be predicted given the large number of open research issues that yet remain.

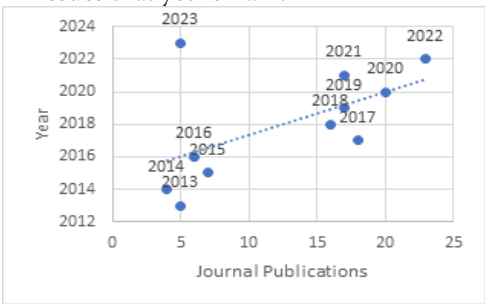

FIG 3. Number of Journal Publications in a Year

2. *Research Journals:* The distribution of papers demonstrating the important role of renowned journals in the topic. (see Figure 4)

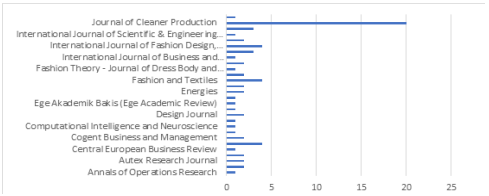

FIG 4. Number of Publications in Journal

3. *Area of Research* Figure 5 illustrates how publications were distributed across several topic areas, including barriers, divers, carbon emissions, circular manufacturing, green manufacturing, recycling, green design, innovation, sewing, GSCM, or literature/systematic reviews. Some articles discussed both textiles and apparel. Unsurprisingly, the discipline is notable for having the most articles published with a focus on integrated textile and garment research

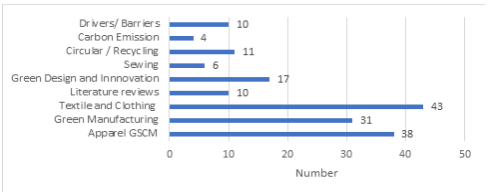

FIG 5. Area of research

Trends in Green Supply Chain

To achieve the goal of this research, mapping of Green Development Areas, Environmental Management Strategies, Green Innovation Strategies, Green Manufacturing Strategies, Green Consumer Behaviour, LCA, and so on is carried out in the apparel manufacturing industry. Furthermore, the study provides a taxonomy of drivers and challenges based on various aspects of sustainability.

1. *Green Development Areas* Several studies on sustainable development have been carried out by academics from different disciplines, involving a variety of research fields, including sustainable fashion supply chain management (Koksalet al., 2017; Shen, 2014; Turker and Altuntas, 2014; Niinimakiet al., 2020), green consumption behaviour (Hong & Kang, 2019; Rausch & Kopplin, 2021), green production, ethical apparel (Carey & Cervellon, 2014), green design (Fletcher, 2014), and green business models (Becker-Leifhold & Iran, 2018; Hirscher et al., 2018), retailing and sales (Ashworthet al., 2006; Leeet al., 2012; Yanget al.,2017), recycling and disposal (Norum, 2017; Shimet al., 2018; Yeeet al., 2016; Zurgaet al., 2015). Utilizing green practices gives organizations a competitive edge (Liet al., 2016), addresses resource shortages (Desore and Narula, 2018), and promotes long-term growth in garment businesses (Todeschini et al., 2017). According to Jia and Jiang (2018) and dos Santos and Campos (2020), green procedures may save natural resources, cut waste production, and maintain operational quality. They also promote the "triple bottom line" of green practices (Cassen, 1987). According to Manage, D. S., and Dissanayake's research (2021), only a few Sri Lankan clothing companies have adopted all of the GSCMPs deemed required to establish a closed-loop supply chain. Green production is used the most in the GSCMP of firms under examination, whereas green delivery is utilized the least.
2. *Green business model strategies* Teece (2010) defines a business model as the framework for a company's means of generating, providing, and acquiring value. The garment industry has utilised sustainable business model ideas. (Nosratabadi et al., 2019; Pal & Gander, 2018; Todeschini et al., 2017; Weissbrod & Bocken, 2017). By offering strategies that support businesses in achieving their financial and sustainability objectives, the sustainable business model efficiently lowers the adverse impact of company operations on surroundings and society. Researchers tried to provide tools and methodologies for building sustainable business models as a result of adverse ecological and societal repercussions. For instance, Kozlowski et al. (2018) offered a business model canvas with twelve bricks based on the creation of a unique design tool called the re Design canvas to ensure that business owners create a long-lasting apparel brand. Hirscher et al. (2018) suggested using DIY and DIY-together design methodologies to turn users into value creators to develop sustainable business models for TA design and manufacture. Furthermore, few research investigations have explored different models of business for apparel, such as cooperative consumption models. (For example, renting, collaborating, and exchanging)

