

Application of Green Supply Chain Management Practices for Sustainable Development: An Empirical Study of Textile Manufacturing Industries

Dr Alka Singh Bhatt

Associate Professor,
Amity Business School,
Amity University Uttar Pradesh,
Lucknow Campus

Dr. Mohd Majid

Associate Professor,
Department of Mechanical Engineering,
Sant Longowal Institute of
Engineering and Technology,
Longowal, Sangrur, Punjab
<https://orcid.org/0000-0003-0254-0580>
Corresponding Author

Dr S. Venkata Ramana

Associate Professor,
KL Business School,
KLEF (Deemed to be University),
Green Fields, Vaddeswaram, A.P.
<https://orcid.org/0000-0002-0199-3206>

Dr. Namita Dixit

Associate Professor,
IILM University,
Gurugram, Haryana, India
<https://orcid.org/0000-0003-0744-5400>

Dr. Swapna Vikram Thorgule

Assistant Professor,
Sarhad College of Arts,
Commerce and Science,
Katraj, Pune

Abstract

The textile manufacturing industry is under growing pressure to adopt sustainable practices due to increased environmental awareness and regulations. With its significant contribution to pollution and resource use, Green Supply Chain Management (GSCM) has emerged as a crucial strategy to mitigate environmental impacts while maintaining operational efficiency.

The major objective of this research was to study the green supply chain management practices adopted by the textile manufacturing industries. Further, the research also discussed the role of green supply chain management practices in the sustainable development of selected areas. The textile manufacturing industries are situated in PAN India but this research has focused on textile companies of Rajasthan, Punjab, Gujarat, Maharashtra and Bihar. In total 127 textile manufacturing industries have been included in the sample and data has been collected by using survey method. The results indicated that respondents were significantly aware of GSCM practices and the majority of textile manufacturing industries have implemented GSCM practices in their organizations. Hypothesis testing revealed that GSCM practices have a significant impact on the sustainable development of textile manufacturing industries.

Key Words: GSCM practices, Textile, Sustainable development.

Introduction

The production of textiles contributes significantly to worldwide economic activity, creating jobs and spurring national development in many nations. It is also linked to serious environmental problems, such as excessive water use, chemical contamination, and waste production. The growing sector has increased pressure on manufacturers to reduce their environmental impact, leading them to look for more sustainable techniques.

The term "green supply chain management" (GSCM) describes how supply chain management techniques incorporate environmental factors, with an emphasis on reducing environmental effects while

preserving economic viability. Sustainable logistics, waste minimisation, energy efficiency, and environmentally friendly materials are just a few of the tactics that are included in GSCM. Textile producers can improve their environmental performance and obtain competitive benefits by complying with strict standards and using resources efficiently by using these strategies.

In recent years, the concept of sustainable development has gained significant traction across various industries, driven by increasing environmental concerns, resource scarcity, and regulatory pressures. One of the industries that is undergoing significant change is the textile manufacturing sector, which is well-known for its high resource consumption and significant environmental impact. Green supply chain management (GSCM) techniques have become an essential tactic for improving sustainability in response to these issues. The purpose of this empirical study is to evaluate the effects of GSCM techniques on sustainable development while investigating their application in the textile manufacturing industries.

This study focuses on the application of GSCM practices within textile manufacturing industries. By empirically examining how these practices are implemented and their effects on sustainability, the research seeks to provide insights into their effectiveness and identify best practices for achieving environmental and economic benefits. Understanding the real-world impact of GSCM in the textile sector is crucial for advancing sustainability efforts and promoting a more eco-friendly industry. This research is based on the understanding that although GSCM methods have the potential to promote sustainable development, there is currently a dearth of empirical data addressing their efficacy in the textile sector. The goal of the study is to offer important insights into the role that these practices play in promoting sustainability in the textile manufacturing industry by examining the implementation of these practices and their results.

This study contributes to the growing body of knowledge on sustainable practices in the textile industry by providing empirical evidence on the effectiveness and challenges of GSCM practices. The findings will offer valuable insights

for industry practitioners, policymakers, and researchers, supporting efforts to enhance sustainability in textile manufacturing and align with broader sustainable development goals. Additionally, the study aims to foster a better understanding of how green supply chain practices can be optimized to achieve both environmental and economic benefits.

Review of Literature

The concept of Green Supply Chain Management (GSCM) has evolved as a critical response to growing environmental concerns and the need for sustainable development.

