Czech University of Life Sciences Prague

Faculty of Economics and Management

International Trade and Business

Master's Thesis

Circular Economy Strategies in India's Textile and Apparel Industry: Enhancing Sustainability in Fast Fashion

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DIPLOMA THESIS ASSIGNMENT

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Thesis title

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Objectives of thesis

The goal of this thesis is to study how the textile and apparel sector in India is introducing circular economic practices and how this benefits the fast fashion industry. The objectives include looking at which circular practices are already being used in the industry, checking if they're doing their job well, and working out how these practices might benefit people and the environment.

Methodology

Secondary quantitative research will be conducted to explore how the textile and apparel industry in India is affected by circular economy plans. A variety of official records, like industry reports, studies, government documents, and academic papers, will be looked at to learn how the agricultural industry uses and reacts to circular economic practices. Key variables of the research will look at ways to cut down on waste, recycle more, use goods more efficiently, and study the money side of the circular economy. Secondary data will help the study spot major trends and patterns that might be harder to notice with primary data in this industry.

Data analysis will mean going through the information step by step and using simple stats like seeing basic figures and running regular calculations. Key characteristics of the data will be found using descriptive statistics, and with regression analysis, we can see how practicing a circular economy helps save the environment and can even lead to better financial outcomes. Additionally, the study wants to see how using circular economic ideas can change important business things like how much money a company makes, how much it saves, and how happy customers are. With the help of reports and data from the industry, the research will show how these strategies are being used and what role they play in reaching sustainability goals in India's textile and apparel industry. The methodology will also look at what other countries are doing when it comes to the circular economy, helping us get a better understanding of how India's progress could help with fast fashion.

The proposed extent of the thesis

60-80 pages

Keywords

Keywords: Circular Economy, Sustainability, Textile and Apparel Industry, Fast Fashion.

Recommended information sources

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Expected date of thesis defence

2025/26 SS – FEM

Thesis supervisor

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Supervising department

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Electronic approval: 14. 11. 2025

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Electronic approval: 19. 11. 2025

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Dean

Prague on 28. 03. 2026

Declaration

I declare that I have worked on my master's thesis titled "Circular Economy Strategies in India's Textile and Apparel Industry: Enhancing Sustainability in Fast Fashion" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 31.03.2026 _____

Muhammed Shuaib Panthalungal

Acknowledgement

I would like to thank doc. Ing. Vladimír Krepl, CSc.and my family for their advice and support during my work on this thesis.

Circular Economy Strategies in India's Textile and Apparel Industry: Enhancing Sustainability in Fast Fashion

Abstract

This paper will discuss how circular economy strategies can be used to improve sustainability in India textile and apparel sector especially fast fashion. The study examines the effects of such practises like recycling, reusing water, reducing waste, and producing sustainably on the environmental and economic performance. The study is conducted with the help of a quantitative approach involving the use of secondary data on 2015-2024, which is used to conduct a descriptive analysis and regression analysis to assess the relationships between the indicators of a circular economy and the impacts of the results such as carbon emissions, water consumption, and contribution to the GDP. The evidence implies that circular practises are beneficial in terms of environmental impact especially in enhanced waste management and efficiency of resources, but their short-term economic implications are moderate. Other obstacles noted in the study are technological constraints, complexity of supply chain and consumer ignorance. On the whole, the study demonstrates that the shift to a circular economy is a key solution to long-term sustainability and competitiveness in the textile industry in India.

Keywords: circular economy, fast fashion, textile industry, sustainability, india, recycling, waste management, water reuse, resource efficiency, carbon emissions, supply chain, economic performance.

Strategie cirkulární ekonomiky v indickém textilním a oděvním průmyslu: Posílení udržitelnosti v rychlé módě

Abstrakt

Tento článek se bude zabývat tím, jak lze strategie cirkulární ekonomiky využít ke zlepšení udržitelnosti v indickém textilním a oděvním sektoru, zejména v rychlé módě. Studie zkoumá dopady takových praktik, jako je recyklace, opětovné využití vody, snižování odpadu a udržitelná výroba, na environmentální a ekonomickou výkonnost. Studie je provedena s pomocí kvantitativního přístupu zahrnujícího využití sekundárních dat za období 2015–2024, která slouží k provedení deskriptivní analýzy a regresní analýzy k posouzení vztahů mezi ukazateli cirkulární ekonomiky a dopady výsledků, jako jsou emise uhlíku, spotřeba vody a příspěvek k HDP. Důkazy naznačují, že cirkulární praktiky jsou prospěšné z hlediska dopadu na životní prostředí, zejména pokud jde o lepší nakládání s odpady a efektivitu zdrojů, ale jejich krátkodobé ekonomické dopady jsou mírné. Dalšími překážkami zmíněnými ve studii jsou technologická omezení, složitost dodavatelského řetězce a nevědomost spotřebitelů. Celkově studie ukazuje, že přechod na cirkulární ekonomiku je klíčovým řešením pro dlouhodobou udržitelnost a konkurenceschopnost textilního průmyslu v Indii.

Klíčová slova: cirkulární ekonomika, rychlá móda, textilní průmysl, udržitelnost, Indie, recyklace, nakládání s odpady, opětovné využití vody, efektivní využívání zdrojů, emise uhlíku, dodavatelský řetězec, ekonomická výkonnost.

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1. Introduction

The textiles and apparel sector is among the biggest sectors in India and holds a significant economic importance since it has been offering jobs to very high populations not mentioning that it has been a great contributor to export earnings and industrial development (PIB, 2025). However, with fast fashion, as an industry based on over consumption and inexpensive garments now amounting to a throw-away, the business has not only become more taxing on resources and ecologically unsustainable but also heavier (Long & Nasiry, 2022). Such a model of production demands speed, and the rhythm of designing and launching new collections is continuously decreasing waves of new disposable clothing with low value requiring a take-made-dispose lineal way of thinking (Dohale et al. 2025). This model has led to a deterioration of environmental issues, such as the overuse of water and chemicals, plant waste and high-distort carbon. Such challenges require a measure of structural transformation of the industrial sector to realize economic prosperity without undermining ecological integrity (Shaheen et al. 2020).