(Armstrong et al., 2015, 2016; Becker-Leifhold & Iran, 2018; Iran & Schrader, 2017; Pal, 2017; Strähle & Erhard, 2017; Todeschini et al., 2017) and upcycled goods (Pal, 2017). Studies have focused on numerous tactics for giving the TAI's business model a sustainable component, including innovation, a distinct advantage and a model framework. (Westerlund, 2013; Sorescu et al., 2011).

3. *Environmental Management Strategies* In developed nations, various industries are implementing a wide range of strategies for environmental management, like implementing greener technologies (Chan et al., 2018); obtaining certification (ISO14001) in the environmental management system; establishing and perpetuating appropriate SCM practises that remain accountable for green society, lowering toxic waste output (Moazzem et al., 2021), circular economy practices (Sharma et al., 2021), and other measures to lessen the adverse the ecological impacts arising from their present manufacturing processes and SCM.
4. *Green Innovation* The most important aspect of GSCM is to use clean, green technology to innovate processes, products, and the environment (De Brito et al., 2008) In this setting, industry and academics are increasingly considering sustainability when creating clothing designs. According to researchers, "green innovation" encompasses recycling, environmentally friendly product designs, reduced energy use and pollutant emissions, as well as process innovation and organisational green culture (Olson et al., 2005). The implementation of SDTAI requires designers (Kozlowski et al., 2019; Niinimaki & Hassi, 2011). A significant impact is through the choice of materials, the use of energy and water, manufacturing techniques, and consumer purchases, uses, and recycling of garments. (Kozlowski et al., 2018). Additionally, a variety of strategies to follow to achieve sustainability are mentioned in Fig. 6. Innovations in products and processes have been created to produce better manufacturing methods that reduce harmful environmental consequences. Research and development provide the organization with innovative products, and production processes that enhance market positioning and raise the firm's value through distinctiveness, quality, and other factors (Shimet et al., 2016) Innovative businesses expand and embrace green manufacturing techniques, which boost their market share. The adoption of green practices was correlated with internal business features such as cultural innovation and social responsibility attitudes. Innovation and aggressive action have a favourable and significant influence on the garment industry's export performance, according to Choi, D., and Han, T. I. (2019). Azmi, I. B. A. G. and Hossain, K. (2021). (2015). Choi (2019) conducted a study on China's textile and apparel sectors, and the results imply that internal firm traits, such as cultural innovation and socially responsible attitudes, are associated with the adoption of green practices.
5. *Green training* As it addresses environmental, social, and environmental problems at many levels, GT is a crucial component of research. 2017 (Masri & Jaaron). According to Jabbour (2015), green Training has a favourable relationship with the firm's ecological

growth. It aids workers in learning how to lessen the environmental effect of the company (Tang et al., 2018). According to research, GT is crucial to the green industry's economics (Jackson et al., 2013). The influence of green performance and green reward on employee performance was proved using multiple regression analysis, according to Sagalee, I. L. L. (2021), research in the Sri Lankan clothing sector. Employee performance is not materially affected by green training.