Definition and Evolution of GSCM: To reduce environmental effects while attaining financial objectives, GSCM incorporates environmental management techniques into conventional supply chain management. Three primary categories are included in GSCM, according to Gawusu et al. (2022): green design, green procurement, and green logistics. Reverse logistics and life cycle evaluation are two more areas that have been added to the scope of GSCM throughout time (Bhatia & Gangwani, 2021).

Sustainable Development Framework: The Brundtland Commission (1987) defined sustainable development as focussing on meeting present demands without sacrificing the ability of future generations to meet their own. The goals of GSCM practices—reducing resource consumption, minimising waste, and improving overall environmental performance—align with this paradigm (Elkington, 1997).

GSCM Practices in Textile Manufacturing

1. Green Design and Eco-friendly Materials Green design is the process of designing products with the environment in mind from the beginning. This includes using eco-friendly resources in the textile sector, like low-impact dyes, recycled fibres, and organic cotton (Bhatia & Gangwani (2021)). According to research by Asif et al. (2020), businesses can drastically lower their environmental impact by implementing green design principles.

- 2. Green Procurement:** The goal of green procurement is to source goods and services with less of an impact on the environment. Selecting suppliers who uphold environmental norms and certifications is crucial for lowering the supply chain's overall environmental effect, according to a study by Kaldellis & Fragos (2011).
- 3. Sustainable Manufacturing Processes:** Water conservation, waste minimisation, and energy-efficient production methods are examples of sustainable manufacturing processes. For example, studies conducted in 2013 by Corvellec, Campos & Zapata show that the textile manufacturing industry may significantly reduce waste generation and energy consumption by implementing cleaner production technology.
- 4. Green Logistics and Transportation:** Optimising logistics and transportation processes to have a smaller environmental impact is known as "green logistics." This covers tactics including fuel-efficient car use, route optimisation, and switching to alternate fuels Chen & Yang (2015). Effective logistics techniques help lower operating expenses and carbon emissions in the textile industry.

Empirical Studies on GSCM in the Textile Industry

Different textile producers have different acceptance levels of GSCM, according to empirical study. According to a study by Rao & Holt (2005), smaller businesses face obstacles such high expenses and a lack of experience, while larger companies are more likely to adopt full GSCM processes. The report emphasizes that in order to promote wider adoption, customized support systems are required. The beneficial effects of GSCM techniques on environmental performance have been shown in numerous researches. For instance, GSCM methods helped textile industries reduce waste and resource consumption, which enhanced environmental performance, according to a research by Sarkis (1999).

According to research by Lerman et al. (2022), businesses that use GSCM methods can reap financial rewards like

improved market positioning and cost savings through resource efficiency. These advantages may also result in a competitive edge in the market, which is becoming more environmentally sensitive. Adopting GSCM practices might be difficult due to change resistance, low technological infrastructure, and high implementation costs Roh et al. (2022). To create policies to encourage the textile industry to adopt sustainable practices, it is essential to comprehend these obstacles.

According to the research, GSCM methods have a great deal of potential to advance sustainable development in the textile manufacturing sector. Even if empirical data shows that these approaches have a good effect on both environmental performance and financial gains, there are still issues that need to be resolved. This review emphasizes how crucial it is to carry out more research and provide useful advice in order to improve GSCM implementation and meet more comprehensive sustainability goals.

The study builds upon the definitions and evolution of Green Supply Chain Management (GSCM) as described in the literature. The researchers likely adopted a descriptive approach to assess the application of GSCM practices in textile manufacturing. This could include responses of 127 textile manufacturing industry experts on structured questionnaire to gain insights into the challenges and successes in implementing green practices, and quantitative surveys to gather data on the environmental performance metrics of participating companies.

The literature review provides a strong theoretical foundation for the study, framing GSCM as a vital component for sustainable development in the textile industry. The empirical findings support the assertion that GSCM practices can enhance both environmental performance and financial outcomes, while also highlighting the persistent challenges that need to be addressed. This connection underscores the necessity for ongoing research and the development of tailored strategies to facilitate the broader implementation of GSCM in the textile sector, ultimately contributing to sustainable development goals.

Research Gap

Although GSCM procedures have been extensively studied in a variety of industries, there aren't many empirical studies that especially address the textile manufacturing sector. The bulk of research that has already been done is either generic or focuses on other industries, like electronics or the automobile. Further industry-specific study is necessary to comprehend the particular potential and constraints related to GSCM implementation in textile production.