One such strategic framework, which more directly responds to some of the sustainability concerns, is the circular economy (Ramírez-Escamilla et al. 2024). Due to the various practices of reuse and recycling, as well as repair and remanufacturing practices yet sustainable design can extend the lifecycle of a product rather than thrash it away. Circular practices can happen at different points on the textile and apparel value chain sustainable fibre production, low-impact dyeing methods, processes to prevent waste in the manufacturing process, recycling textiles through resale marketplaces or producer-led take-back systems (Günaydın & Avinc, 2026). However, closing material loops and moving away from unused-resource-use can also have environmental advantages as well as a long-term solution for business resilience.

India occupies a key position in the context of sustainability transitions around the world due to the scale of global textile production and export. But fragmented supply chains, inadequate recycling infrastructure and technological limitations present enormous challenges (Kazancoglu et al., 2020). This research explores the extent of implementation and awareness of circular economy practices across sectors of India's textile and apparel industry as well as the environmental, economic and social benefits achieved through their implementation. Using secondary quantitative analysis, this work investigates to what extent circular strategies can lead to waste reduction and cost optimization in fast fashion firms, as well as enabling them to use their resources more efficiently for profitable competitive advantage. So, in the spirit of

sustainable growth, moving toward circularity is an environmental imperative and a strategic opportunity.

Top States

Highest concentration of Textile mills

STATE	BUSINESS COUNT	PERCENTAGE
Tamil Nadu	4,202	26.7%
Gujarat	2,849	18.1%
Maharashtra	1,967	12.5%
Rajasthan	983	6.2%
Haryana	627	4%
Uttar Pradesh	508	3.2%
Punjab	429	2.7%
Karnataka	372	2.4%

Figure 1: Top States in Textile Industry

(Source: Poidata, 2026)

1. Tamil Nadu

Tamil Nadu is recognised as 1st in India's Textile and Apparel industry sector by 2025, with the highest number of textile mills, export performance (Poidata, 2026). Tiruppur is among the largest knitwear and garment hubs in India. This has earned Tamil Nadu, particularly Tiruppur, its name as the knitwear capital of India. Housing more than 10,000 manufacturing units, the state accounts for over 40% of India's total knitwear exports. Circle initiatives have been

upscaled to large-scale water recycling systems and the use of renewable energy in selected textile clusters. Tiruppur's zero-liquid discharge model is considered a global standard in sustainable textile processing. Companies in textiles are exploring and investing in technologies that recycle fabrics, new methods of dyeing them that keep the use of toxic chemicals or water to a minimum (Baloyi et al., 2023). This circular economy practices aid in improving the competitiveness of Tamil Nadu in global fast fashion industry and responsible resource utilization & pollution control.

2. Gujarat

In 2025, Gujarat is the largest cotton producer in India and remains India's largest supplier of raw material for textile manufacturing (Desh Gujarat, 2026). This would be complimented with their good processing of cotton, spinning and synthetic textile manufacturing. The second covers circular strategies, like wastewater treatment, zero-liquid discharge systems and chemical management for dyeing units. The collective environmental compliance under this scheme — common effluent treatment plants in advance textile parks. Then there is the slow progress of textile-waste recycling and sustainable-fibre alternatives (Chowdhury, 2025). Such initiatives could foster sustainability in fast fashion and save water consumption and industrial waste, besides improving Gujarat's long-term environmental profile as well export competitiveness.

States	2021-22	2022-23	2023-24
Gujarat	7509.34	8795.33	9056.99
Maharashtra	8249.24	8315.67	8045.49
Telangana	4878.06	5744.62	5079.71
Rajasthan	2480.99	2774.47	2621.66
Karnataka	1954.60	2567.88	2058.55
Madhya Pradesh	1419.76	1433.25	1801.06
Haryana	1316.06	1000.50	1508.76
Andhra Pradesh	1707.62	1540.52	737.26

Figure 2: Cotton Producer

(Source: Desh Gujarat, 2026)

3. Maharashtra

By 2025, Maharashtra will be ranked number 3 in the Indian states in terms of the textile industry, owing to high cotton production and considerable quantity of mill pre-established (Linkedin, 2025). This has grown to be one of the biggest textile centres with garment manufacturing centres in Mumbai along with other manufacturing industries. In the garbage treatment all the way to the recycling of garments, even water-saving dyeing methods. Industrial Park systems based on cleaner production and the use of renewable energy sources to cut down carbon emissions. Fibres that could be used by repurposing the post-industrial waste are being developed by manufacturers together with recycling companies. These cyclic practices enable sustainability in fast fashion through not only cutting down the environmental costs but also going ahead to enhance cost-effectiveness and competitiveness worldwide (James et al., 2023).

4. Karnataka

As one of the leading manufacturers of apparel and innovations, Karnataka is slowly becoming a satellite in fashion (Linkedin, 2025). The projects might be sustainable fashion startups and projects that specialise in upcycling as well as organised networks of collectors of textile waste. The manufacturers also are moving toward the use of eco design and new digital tracking systems that enables them to get to know a little more about their own supply chains. To them, the environmental performance is improved, formulating renewable energy, and conservation of water. The start-up is developing a system of transformational sustainable materials that are cross pollinated in a house of innovation and other manufacturers and research labs (Sehnem et al., 2021).

5. Rajasthan

As of 2025, Rajasthan comes 8th since it was producing cotton and the processing section that had come up with developed textile processes. The region is considered the land of traditional fabrics, dyeing and handicraft (Singh and Gupta, 2020). Circular-oriented solutions foster the use of natural dyes, high-quality textiles, the production of organic cotton and even the use of textile waste in small-unit applications. Increasingly textile clusters are becoming organized with localized recycling systems and water saving strategies. On the artisanal front, there is a mixing of the old and the new school in craft and sustainable practices by the producers. The aims of Rajasthan are to minimise the application of chemicals and related deterioration of the

environment, to preserve cultural heritage by introducing the principles of horizontal economy. The strategies enable ethical fast fashion segments that are centred on quality, authenticity and sustainability sourcing (Wijeweera, 2024).