6. *Green suppliers,* Western garment businesses should work with suppliers to improve sustainable practices and reduce environmental effects, according to research studies (Koksalet al., 2017). A fuzzy "multi-criteria decision-making" (MCDM) framework and the triple bottom line technique are used to evaluate and choose green suppliers, according to Zhang, D., and Yang, J. (2017). Guo, Z., and Liu, H., investigate how well-versed international purchasers are in social management in Bangladesh's garment sector. Asif (2017) set out to look at the general sustainability situation in the apparel manufacturing sector, the reasons driving suppliers in developing nations to adopt sustainable and socially responsible practices, and the potential and challenges associated with implementation.
7. *Green Manufacturing* Green manufacturing refers to a methodical, sustainable strategy for producing goods and providing services without harming the environment Douglas (IPCC, 2009). The use of products, methods, and materials that have significant beneficial benefits on the economy and environment while having little to no short-term negative consequences on the health of customers is another way to define green manufacturing. (Das, 2013). Environmentally responsible manufacturing, as per the "United Nations Development Programme" (UNDP), is essential to protecting the environment. Businesses adopt more environmentally friendly manufacturing techniques to minimise the effect of goods and processes on the surroundings. (Hens L et al., 2018); H. Yüksel, 2008). Globally, various scholars have assessed environmentally friendly methods of producing textiles and clothing. (Saxena, A., and Khare, A.K. 2021; Baskaran, 2014; Caniato, 2015). Using research on ecologically friendly production techniques, Islam et al. (2021) created a theoretical framework for the textile and garment industry; Thorisdottir and Johannsdottir (2020) investigated CSR in the fashion industry between 2003 and 2019; the Textile and Apparel Industry (TAI) model was made as a consequence of Jia et al.'s inquiry into the circular economy and comprised practices, barriers, drivers, and solutions. Findings from past studies indicate that the fashion industry has embraced the concept of green production more frequently. Cay A. (2018) contends that adopting more environmentally friendly manufacturing practices is essential for sustainable production. Only companies utilizing environmentally friendly manufacturing processes and economical raw materials, energy, and water consumption will be able to reach output requirements. (2007) Glavic P. et al.For instance, Moon et al. (2013) suggested developing clothing-related products that conserve energy. The findings provided designers with useful

information for developing energy-saving products and helped firms properly understand the environmental requirements of various clientele. The problems facing the garment business were studied by Curwen et al. (2013) a real-world case study of making ecologically friendly apparel. They came up with some ideas on how to make the business sustainable. Additionally, several academics have predicted that integrating green manufacturing utilizing Chinese fashion enterprises will be particularly challenging shortly due to factors including restricted capacity and rising costs (Choi et al. 2017). Sustainable production techniques have been created and effectively applied in clothing companies all around the world. Redesigning waste management and contamination control systems has been the attention of several studies. Numerous research has also concentrated on revamping the production process from a sustainable environmental standpoint. For instance, several technologies have been used in businesses, which are listed in Fig 6.

8. *LCA* It serves as a decision-making tool for sustainable development across all the stages of the life span of apparel items, comprising sourcing of materials needed for creation, assembly, transit, dispersion, use, and disposal (Yasin et al., 2016). LCA provides a scientific framework for managing environmental sustainability and evaluating it, while also outlining potential areas for improvement. Because of this, LCA has gained widespread acceptance among academics researching green garments (Kazan et al., 2020). The research in LCA includes items such as carpets, cotton T-shirts, antibacterial T-shirts, carpet tiles, cloth diapers, etc as mentioned in Fig 6.

9. *Consumers,* The garment industry needs a sustainability strategy since it caters to consumers and is heavily influenced by public opinion. (Macchionet al., 2018). This is necessary for corporate growth and strategic advantage. It is now more important than ever to incorporate green practices since garment consumers regularly discuss issues related to society and the surroundings. (Macchain et al., 2018). Niinimäki (2010) discussed consumer decisions and the use of eco-friendly clothing. According to their results, moral conviction and aspirations are important drivers of eco-friendly apparel purchases. Fig 6 provides a list of the research topics on consumer purchasing habits for green clothing.

10. *Drivers and Challenges* Several scholars have studied the drivers and obstacles to sustainable supply chain management. Another query is if regulatory constraints, customer demands, or competitive pressure are the primary factors affecting the adoption of green production in the garment industry. Managers and top executives are responsible for identifying important factors from the point of view of those involved if they want to implement green technologies.