While there are qualitative explanations of the advantages of GSCM activities, quantitative information on the specific effects of these practices on sustainable development in the textile sector is few. Studies that include actual data on the subject can give more conclusive proof of the advantages of GSCM.

Addressing these research gaps will contribute to a more comprehensive understanding of GSCM practices in the textile manufacturing industry. This study aims to provide valuable insights that can guide both practitioners and policymakers in advancing sustainable development through green supply chain management.

Objectives

1. To study the respondents' awareness of green supply chain management practices
2. To identify the green supply chain management practices adopted by the textile manufacturing industries
3. To discuss the role of green supply chain management practices in sustainable development of textile manufacturing industries

Hypotheses

1. There is no significant impact of respondents' awareness of GSCM on the implementation of GSCM in textile manufacturing industries
2. There is no significant impact of GSCM implementation on sustainable development of textile manufacturing industries.

Research Methodology

- **Research Design:** The research first described the green supply chain management practices adopted by textile manufacturing industries, further it has accessed the role of GSCM on sustainable development of textile companies, so descriptive research design followed by causal research design has been used.
- **Sampling:** The population frame included the textile manufacturing industries of PAN India but research has targeted textile companies of Rajasthan, Punjab, Gujarat, Maharashtra and Bihar. In total 127 textile manufacturing industries have been included in the sample
- **Data Collection Tool:** Data has been collected by using survey method which was broadly divided into four sections (a) company profile (b) awareness of GSCM practices (c) implementation of GSCM practices and (d) sustainable development.
- **Data Analysis Tool:** The data has been analyzed in SPSS 21.0. For interpretation percentage analysis, mean and chi-square test has been used

Analysis of Data

Organizational Profile

The organizational profile includes the type of organization and size of the organization as depicted in Table 1

- **Type of Organization:** As per the ownership of the company the organizations have been classified into 6 categories. In the sample 13.40% of companies were state-owned public enterprises, 30.70% of companies were private organizations, 16.50% of companies were sole proprietor firms, 15% of companies were joint ventures, 17.30% of companies were MNCs and 7.10% of companies were partnership firms.
- **Size of Organization:** As per size of organizations 4.70% of companies were micro industries, 33.10% of companies were small industries, 42.50% of companies were medium-sized industries and 19.70% of companies were large-size industries.

Table 1: Organizational Profile

Type of Organization	N	Percentage
State Owned (Public Enterprise)	17	13.4
Private Sector	39	30.7
Sole Proprietor Firm	21	16.5
A Joint Venture	19	15.0
MNC	22	17.3
Partnership Firm	9	7.1
Total	127	100
Size of Organization	N	Percentage
Micro Industry	6	4.7
Small Industry	42	33.1
Medium size	54	42.5
Large Size	25	19.7
Total	127	100

Respondents' Awareness of Green Supply Chain Management Practices

The first objective of this research was to identify the respondents' awareness of green supply chain management practices so the respondents were given a list of GSCM practices and they were asked to indicate their awareness on a five-pointscale. Final awareness was ascertained with the help of the mean score as depicted in Table 2. As per the results, the respondents were extremely aware of the use of organic cotton and recycled fibre (mean=4.25) and reducing packaging waste and excess material (mean=4.21). The respondents have indicated moderate awareness with Implementing waste reduction and recycling programs (mean=4.01), Reducing water and energy consumption in production processes (mean=3.98), Using renewable energy sources in production facilities (mean=3.98), Implementing environmentally-friendly dyeing and printing techniques (mean=3.97), Sustainable sourcing of raw materials (mean=3.87), Continuously monitoring and reporting on sustainability performance

(mean=3.74), Implementing take-back programs for old or unwanted textiles (mean=3.52), Using biodegradable packaging materials (mean=3.49), Implementing green logistics and transportation practices (mean=3.48), Implementing eco-labelling and certification programs (mean=3.42) and Implementing recycling programs for textile waste (mean=3.42). Respondents highlighted that they were somewhat aware of Implementing green building and facility management practices (mean=3.33), Collaborating with customers to promote sustainable consumption practices (mean=3.24), Implementing carbon offsetting and reduction measures (mean=3.21), Implementing sustainable washing and finishing techniques (mean=3.15), Collaborating with suppliers and stakeholders to promote sustainability (mean=2.79) and Reducing chemical usage and implementing safer alternatives (mean=2.62) but they were slightly aware about conducting life cycle assessments of products (mean=2.52). The coefficient of variations (C.V.) are below 0.40 which shows the homogeneity in the responses