6. Haryana

Haryana ranks in top 10 in the country due to its increasing industry of textiles and cotton activity as of 2025. It has strong clusters of garment production in and around the Delhi NCR. The projects include energy-efficient machinery, as well as textile waste separation and recycling initiatives, all of which will contribute to the protection of the planet through circular economy practices. Industrial units are also delving on sustainable compliance frameworks demanded by international buyers. Technologies for reducing economic and environmental footprints within wastewater treatment and resource optimisation. Logistics in Haryana also enable sustainable supply chains and take-back systems. The use of circular methods serves to utilize fast fashion sustainability through operational efficiencies, waste reduction, and strengthening the garment industry's export-driven economy (niluka ALGAWATTA et al., 2020).

2. Objectives and Methodology

2.1 Objectives

The overall goal of the research is to assess how the concept of a circular economy can be utilized to enhance sustainability outcomes in the Indian textile and apparel sector and as applied to fast fashion.

To reach this objective, the paper will be based on the following concrete objectives:

- To examine the adoption levels of circular economy solutions in the Indian textile and apparel sector such as water reuse systems, waste recycling programs, resource efficiency plans, and take-back programmes.
- To evaluate the environmental effects of the practice of the circle economy with the emphasis on the reduction of waste, the efficiency of resources and the minimization of pollution.
- To weigh out the economic effects of the circular initiatives, such as cost efficiency, export performance, and industry competitiveness in general.

- To study the association between the implementation of circular economy and sustainability performance through quantitative analysis.
- To investigate the role of circular economy to meet the sustainable development goals in the textile and apparel value chain in India.
- To offer understanding about the effective application of circular economy practice in the fast fashion sector to policymakers, industry stakeholders as well as researchers.

2.2 Methodology

The research design that has been followed in this study is a quantitative research design that relies on secondary data analysis to investigate how the implementation of circular economy can influence the sustainability outcomes in the textile and apparel sector in India in 2020-25. Such a secondary approach would be suitable because it allows examining the macro-level trends in the industry, over-the-period analysis, and macro-level performance data, which cannot be collected based on the primary data collection (Sugeng et al., 2022).

Data Sources

The data used by the study is gathered by several reliable resources to be reliable and valid. Among them, there are official documents on the Ministry of Textiles (Government of India) and national statistical databases and international data like industry and sustainability reports. Additional information will be sourced through market research report and scholarly research that will give information on the quantities of textile waste, recycling efforts, and sustainability implementation within the firms.

Key datasets include:

- Textile statistical production and export nationally.
- Production and recovery of textile garbage.
- Water consumption and the use of renewable energy resources.
- Industry level economic performance indicators.

What is more, indicators within the domain of circular economy are included, including the implementation of water recycling systems, zero liquid discharge technologies, and waste recovery initiatives, among the other ones to measure the advancement of circularity in the industry.

Variables and Measurement

The paper examines how circular economic practices and sustainability are related through the following variables:

Independent variables (Circular Economy Indicators):

- Recycling rate (%)
- Implementation of water reuse.
- Efficiency of the resources (e.g. use of renewable energy)
- The adoption score on sustainability.

Dependent variables (Performance Outcomes):

- Performance on the environment (i.e., decrease of waste and emissions)
- Economic performance (e.g. export growth, cost efficiency)

These variables are picked because of their value to the green sustainability of the environment as well as economic competitiveness in the textile and apparel industry.

Analytical Methods

This analysis is done in two phases.

At the beginning, descriptive statistics analysis is resorted to to outline trends in circular economy adoption and industry performance. This involves use of percentages, growth rates and comparative indicators to give an overview of how the production of textile waste, rates of recycling and efficiency of the resources have changed (Bravo, 2022).

Second, we use regression analysis to investigate the correlation between the practises related to the circular economy and sustainability outcomes. The given regression model can be represented as follows:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \varepsilon$$

Where:

- *Y* represents sustainability outcomes (environmental or economic performance)
- *X1, X2, X3* represent circular economy indicators
- *β0* is the intercept
- *β1–β3* are coefficients
- *ε* is the error term

The approach provides identified statistically significant connexions between circular practises and performance indicators to give empirical evidence to support descriptive observations.

Research Hypotheses

The hypotheses of the study include the following: to direct the empirical analysis, the authors use the following tests:

- **H1:** Circular economy practices have a positive impact on environmental sustainability in the textile industry.

- **H2:** Circular economy practices improve economic performance in the textile and apparel sector.

Comparative and Contextual Analysis

Besides the quantitative analysis, the paper also considers comparative knowledge of the international experiences of the European Union countries where the practise of the circular economy is well developed. The given comparison serves as the reference point where the development of India could be judged, and the best practises could be offered that would be adjusted to the local industrial environment.

In addition, interpretation of the findings is done with reference to the existing academic literature to make certain that the statistical findings are put in perspective with the wider theoretical and industry specific debates. Such triangulation increases the strength of the analysis and allows achieving a more in-depth view of the implementation of the circular economy.

Limitations

Though the study possesses some strengths, it is limited by some weaknesses. The use of secondary data can create internal contradiction because data are not all collected in the same way by different sources. Also, the aggregated industry-level data might consist of limited ability to measure the firm-level differences. The statistical strength of the findings could also be influenced by the rather limited size of the dataset that underwent the analysis of the regression process.