10.1 *Drivers* To hasten the adoption of sustainable practices and technologies, garment makers must consider several crucial factors. These variables include the backing of top management (TM) (Fuet al., 2018; Wenget al., 2015; Qureshiet al., 2019), technological, organizational, and environmental aspects of green practices, government

Green development Areas	
Sustainable fashion supply chain management	K€oksalet al., 2017; Shen, 2014; Turker and Altuntas, 2014; Niinimakiet al., 2020
Sustainable consumption behaviour	Hong & Kang, 2019; Rausch & Kopplin, 2021
Sustainable production, ethical apparel	Carey & Cervellon, 2014
Sustainable design and innovation	Fletcher, 2014)
Sustainable business models	Becker-Leifhold & Iran, 2018; Hirscher et al., 2018
Sustainable retailing and sales	Ashworthet al., 2006; Lee et al., 2012; Yanget al.,2017
Recycling and disposal	Norum, 2017; Shim et al., 2018; Yee et al., 2016; Zurga et al., 2015
Closed-loop supply chain	Manage, D. S., and Dissanayake's, 2021
Environmental Management Strategies	
Certification (ISO14001)	Quintana et. al., 2021
Social sustainability	Moktadir et. al 2018
Cleaner technology	Chan et.al.,2018
Minimize the hazardous emissions	Yaghin et.al. 2021
Reduce Toxic waste generation	Moazzem et. al., 2021
Circular economy practices	Sharma et. al., 2021
Green business model strategies	
re Design canvas	Kozlowski et al., 2018
Do-it-yourself and do-it-together design strategies	Hirscher et al., 2018
Collaborative consumption models	Armstrong et al., 2015, 2016; Becker-Leifhold & Iran, 2018; Iran & Schrader, 2017; Pal, 2017; Strähle & Erhard, 2017; Todeschini et al., 2017
Upcycled goods	Pal., 2017
Green Innovation Strategies	
Slow fashion	Tefko & Steffek, 2018
R's principles	Early, 2017
Circularity	Lieder and Rashid, 2016; Moorhouse and Moorhouse
Longevity design	Connor-Crabb et al., 2016; Niinimaki & Hassi, 2011
Cradle-to-cradle design	Michel & Lee, 2017
Closed loop fashion	Araet al., 2019
Eco-design	Kozlowskiet al., 2018
Upgrade recycling and remanufacturing design	Han et al., 2017
Green Manufacturing Strategies	
Renewable energy in production	Na & Na, 2015; Niin-imāki & Hassi, 2011; Şen, 2008; Sezen, 2013
conserve natural resources, reduce waste generation and sustain quality in operations	Jia and Jiang, 2018; dos Santos and Campos, 2020
Achieving certification (ISO14001/WRAP, LEED) in the environmental management system	Quintana et. al., 2021
Social sustainability practices	Moktadir et. al 2018
Adopting cleaner technology	Chan et.al.,2018
Minimizing the hazardous emissions	Yaghin et.al. 2021
Reducing toxic waste generation	Moazzem et. al., 2021
Circular economy practices	Sharma et. al., 2021
Green consumer behaviour	
Consumer demand	Butler, 1997; Dickson, 2000
Consumer awareness	Harris et al., 2016
Eco-labelling and sustainability labelling	Almeida 2015 and Ma et al. 2017
Consumer purchases of green sportswear	Nam et al. 2017
Ethical fashion consumption behaviour	Saricam and Okur, 2019
Moral Philosophy and moral intensity	Hong and Kang, 2019
Attitude-behaviour gap	Maloney et al., 2014; Phau et al., 2015; Wiederhold & Martinez, 2018
Life cycle assessment (LCA of Merchandise)	
Medical textiles	Ponder, 2009
Bed sheets	De Saxce et al., 2012
Cotton T-shirts	Kazan et al., 2020; Zhang et al., 2015
Recovered cotton	Esteve-Turrillas & de la Guardia, 2017
Antibacterial T-shirts	Manda et al., 2015
Carpets	Sim & Prabhu, 2018
Cloth diapers	Hoffmann et al., 2020

FIG 6. Trends in Green Supply Chain Research

regulations (Qiet al., 2010; Wenget al., 2015), customer concerns (Thgersen and Zhou, 2012; Wenget al., 2015), and competitive environments (Fuet al., 2018; Lin and Ho, 2011). The Diabat et al. (2014) study identified several factors that are essential for implementing sustainable supply chain management, including employee participation, stability, and community economies. According to Li et al.'s 2014 study, improving internal corporate governance and productively collaborating with stakeholders may make it easier to realize the sustainability of the fast fashion supply chain management. The essay examines Sri Lankan garment producers' motivations and the environmental conditions they accept. The results show that GVCs, especially for businesses in relational networks, act as both a catalyst for environmental upgrading and a means of obtaining the knowledge needed to do so. (2015). Khattak, A., Stringer, C., Benson-Rea, & Haworth.