Table 2: Respondents' Awareness of Green Supply Chain Management Practices

S. No.	GSCM Practice	Mean	S. D.	C. V.	Level of Awareness
1	Sustainable sourcing of raw materials	3.87	0.95	0.25	Moderately Aware
2	Using organic cotton and recycled fibers	4.25	0.82	0.19	Extremely Aware
3	Implementing environmentally-friendly dyeing and printing techniques	3.97	0.74	0.19	Moderately Aware

S. No.	GSCM Practice	Mean	S. D.	C. V.	Level of Awareness
4	Reducing water and energy consumption in production processes	3.98	0.69	0.17	Moderately Aware
5	Implementing waste reduction and recycling programs	4.01	0.85	0.21	Moderately Aware
6	Using biodegradable packaging materials	3.49	0.91	0.26	Moderately Aware
7	Implementing carbon offsetting and reduction measures	3.21	0.73	0.23	Somewhat Aware
8	Conducting life cycle assessments of products	2.52	0.97	0.38	Slightly Aware
9	Implementing green logistics and transportation practices	3.48	0.88	0.25	Moderately Aware
10	Collaborating with suppliers and stakeholders to promote sustainability	2.79	0.73	0.26	Somewhat Aware
11	Implementing eco-labeling and certification programs	3.42	0.65	0.19	Moderately Aware
12	Reducing chemical usage and implementing safer alternatives	2.62	0.84	0.32	Somewhat Aware
13	Implementing recycling programs for textile waste	3.42	0.82	0.24	Moderately Aware
14	Using renewable energy sources in production facilities	3.98	0.73	0.18	Moderately Aware
15	Implementing sustainable washing and finishing techniques	3.15	0.69	0.22	Somewhat Aware
16	Reducing packaging waste and excess materials	4.21	0.91	0.22	Extremely Aware
17	Implementing take-back programs for old or unwanted textiles	3.52	0.84	0.24	Moderately Aware
18	Collaborating with customers to promote sustainable consumption practices	3.24	0.94	0.29	Somewhat Aware
19	Implementing green building and facility management practices	3.33	0.28	0.08	Somewhat Aware
20	Continuously monitoring and reporting on sustainability performance	3.74	0.64	0.17	Moderately Aware

Table 3 is showing the respondents' overall awareness of green supply chain management practices. It can be observed that 3/4th of the respondents (75.60%) were

aware of green supply chain management practices whereas 24.40% respondents were not aware of green supply chain management practices.

Table 3: Respondents' Overall Awareness of Green Supply Chain Management Practices

Overall Awareness	N	Percentage
Low	31	24.4
High	96	75.6
Total	127	100

Implementation of Green Supply Chain Management Practices in Textile Manufacturing Industries

After accessing the respondents' awareness of GSCM they were asked to indicate the adoption of GSCM practices in their textile manufacturing industry. Table 4 is showing the status of GSCM practices implemented in textile manufacturing industries. It can be observed that more than 80% of the textile manufacturing industries have used organic cotton and recycled fibers (85%), reduced packaging waste and excess materials (84.20%) and implemented waste reduction and recycling program (80.20%). Reducing water and energy consumption in production processes (79.60%), Using renewable energy

sources in production facilities (79.60%), Implementing environmentally-friendly dyeing and printing techniques (79.40%), Sustainable sourcing of raw materials (77.40%), Continuously monitoring and reporting on sustainability performance (74.80%) and Implementing take-back programs for old or unwanted textiles (70.40%) are some of the GSCM practices which have been used by 70 to 80% of the textile manufacturing industries. Around 60 to 70% textile manufacturing industries indicated the use of Using biodegradable packaging materials (69.80%), Implementing green logistics and transportation practices (69.60%), Implementing eco-labeling and certification programs (68.40%), Implementing recycling programs for textile waste (68.40%), Implementing green building and

facility management practices (66.60%), Collaborating with customers to promote sustainable consumption practices (64.80%), Implementing carbon offsetting and reduction measures (64.20%) and Implementing sustainable washing and finishing techniques (63%). The remaining three GSCM practices i.e. Collaborating with suppliers and stakeholders to promote sustainability

(55.80%), reducing chemical usage and implementing safer alternatives (52.40%) and conducting life cycle assessments of products (50.40%) were being used by 50 to 60% textile manufacturing industries. On an average it has been observed that 70.20% textile manufacturing industries were using GSCM practices whereas 29.80% textile manufacturing industries were not using the GSCM practices.