3. Literature Review

Circular economy (CE) has become a revolutionary paradigm to substitute the historical linear production approach of take-make-dispose with a protegetic and healing production paradigm. In a textile and apparel industry, CE is becoming a strategic path towards environmental degradation, resource depletion, and waste production as related to fast fashion practises. The available literature outlines several aspects of circular economy application in textile systems. Akter et al. (2022) define the concept of circular strategies as are based on a combination of sourcing, production, consumption, and waste management and are in line with the Sustainable Development Goal 12 on responsible consumption and production. They focus on the framework and highlight the minimisation of waste, closed-loop recycling, and the lifecycle extension as the key instruments to attaining sustainability. Nonetheless, as much as this view offers the firm an organised operational orientation, it has a penchant of concentrating on firm-

level practises without necessarily considering extensive systemic change that needs to be in place throughout the value chain.

Hora et al. (2023) on the contrary are more comprehensive and systemic by defining circular economy as a multi-dimensional transformation that may cover eco-design, industrial symbiosis, reverse logistics, and supply chain integration. This expanded meaning is that circularity goes beyond the single recycling programmes and involves aligned measures in an upstream, midstream, and downstream programme. This opinion is what the argument of successful circular transitions in fast fashion should be that should consider not only post-consumer recovery systems but also sustainable fibre production and cleaner manufacturing technologies. Moreover, the use of digital technologies as one of the major facilitators of the circular economy implementation is highlighted in recent research. Major technologies, including blockchain, artificial intelligence, and lifecycle tracking systems, have already been identified as the critical ones to enhance the level of transparency, traceability, and efficiency in using resources in the textile supply chains. Such technologies promote more effective coordination of the stakeholders and make it possible to manage the circular flows more efficiently, which increases the scalability of the circular business models.

Socio-economic in nature, circular economy transformations are also altering global value chains in the apparel sector. According to Reppl et al. (2021), the switch toward circularity is related to the structural change in employment rates, with a reduction in primary production activities and a rise in the number of activities connected to reuse, repair, and recycling. This means that CE is not merely a strategy towards the environment but also the means of economic restructuring, which affects the formation of values and labour distribution in the industry. Such developments notwithstanding, it cannot be concluded clearly on how well the circular economy practises can be applied in the emerging economies. Although frameworks created in settings like Bangladesh can have a lot to tell, their extension to India must take into consideration carefully, structural similarities and differences, such as the labour intensity, that are wound up within the supply chain and technology capabilities.

The textile and apparel industry in the Indian context is an important sector of the economy with a high level of domestic demand, exportation, and governmental favour. The sector has both economic and sustainability changes, as far as it is important to the national income, and employment. Nevertheless, the industry size and intricacies are also problematic concerning

the extensive implementation of the circular economy, especially as far as infrastructure constraints and the disaggregated supply chains are concerned. Overall, the offered literature indicates that despite the potential of circular economy as the viable approach to the sustainable development of the textile and apparel industry, its effective demand presupposes the multi-level mechanism incorporating technological advancement, policy enablement, and supply chain alignment.

Category	Period	Current Value (USD)	Previous Value (USD)	% Growth/Decline
Total T&A Exports	Apr-Jun 2025	$9.082 Billion	$8.785 Billion	+3.37%
Apparel Exports	Apr-Jun 2025	$4.192 Billion	$3.849 Billion	+8.91%
Textile Exports	Apr-Jun 2025	$4.889 Billion	$4.936 Billion	-0.94%
Cotton Yarn/Handloom	Apr-Jun 2025	$2.860 Billion	-	-1.94%
Man-made Yarn/Fabrics	Apr-Jun 2025	$1.166 Billion	-	+0.11%
Carpet Exports	Apr-Jun 2025	$370.85 Million	-	+2.06%
Raw Cotton Imports	Apr-Jun 2025	$262.92 Million	$152.01 Million	+72.96%
Textile Yarn Imports	Apr-Jun 2025	$619.95 Million	$557.10 Million	+11.28%

Figure 3: India Textile & Apparel Export Data (April–June 2025)

(Source: In-CAI, 2026)

On the export front, IndiaExportNext indicated that textiles and apparel export of Q1 FY26 (April-June 2025) stood at an approximate of 78020 crores with Ready-Made Garments constituting 45 per cent of the total value, cotton textile making 30 per cent and man-made textile making an addition of 12% according to InCAI (2026). The exports of textiles in FY25 were estimated to be approximately 303 crores in value and support the economy in providing nearly 5 percent of all it merchandizes export with a target of 8,30000 crore by the year 2030. India contributes 4.6 in the international textile business and is a large manufacturer of textiles and garments and the third largest exporter of the world. The policy support is furthered on FDI being allowed up to 100 percent under the automatic route and overall inflow of FDI as high as about 3,940 crores between the period of April 2000 and June 2025. The Ministry of Textiles along with production-linked incentive (PLI) scheme benefits and extension of PM MITRA mega textile parks are allocated to 5,272 crores under the Union Budget 202526, which has enhanced competitiveness and long-run growth trajectory of India.