10.2Barriers Technology shortcomings, a lack of employee awareness, traditional mindsets towards traditional buildings, a lack of government support, a lack of inter-sectoral coordination among related sectors, and a shortage of subject-matter experts in Sri Lankan apparel companies are the main barriers to advancing green environmental planning. A. W. G. N. M. Abeyrathna (2019). It is crucial to include sustainability in textile and apparel (TA) business models to identify obstacles and disruptions that prevent the achievement of goals for economic, environmental, or social sustainable development (Manninen et al., 2018). Guo, H. (2022) claims that the research study conducted in China enumerates and prioritizes the obstacles to the adoption of GM in the garment industry. The challenges and difficulties that the apparel manufacturing sector has encountered in implementing green manufacturing are all outlined in Figure 7 in accordance with the findings of the research articles examined.

Main Drivers	
Top management (TM) support	Fuet al., 2018; Weng et al., 2015; Qureshiet al., 2019
Technological, organizational, and environmental aspects of green practices, government regulations	Qiet al., 2010; Weng et al., 2015
Buyer concerns	Thgersen and Zhou, 2012; Weng et al.,2015
Competitive environments	Fuet al., 2018; Lin and Ho, 2011
Major Challenges	
· Technological shortcomings · Lack of employee awareness · Traditional mindsets towards traditional buildings · A lack of government support · A lack of inter-sectoral coordination among related sectors · A shortage of experts	Abeyrathna, A. W. G. N. M. (2019).
· High costs · Poor utility supply · A lack of top management support · Suppliers	Rahman, S., Quaddus, M. A., & Shi, Y. (2023).
14 important barriers including · Poor infrastructure · A lack of government initiatives	Gardas, B. B., Raut, R. D., & Narkhede, B. (2018)
Internal obstacles · Lack of understanding and expertise in sustainable design · Lack of design-led approaches · Perceived trade-offs with other design requirements, such as aesthetics, cost, and fashion trends External obstacles · The intricacy of sustainability issues · Perceived insufficient customer demand, attitudes and behaviour gap in consumer purchase behaviour	Hur, E., & Cassidy, T. (2019).

FIG. 7. Drivers and Challenges

Conclusion

The purchase of raw materials, their preparation and manufacture, delivery, transit, customer consumption and recycling all result in important ecological and societal implications. Sustainability challenges in the TAI have gotten a lot of attention from practitioners and scholars.

However, this research is rarely thoroughly evaluated. The research being conducted seeks to improve apparel manufacturing by mapping out green strategies in the areas of green development, environmental management, green innovation, green manufacturing, green consumer behaviour, and LCA. The research provides information, evaluates recent findings, outlines relevant strategies, and offers

academics and industry people helpful resources. As a result of a literature analysis conducted in this field, the most significant drivers and difficulties are also identified. Additionally, pertinent research data need to be updated often, and future studies might further strengthen the apparel manufacturing knowledge roadmap as investigate concepts and uses within the realm of clothing manufacturing expand and advance.

Some potential areas for more research are indicated based on an examination of the apparel supply chain during the previous ten years. First, there is a wider area of research on the habits of apparel consumers for sustainable consumption. Second, there is a paucity of quantitative research on the contributing elements, techniques, and tools for sustainable design. Third, the use of case studies to illustrate the strategy for implementing sustainability in the sector is lacking, which would encourage its adaptation. Fourth, as science and technology advance and industry 4.0 capabilities like blockchain, the IoT, big data analysis, and visualization become available, it will be possible to attain accountability, genuineness, and the ability to track ecological information in garments in the future.

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