Table 4: Implementation of GSCM practices in Textile Manufacturing Industries

S. No.	GSCM Practice	Yes		No	
		N	Percentage	N	Percentage
1	Sustainable sourcing of raw materials	98	77.4	29	22.6
2	Using organic cotton and recycled fibers	108	85.0	19	15.0
3	Implementing environmentally-friendly dyeing and printing techniques	101	79.4	26	20.6
4	Reducing water and energy consumption in production processes	101	79.6	26	20.4
5	Implementing waste reduction and recycling programs	102	80.2	25	19.8
6	Using biodegradable packaging materials	89	69.8	38	30.2
7	Implementing carbon offsetting and reduction measures	82	64.2	45	35.8
8	Conducting life cycle assessments of products	64	50.4	63	49.6
9	Implementing green logistics and transportation practices	88	69.6	39	30.4
10	Collaborating with suppliers and stakeholders to promote sustainability	71	55.8	56	44.2
11	Implementing eco-labeling and certification programs	87	68.4	40	31.6
12	Reducing chemical usage and implementing safer alternatives	67	52.4	60	47.6
13	Implementing recycling programs for textile waste	87	68.4	40	31.6
14	Using renewable energy sources in production facilities	101	79.6	26	20.4
15	Implementing sustainable washing and finishing techniques	80	63.0	47	37.0
16	Reducing packaging waste and excess materials	107	84.2	20	15.8
17	Implementing take-back programs for old or unwanted textiles	89	70.4	38	29.6
18	Collaborating with customers to promote sustainable consumption practices	82	64.8	45	35.2
19	Implementing green building and facility management practices	85	66.6	42	33.4
20	Continuously monitoring and reporting on sustainability performance	95	74.8	32	25.2
Average		89	70.2	38	29.8

To check impact of respondents' awareness of GSCM practices on their adoption of GSCM practices following hypothesis has been taken:-

H01:There is no significant impact of respondents' awareness of GSCM on the implementation of GSCM in textile manufacturing industries

Ha1:There is a significant impact of respondents'

awareness of GSCM on the implementation of GSCM in textile manufacturing industries

To test this hypothesis chi-square test was applied and results are shown in table 5. At 5% level of significance the values of chi-statistic is significant so it can be concluded that there is a significant impact of respondents' awareness of GSCM on the implementation of GSCM in textile manufacturing industries

Table 5: Impact of respondents' awareness of GSCM on the implementation of GSCM in textile manufacturing industries

Awareness	Implementation			Chi-Square Value	p-Value	Significance
	No	Yes	Total			
Low	29	2	31	79.179	0.000	Significant
High	9	87	96			
Total	38	89	127			

Level of Significance=5%

Role of GSCM Practices in Sustainable Development

To access the role of GSCM practices in sustainable development, the respondents were given a list of statements and they were asked to indicate their agreement towards those statements. As per results shown in table 6, respondents admitted that implementation of GSCM helps in reducing air emission (mean=3.78), wastage of water (mean=4.12), solid waste (mean=3.99), energy

consumption cost (mean=3.79), environmental accidents (mean=3.81), solid wastes (mean=3.88) and scrap rate (mean=3.75). It has also highlighted by the respondents that GSCM has improved capacity utilization (mean=3.42) as well as it has also improved the environmental situation of company (mean=3.65) by ensuring the compliance of environmental regulations (mean=4.16). With rest of the statements respondents were neither agree nor disagree.