3.2 Understanding how circular initiatives impact industry competitiveness

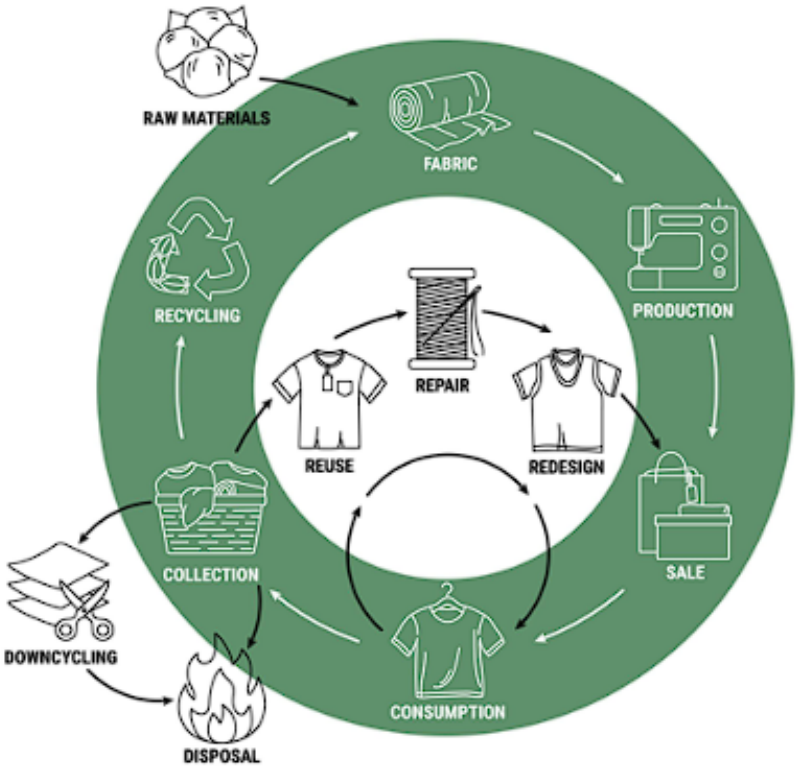

Figure 4: Circular Economy Model in Textile Industry

(Source: Adapted from Ellen MacArthur Foundation (2017) – Circular Fashion System)

To find the competitive landscape of the Indian apparel and fast fashion sectors with the help of circularity, the systemic shifts must be checked ranging from waste as a cost to waste as a feedstock that redefines value (Mishra et al. 2021). Through decoupling economic growth from the consumption of virgin resources, the industry can separate itself from global volatility while capturing new market segments. The following analysis details how circular initiatives drive competitiveness in various factors, utilizing distinct insights and theoretical frameworks while strictly avoiding any data or specific initiatives mentioned in your provided text.

3.2.1 Cost Savings

The landscape in the year 2026 has evolved rapidly, and a structural shift has been seen in the textile and apparel industry of India. Through the transition from a linear model of take-make-dispose to a circular economy, the sector is trying to address the fallout of environmental issues related to fast fashion while finding out the significant economic value. The circular initiative

of India is no longer just about activities of corporate social responsibility, and they are important factors for cost competitiveness. In the year 2026, the recycling market of Indian textiles is valued at approximately 337 million US dollars, with a proper trajectory towards an amount of 3.5 billion USD by the year 2030 (Thinakaran et al. 2022). This growth is given by the ability of the industry to turn waste into a particular strategic resource. However, the primary driver related to cost savings is the efficiency of resources.

In future, the sector has set a benchmark on a global level for the operations of closed loop by reintegrating nearly all the spinning waste back into the line of production. It can be stated that this type of in situ recycling diminishes the requirement of expensive raw materials of virgin category, such as petroleum-based polyester, along with cotton. This type of virgin raw materials has a high chance of volatile pricing on a global level. Further, the carbon footprint associated with recycling an item of textile in India has been found to be 50% lower than the production of new fibre (Wagaw & Babu, 2023). It has resulted in a reduction of energy expenditures and lowered the liabilities of carbon tax in a world which is highly focused on compliance with ESG. The cost of populations is being optimised through the integration of Technology.

The initiative of Tex-Eco introduced in the union budget of 2026 has boosted the adoption of digital pattern making powered by artificial intelligence. This type of Technology has optimised the layout of fabric to a smaller size, which makes reduction in the waste of the cutting room. In addition to that, Kapoor & Khare (2019) stated that hubs such as Panipat have emerged as the giants of mechanical recycling, which allows producing shoddy yarn and recycled blankets at a lower cost than their virgin counterparts. Domestic virgin polyester is a price competitor and the rise of joint ventures related to chemical recycling, such as the venture between the Ester industries and the Loop industries, introducing parity in prices. The purity is mainly between the price associated with recycled high-quality fibres and the virgin materials.

According to Rahaman & Pranta (2025), the evolution to a circular economy in the apparel segment signifies an important pivot from Linear Value Depletion to Circular Value Retention. In an outdated fast fashion model, effectiveness is often stated by labour arbitrage and cheap, virgin synthetic contributions. However, as world-wide resource scarcity strengthens, the primary driver of cost competitiveness changes toward Resource Efficiency and Secondary Material Valorisation.

As per Gigli, Landi & Germani (2019), one of the most important cost-saving controls in a circular system is the decrease of reliance on main virgin inputs. The manufacture of virgin cotton and petroleum-based synthetics is extremely vulnerable to "External Shock Costs" involving climate-driven crop let-downs, water scarcity duties, and variations in Brent Crude oil prices. Through applying high-tier mechanical and chemical reusing, producers generate a Buffered Supply Chain. When post-industrial surplus such as the scraps from the assembly line and post-consumer surplus such as discarded garments) are administered back into superior yarn, the producer successfully decreases the Procurement Price Index (PPI). The price of removing value from current materials is gradually lesser than the price of obtaining, distribution, and treating virgin materials from the beginning. In a 2026 manufacturing atmosphere, the capability to close the ring on fibre surplus acts as a evade against rise, allowing companies to uphold stable pricing even when international product marketplaces are in chaos.

According to the view of Esposito, Tse & Soufani (2018), circularity requires a reshape of the manufacturing floor, leading to considerable investments in utility expenses. Closed-loop wet treating where water is preserved, filtered, and recirculated rather than cleared decreases the above costs related with industrial water procurement and sewage treatment dues. Furthermore, the energy required to develop reprocessed polymers is considerably lesser than the thermal energy compulsory for the polymerization of virgin plastics. These operative efficiencies are supplemented by Analytical Waste Easing. As per Nandini (2025), through shifting toward Zero-Waste Design values, where design plans are algorithmically enhanced to utilize majority of the fabric roll, firms radically decrease the dead-capital sedentary on the cutting room base. In the high-volume domain of fast fashion, saving even small amount of cloth across a million-unit manufacture run interprets into millions of dollars in straight bottom-line influence.

According to opinion of Adisorn, Tholen & Götz (2021), as global financial markets integrate carbon pricing and Extended Producer Responsibility (EPR) frameworks, circularity develops a tool for Obligation Lessening. Businesses that continue to function on a rectilinear "take-make-dispose" exemplary face cumulative financial consequences in the procedure of carbon taxes, landfill levies, and advanced interest rates from ESG-conscious creditors. Conversely, circular firms profit from "Green Financing" motivations and lessen insurance premiums due to their condensed environmental hazard profile. In 2026, cost investments are not just about

lesser input prices; they are about eluding the increasing costs of "linear debt" which is the ecological and supervisory concern of out-dated manufacturing.

3.2.2 Export Performance

According to Thakker & Sun (2023), there is a proper link of the export strategy of India in the year 2026 to circularity. Vision 2030 of the government has the aim, which is approximately 100 billion USD in the exports of textile. To achieve this target, the government needs to meet the street green mandate in major markets such as the United States and the European Union. Circularity is the main thing for unlocking this type of performance. The mission of export promotion involves an investment of ₹25060 crore which focuses on compliance with the standards of global sustainability (Rebasiddanavar & Relekar, 2023). Because the strategy for sustainable and circular textiles in the EU is affecting fully, the exporters of India have been successful in adopting norms of Niyat Disha. This is highly focused on recycling mono-material and traceability. In the year 2026, India is increasingly considered as the destination of Sustainable sourcing, which is competing with countries such as Bangladesh and Vietnam by delivering certified content after recycling. This shift has been seen in the huge growth of the exports of readymade garments to the markets that are conscious about sustainability, such as Spain and France. Further, the initiative Tex Eco has boosted producing technical textiles having high value along with the performance made from the industrial scraps after recycling them. Through diversification of export materials away from general commodities and towards high technology circular apparel, India is separating itself from the wars of price related to ultra-fast fashion.

In the 2026 global trade setting, circularity is the New Gold Standard for market entrance. As main introducing blocks like the European Union and North America move toward compulsory sustainability disclosures, the competitiveness of Indian clothing exports is progressively well-defined by Transparency and Regulatory Alignment. As per Battaïa et al. (2018), shipping to high-value markets now requires more than just low values, its necessities a Sustainability Passport. Countries that have exploited in circular infrastructure such as central fibre-sorting centres and chemical reprocessing plants can carry global buyers with the long-established recycled content certifications they want to encounter their own local rules. Through accepting Design for Disassembly, Indian exporters differentiate themselves from contenders who still produce complex, multi-fibre clothes that are problematic to reprocess. This alignment with the Ecodesign directives of the Global North lets Indian manufacturers to secure long-standing,

high-margin obtaining agreements. It effectively changes circularity from a load into a Strategic Trade Asset, decide to exporters to alteration from being commodity suppliers to strategic innovation partners.

Circularity will enable the Indian apparel industry to avoid the commodity trap. In a linear world mass-market clothes can be easily substituted by other suppliers who have cheaper labour. Nonetheless, circular clothes, including Regenerated Cellulose or bio-synthetic blends have a Technical Value that cannot be easily copied. By focusing on the high-growth Performance Apparel and Technical Textile segments, India can make the transition to specialising in the Regenerative Exports (Appiah and Senayah, 2025). such items have a significantly higher price per kilogramme, and they are not a direct target of the price wars typical of ultra-fast fashion. By doing this, migration up the value chain gives the exports an impetus to grow based on the Knowledge Capital and Circular Innovation as opposed to the race to the bottom on wages, to create a stronger and more dignified Made in India label in the global market. Bringing the traceability of the circular loop to block chains facilitates a circular loop with a certain level of supply chain security that cannot be achieved by linear models. Greenwashing and Modern Slavery in the supply chain are becoming progressively risk-averse to international retailers. The very nature of a circular system that necessitates careful monitoring of materials used in disposal to manufacturing is data-rich and as such produces the audit trails so sought after by global brands. With the help of this Integrity Premium, Indian exporters can defend higher price tags and establish sticky relationships with foreign fashion houses that put much emphasis on the supply chain ethics as the quality of garments do.

3.2.3 Customer Engagement

Figure 5: Circular Customer Engagement Model

Source: Adapted from Accenture Circular Economy Report (2022)

In the year 2026, the consumers in the Indian market particularly in the section of genesis and millennium have turned from passive consumption towards conscious participation. The circularity has altered the interaction of brands with their audience fundamentally by shifting the focus totally from the point of sales to the whole life cycle of a product. As per Bolton et al. (2018), digital transparency can be considered as the new standard related to customer engagement. Brands are using traceability based on block chain to allow the consumers for scanning a QR code and see the history related to a garment. The history is associated with the range from the source of recycled fibre to the stats of water usage in the factory. This narrative branding helps in building deep loyalty on an emotional level, which in turn transcends price.

According to Kant Hvass & Pedersen (2019), major retailers in India have launched Take Back programs where store credits are received by the consumers to return their old clothes. It has turned the customers into a particular supply in the whole circular loop. Moreover, the models of Rental and Resale have moved from the niche start-up companies to mainstream retail companies. Platforms such as Zara pre-owned and domestic equivalents of India allow the brand to maintain engagement with the consumers who are value driven and seeks for high quality fashion without damaging the environment. This has resulted in the transformation of

relationship between the brand and the customer into a service agreement of long term. This agreement involves the services involving repair and updates in the modular design. Through delivering services such as the transformation of garments and conducting workshops of upcycling brands, they are not just involved in selling a product, but they are boosting a community of sustainable practitioners.

Consciousness Revolution The psychology of the apparel consumer has been revolutionised in 2026. The customer interaction advantage has moved away off High-Volume Acquisition and Lifecycle Retention. Circularity, according to Balo et al. (2025), assists in offering the platform to this more in-depth non-transactional relationship. The Digital Native generations, or modern consumers do not consider clothing as a disposable good anymore but as an expression of themselves. The idea of circularity promotes a high level of trust in the form of Process Visibility. When a brand lets a customer understand the Environmental ROI of their purchase the number of litres of water saved or the place of origin of the recycled fibre, it invokes an emotional connexion which is beyond the actual physical item. Such openness will make brand-consumer a Shared Mission. The customer does not receive a product passively anymore but gets into a movement of a circle. This psychological congruency forms a "Value Moat" ensuring it is very hard to attract consumers out of traditional opaque fast-fashion brands with the price wheel only.