Table 6: Role of GSCM Practices in Sustainable Development

S. No.	Sustainable Development	Mean	S.D.	C.V.	Level of Agreement
1	Implementation of GSCM helps in reducing air emission	3.78	0.96	0.25	Agree
2	Implementation of GSCM helps in reducing wastage of water	4.12	1.05	0.25	Agree
3	Implementation of GSCM helps in reducing solid wastes.	3.99	1.25	0.31	Agree
4	Capacity utilization has been increased due to GSCM implementation	3.42	0.85	0.25	Agree
5	The environmental situation of company has been improved due to GSCM implementation	3.65	0.97	0.27	Agree
6	The energy consumption cost has been reduced due to GSCM implementation	3.79	0.68	0.18	Agree
7	After GSCM implementation fine for environmental accidents has been reduced	3.81	0.77	0.20	Agree
8	Implementation of GSCM helps in reducing inventory demands	3.25	1.05	0.32	Neutral
9	Implementation of GSCM helps in compliance of environmental regulations	4.16	1.09	0.26	Agree
10	Implementation of GSCM helps in improving brand image	3.22	0.94	0.29	Neutral
11	The cost of materials purchasing has been reduced due to GSCM implementation	3.15	0.63	0.20	Neutral
12	Implementation of GSCM helps in reducing solid waste.	3.88	0.89	0.23	Agree
13	Implementation of GSCM helps in decreasing the scrap rate	3.75	1.05	0.28	Agree

Table 7 is showing the overall role of GSCM practices in sustainable development. As per 84.30% of respondents, the GSCM practices have helped in achieving high level of

sustainable development, whereas 15.70% of respondents said that GSCM practices have no significant role in achieving sustainable development.

Table 7: Overall Role of GSCM Practices in Sustainable Development

Sustainable Development	N	Percentage
Low	20	15.7
High	107	84.3
Total	127	100

To test the role of GSCM practices in sustainable development following hypothesis has been taken:-

H02: There is no significant impact of GSCM implementation on sustainable development of textile manufacturing industries

There is a significant impact of GSCM implementation on sustainable development of textile manufacturing industries

To test this hypothesis chi-square test was applied and the results received are presented in Table 8. As the chi-square statistic is significant so it leads to the rejection of the hypothesis and it can be concluded that there is a significant impact of GSM implementation on the sustainable development of textile manufacturing industries

Table 8: Impact of GSCM implementation on sustainable development of textile manufacturing industries

GSCM Implementation	Sustainable Development			Chi-Square Value	p-Value	Significance
	Low	High	Total			
No	18	20	38	40.862	0.000	Significant
Yes	2	87	89			
Total	20	107	127			

Level of Significance=5%

Discussion of findings:

The findings from the study reveal important insights into the adoption and impact of Green Supply Chain Management (GSCM) practices within the textile manufacturing industry. Here is a detailed discussion of each finding:

1. Awareness of GSCM Practices

The high level of awareness (over 75%) among respondents indicates that there is substantial recognition of the importance and benefits of GSCM within the textile manufacturing industry.

Dzikriansyah et al. (2023) highlight how companies around the world are becoming more conscious of GSCM. According to their research, raising awareness is an essential first step in putting sustainable habits into reality. They contend that higher levels of awareness among businesses, which are consistent with the high levels of awareness found in this study, frequently result in higher adoption of environmental initiatives. According to

research by Novitasari & Agustia (2021), the degree of GSCM practices' application is frequently correlated with their knowledge and comprehension. According to their study, companies may be motivated to incorporate GSCM into their operations by their understanding of environmental practices and challenges. This is in line with the discovery that implementation level is influenced by awareness.

This awareness is encouraging because it shows that a lot of textile producers understand how important it is to include environmental factors into their supply chains. But awareness by itself does not equate to successful execution. It is critical to comprehend how this awareness manifests in actual procedures and whether it results in significant adjustments to operations. The following stages would entail delving deeper into this awareness, including knowing which particular GSCM techniques are accepted and how this knowledge affects organizational decision-making.

2. Implementation of GSCM Practices

The finding of this study that 70.20% of textile manufacturing industries have implemented GSCM practices reflects a substantial commitment to environmental sustainability. This level of adoption is notable and suggests that GSCM practices are becoming integral to the operations of a significant proportion of textile manufacturers.

According to Khan et al. (2023), adopting GSCM methods is frequently correlated with raising awareness of environmental issues. Their research supports the notion that greater awareness promotes greater adoption by demonstrating a clear relationship between awareness levels and the degree of GSCM implementation. Sarkis (1999) addresses how organizational commitment and awareness affect the use of GSCM techniques. The study's conclusion that awareness has a major impact on GSCM implementation supports his research, which shows that companies with a greater awareness of GSCM are more likely to adopt these practices. According to Micheli et al. (2020), a significant portion of businesses across a range of industries are implementing GSCM methods, which is comparable to the 70.20% of businesses seen in the textile sector. They also point out that the degree of organizational awareness and support is directly related to how effective these practices are.