Circular business models such as Rental-as-a-Service (RaaS) and Resale-Marketplace-Integration, fundamentally change how brands interact with their audience (Bodenheimer, Schuler & Wilkening, 2022)). Through offering Take-Back incentives, brands ensure that the customer returns to their ecosystem at the end of a garment's life and this leads to Continuous Engagement Loop. Instead of a single transaction every six months, the brand engages the customer multiple times: at the initial sale, during the offering of repair services, through the resale of the item, and finally during the collection for recycling. Each of these touch points is an opportunity to collect consumer data, offer personalized experiences, and reinforce brand loyalty. In this model, the "Lifetime Value" (LTV) of a customer is exponentially higher than in a linear model, as the brand captures value at every stage of the product's life.

According to Conduit, Karpen & Willmott, (2023), circularity encourages the rise of the Prosumer in which a consumer who also acts as a supplier to the brand’s circular loop (10). Through facilitating peer-to-peer resale and Upcycling Communities, brands foster a sense of belonging and social status. In 2026, wearing a garment that has been certified pre-owned or

expertly repaired carries more social capital than wearing a new, disposable item. Brands that provide the digital and physical infrastructure for these communities, such as in-store repair hubs or digital Garment Passports for the second-hand market to build an organic, self-sustaining fan base. This engagement model reduces marketing costs, as the community itself becomes the primary driver of brand advocacy. The competitive winner in 2026 is not the brand that sells the most items, but the brand that remains the centre of the consumer's Circular Lifestyle. In the year 2026, the intersection between Community-Centricity along with prosumers has emerged as one of the most resilient engines in the circular economy. It can be stated that this model is beyond the take-make-waste linear system of traditional categories through the transformation of passive consumerism into distinct active prosumers. According to Ahmadi et al. (2026), it is to be noted that by the year 2026, digital tools such as digital product passports and trust currency based on blockchain can allow communities for verification of circular power of goods. This circular social enterprise model not only lowers the footprints of environment but also helps in building social capital. It mainly democratises the economy through keeping wealth in the neighbourhood and boosting a business logic based on Dharma, where the waste generated by one neighbour becomes raw material for another one.

3.3 Environmental Impact of Fast Fashion

3.3.1 Textile Waste Generation and Landfill Impact

Figure 6: Textile Waste Generation and Landfill Impact

Source: UNEP (United Nations Environment Programme, 2021)

Fast fashion has greatly contributed to the growth of textile wastes across the world. The fast fashion system persuades people to buy cheap clothes that become overshadowed and are discarded shortly thereafter. This has led to an increase in the quantity of textile waste that gets

into landfills by a sizeable margin in the last 20 years. Singh, Sahay and Sharma (2025) note that the reason why textile waste is formed refers to multiple steps of the clothing value chain, such as the production of fibre, manufacturing, retail distribution, and the post-consumer disposal. The amount of pre-consumer waste generated by the processes of fabric cutting and garment production are large, and the post-consumer waste is primarily represented by discarded clothing no longer in use by the consumer.

One of the key environmental issues that are related to textile waste is that it is deposited in landfills. Many textiles are non-biodegradable, and some can need several decades to fully decompose such as the man-made fibres of polyester and nylon. Since the materials take a long time to degrade, they take up a precious area in the landfills and emit toxic substances to the surrounding ecosystems. According to Pervez et al. (2021), when the textile waste is disposed in the landfills, it might result in the emission of wastes that have toxic chemicals, dyes and finishing agents utilised during the manufacturing of the textile. These chemicals could be found in soil and ground water systems, and this could be hazardous to the ecosystem and health of a human being. The growing fashion trend concerning rapid fashion has also heightened the consumption of global textiles which in turn contributes to the production of waste as well. A large proportion of garments are developed considering that they have short lifespan and low durability that promotes the consumer to make regular replenishment. This overconsumption trend enhances the build-up of the textile wastes in the city waste disposal channels. Moreover, there are a lack of recycling facilities in most developing countries which increases the situation as most of the discarded clothing are going in to landfills instead of being reused or recycled. Thus, reduction of textile waste production has become one of the key sustainable development issues of the fashion industry. Recycling, reuse and long-life cycles of products are some of the practises that the circular economy embraces and can achieve a great deal when it comes to reducing landfill waste and the negative impact of fast fashion production systems on the environment.

3.3.2 Water Consumption and Chemical Pollution

Figure 7: Water Pollution from Textile Dyeing

Source: World Bank (2019) – Pollution from Textile Dyeing

Textile and clothing industry is generally viewed as a manufacturing industry that consumes the highest amount of water globally. The amount of water used in many processes of textile manufacturing, such as fibre growing, dyeing, and finishing of fabrics, etc. is huge. More specifically, the dyeing and treatment activities use large volumes of freshwater and, at the same time, produce large volumes of wastewater pollution. According to Hou et al. (2022), the processes of industrial production in the textile industry are a significant source of water pollution, which is explained by the release of untreated or insufficient treated effluents with chemicals, dyes, and other dangerous agents. In the process of textile processing, chemical compounds of various types are employed in acquiring colours, textures and useful properties to fabric. Examples of these chemicals are synthetic dyes, bleaching agents, fixing agents and finishing chemicals, most of which are either toxic or persistent in water. In circumstances where the textile factory wastes are released into rivers or lakes without proper treatment, these chemicals may settle in water bodies, leading to disruption of aquatic ecosystems. These are the effects of polluted freshwater systems on the community that, besides endangering biodiversity, they also impact the community that relies on the water source to drink, create farmland, and fish.