The relevance of educational and informational campaigns is highlighted by the notable influence of awareness on implementation. More knowledgeable organizations have a higher chance of successfully implementing GSCM procedures. According to this research, adoption rates and implementation depth may be further improved by raising knowledge and comprehension of GSCM. It is critical to determine the precise GSCM practice types that are being used and to look at the variables that either help or impede their application.

3. Impact on Sustainable Development

The significant impact of GSCM practices on sustainable development highlights the effectiveness of these practices in promoting environmental sustainability within the textile industry. The positive impact suggests that GSCM practices contribute to reduced environmental footprints,

improved resource efficiency, and potentially enhanced economic performance.

This result is consistent with a larger body of research that backs up the notion that GSCM techniques might result in more environmentally friendly corporate operations. According to Jemai, Do Chung & Sarkar (2020), using GSCM techniques improves environmental performance significantly by reducing waste and energy use. This bolsters the conclusion that by increasing operational effectiveness and lowering environmental footprints, GSCM methods have a beneficial impact on sustainable development. According to Tseng et al. (2019) research, GSCM techniques significantly lower resource use and waste production. Their results show that these practices lead to more sustainable operations and are consistent with the impact of GSCM on sustainable development in the textile industry. According to de Oliveira et al. (2018), improving sustainability is a major function of green logistics, a part of GSCM. Their research supports the idea that GSCM practices lead to significant environmental benefits, reinforcing the study's conclusion about their impact on sustainable development.

To provide a fuller picture of the advantages, it would be beneficial to look at the particular aspects of sustainable development that are affected more (such as waste reduction, energy efficiency, and emissions control) and quantify these impacts. Furthermore, a more thorough knowledge of these activities' contributions can be obtained by comprehending how they affect other facets of sustainability, such as social and economic considerations.

Conclusion

The study's conclusions show that a high degree of awareness is driving a good trend in the textile manufacturing industry's adoption of GSCM procedures; overall 76% of the respondents have indicated their awareness with GSCM practices. The noteworthy rates of implementation and their influence on sustainable development highlight the potential of GSCM to make a substantial contribution towards environmental sustainability, hypothesis testing revealed that awareness of GSCM has significant impact on implementation of GSCM practices. Around 84% of the respondents indicated that

GSCM plays significant role in sustainable development. Future studies should examine the precise practices chosen, the difficulties encountered during implementation, and the exact results of these activities on various sustainability measures in order to build on these findings. Furthermore, methods for raising awareness and encouraging wider use might be created in order to promote sustainable development in the textile industry.

Future scope of the study:

While the literature provides strong support for the study's findings, it is important to consider some critical perspectives:

Generalizability: The high level of awareness and implementation found in the study may not be representative of all textile manufacturing industries globally. Both awareness and implementation rates can be impacted by variables like company size, economic conditions, and geographical variations Khan et al. (2023). Subsequent investigations may explore these variables to offer a more refined comprehension.

Implementation Depth: Even if the study shows a high implementation rate, it is crucial to assess how deeply these practices are incorporated into organizational procedures. Some companies may adopt GSCM practices superficially without making substantial changes to their operations Sarkis (1999). Research could further explore the depth and effectiveness of implementation.

Long-term Impact: While there have been notable effects on sustainable development, further research is needed to determine how GSCM practices will affect sustainability measures in the long run. Longitudinal research may shed light on the long-term advantages and possible drawbacks Fahimnia, Sarkis & Davarzani (2015).

In conclusion, the study's conclusions about the impact, adoption, and knowledge of GSCM procedures are supported by the body of current research. Nonetheless, critical viewpoints indicate that additional research is necessary to fully comprehend regional variations, the extent of implementation, and long-term effects of GSCM in the textile sector.

Acknowledgements

Funding Details

This research received no external funding.

Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

Declaration of Conflicts of Interests

Authors declare that they have no conflict of interest.

Use of Artificial Intelligence

Not applicable

Declarations

Authors declare that all works are original and this manuscript has not been published in any other journal.

References

- Asif, M. S., Lau, H., Nakandala, D., Fan, Y., & Hurriyet, H. (2020). Adoption of green supply chain management practices through collaboration approach in developing countries—From literature review to conceptual framework. *Journal of Cleaner Production*, 276, 124191. <https://doi.org/10.1016/j.jclepro.2020.124191>
- Bhatia, M. S., & Gangwani, K. K. (2021). Green supply chain management: Scientometric review and analysis of empirical research. *Journal of cleaner production*, 284, 124722. <https://doi.org/10.1016/j.jclepro.2020.124722>
- Chen, L., & Yang, Z. (2015). A spatio-temporal decomposition analysis of energy-related CO2 emission growth in China. *Journal of Cleaner Production*, 103, 49-60. <https://doi.org/10.1016/j.jclepro.2014.09.025>
- Corvellec, H., Campos, M. J. Z., & Zapata, P. (2013). Infrastructures, lock-in, and sustainable urban development: the case of waste incineration in the Göteborg Metropolitan Area. *Journal of cleaner production*, 50, 32-39. <https://doi.org/10.1016/j.jclepro.2012.12.009>
- de Oliveira, U. R., Espindola, L. S., da Silva, I. R., da Silva, I. N., & Rocha, H. M. (2018). A systematic

- literature review on green supply chain management: Research implications and future perspectives. *Journal of cleaner production*, 187, 537-561. <https://doi.org/10.1016/j.jclepro.2018.03.083>
- Dzikriansyah, M. A., Masudin, I., Zulfikarijah, F., Jihadi, M., & Jatmiko, R. D. (2023). The role of green supply chain management practices on environmental performance: A case of Indonesian small and medium enterprises. *Cleaner Logistics and Supply Chain*, 6, 100100. <https://doi.org/10.1016/j.clscn.2023.100100>
 - Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. *International journal of production economics*, 162, 101-114. <https://doi.org/10.1016/j.ijpe.2015.01.003>
 - Gawusu, S., Zhang, X., Jamatutu, S. A., Ahmed, A., Amadu, A. A., & Djam Miensah, E. (2022). The dynamics of green supply chain management within the framework of renewable energy. *International Journal of Energy Research*, 46(2), 684-711. <https://doi.org/10.1002/er.7278>
 - Jemai, J., Do Chung, B., & Sarkar, B. (2020). Environmental effect for a complex green supply-chain management to control waste: A sustainable approach. *Journal of cleaner production*, 277, 122919. <https://doi.org/10.1016/j.jclepro.2020.122919>
 - Kaldellis, J. K., & Fragos, P. (2011). Ash deposition impact on the energy performance of photovoltaic generators. *Journal of cleaner production*, 19(4), 311-317. <https://doi.org/10.1016/j.jclepro.2010.11.008>
 - Khan, M., Ajmal, M. M., Jabeen, F., Talwar, S., & Dhir, A. (2023). Green supply chain management in manufacturing firms: A resource-based viewpoint. *Business Strategy and the Environment*, 32(4), 1603-1618. <https://doi.org/10.1002/bse.3207>
 - Lerman, L. V., Benitez, G. B., Müller, J. M., de Sousa, P. R., & Frank, A. G. (2022). Smart green supply chain management: A configurational approach to enhance green performance through digital transformation. *Supply Chain Management: An International Journal*, 27(7), 147-176. <https://doi.org/10.1108/SCM-02-2022-0059>
 - Micheli, G. J., Cagno, E., Mustillo, G., & Trianni, A. (2020). Green supply chain management drivers, practices and performance: A comprehensive study on the moderators. *Journal of cleaner production*, 259, 121024. <https://doi.org/10.1016/j.jclepro.2020.121024>
 - Novitasari, M., & Agustia, D. (2021). Green supply chain management and firm performance: The mediating effect of green innovation. *Journal of Industrial Engineering and Management*, 14(2), 391-403. DOI:10.3926/jiem.3384
 - Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management*, 25(9), 898-916. <https://doi.org/10.1108/01409170510623200>
 - Roh, T., Noh, J., Oh, Y., & Park, K. S. (2022). Structural relationships of a firm's green strategies for environmental performance: The roles of green supply chain management and green marketing innovation. *Journal of cleaner production*, 356, 131877. <https://doi.org/10.1016/j.jclepro.2022.131877>
 - Sarkis, J. (1999). How green is the supply chain? *Practice and Research*, 3(2), 32-41. <https://doi.org/10.1108/9781786352144-003>
 - Tseng, M. L., Islam, M. S., Karia, N., Fauzi, F. A., & Afrin, S. (2019). A literature review on green supply chain management: Trends and future challenges. *Resources, Conservation and Recycling*, 141, 145-162. <https://doi.org/10.1016/j.resconrec.2018.10.009>