Textile production contributions to human health are also relevant besides pollution of the environment by the chemicals produced. According to Landrigan et al. (2020), industrial activities might cause pollution, which in turn can bring dangerous substances to the marine and freshwater environment and later to the food chain of humans. The toxic substances contained in the textile dyeing processes can be absorbed in fish and other aquatic creatures hence health hazards to the population using such resources as their food. Moreover, over-exploitation of water in the textile industry leads to shortage of water in areas that have already severe scarcity of water. A lot of large clothing manufacturing centres can be found in the developing world where the water management facilities are usually poor. Consequently, the practise of unsustainable water consumption within the fashion sector burdens the local water resources. As a result, enhancing water efficiency and minimising chemical contamination have been declared vital targets to the attainment of the sustainability of the textile industry. Recreational steps like water recycling systems, closed-loop dyeing technologies and environmentally friendly alternatives to chemicals are being considered more extensively as ways of tackling the environmental challenges.

3.3.3 Carbon Emissions and Energy Consumption

Figure 8: Carbon Emissions in Textile Production

Source: McKinsey & Company (Fashion on Climate Report, 2020)

The textile and clothing sector is a major contributory to the emission of carbon in the world since it consumes energy intensive in its production and as well as the fact that it utilises sources of energy which are usually derived through fossil fuels. A fibre production cost a lot of energy which is used throughout the value chain until manufacturing and distribution which cause a significant environmental footprint. McKinsey and Company (2020) argue that the fashion industry contributes to the global greenhouse gas emissions, which are 48 percent to 8 percent, making this industry of critical interest in climate change.

The textile industry is a high consumer of energy especially when producing fibrils, spinning, weaving, dyeing, and finishing of the textile. Of these processes, wet processing processes, particularly dyeing and finishing are the highest energy consuming processes because of the need to heat, chemically treat and process water. These usually take the help of non-renewable sources of energy such as coal and natural gas especially in the developing economies where the clean energy infrastructure is scarce. Consequently, the industrial emissions are high as the carbon intensity of textile production is great (IEA, 2021).

Along with direct emissions caused by the manufacturing processes, the indirect emissions are emitted during the supply chain. Transport, packaging and global distribution systems also add on to the carbon footprint of the textile and apparel industry. The business models of fast fashion make this problem even worse as they accelerate the processes of production and raise the rate of transportation, which leads to increased energy usage and emissions severity.

Air quality and the well-being of people are also affected by the environmental impact of carbon emissions in the textile industry other than climate change. The emissions in the textile production industries are usually industrial in nature and contain particulate matter and other pollutants that cause respiratory illness and degradation of the environment. According to Landrigan et al. (2020), the significant role in health risk can be referred to as industrial pollution that is especially dominant in developing countries with weaker environmental regulations.

Notwithstanding such realisations, there is an increasing realisation that carbon emission reduction must be made in the textile industry. The practises suggested by a circular economy could help to find a solution to the problem because they result in increasing the efficiency of the use of resources, decreasing the use of virgin materials, and facilitating the production process using less power. As an example, utilisation of recycled fibres normally consumes less energy as compared to manufacturing of new substances and therefore reduces the total

emissions. Correspondingly, incorporation of renewable forms of energy and more environmentally friendly methods of production can lower the intensity of carbonation of the textile industry process considerably.

Nevertheless, the shift to low-carbon production is still not even throughout the industry. The barriers blocking the spread of sustainable practises include structural barriers like high entry costs, access to certain technology and the disintegration of supply chains that add to the barriers. Consequently, effective level of success regarding significant carbon emission cuts involves concerted efforts that encompass technological breakthroughs, policy provisions, and industrial partnerships.

3.3.4 Microplastic Pollution from Synthetic Fibres

Figure 9: Microplastic Pollution from Synthetic Fibres

Source: IUCN (International Union for Conservation of Nature, 2017)

A second environmental problem that appears with the fast fashion industry is the pollution of microplastic by synthetic fibres. A lot of modern clothing is manufactured with non-organic fabrics which include polyester, nylon and acrylic which are petroleum-based compound polymers. These garments discharge minute plastic fibres called microplastics into the wastewater systems during washing and in the daily operations. Priyadarshini, Jagatee and Das (2024) suggest that synthetic textiles become one of the key polluters of microplastic in water bodies.

When discharged in waterways, microfibres are so hard to eliminate due to their microscopic dimensions. It cannot always be alleged that wastewater treatment facilities can capture all microplastic particles, and release them into rivers, lakes, and oceans. According to Palacios-

Marinas and Tausif (2021), these microfibres have the potential to enter the sea ecosystem and be consumed by marine species. This pollution can interfere with food chains, and it may even destroy the health of human beings by consuming the contaminated seafood.

Thus, the microplastic pollution due to synthetic textile usage has turned into a significant problem of development of sustainable fashion.

3.4 Circular Economy Practices in India's Textile Industry

3.4.1 Growth of the Indian Textile and Apparel Sector

Indian textile and apparel industry is one of the key industries of the Indian economy and among the largest manufacturing sectors in the country. The industry plays a major role in terms of job creation, export revenue and industrialization. The textile and apparel sector is a significant part of the Indian economic system and the authors state that the sector directly and indirectly employs millions of workers nationwide (Majumder and De, 2023). The industry equally has an important contribution in terms of gross domestic product of the country and has a significant portion of manufacturing output and export revenues.

India boasts of a rich textile value chain that extends to the fibre to garment and distribution of export. The nation is a major manufacturer of cotton and other natural fibres, and it has also had a high level of presence in the production of synthetic fabric. Presence of raw materials, skilled labour and well-developed manufacturing infrastructure has helped the sector grow at a very fast rate in the recent decades. As Atkar et al. (2021) emphasise, the global textile industry has seen significant transformation because of growing demand of fast fashion products, technological development and growth in international trade. This has seen Indian textile manufacturers becoming more integrated into the world supply chains.

Nevertheless, the fast growth of the textile industry has produced some environmental issues as well such as the excessive use of resources and increasing textile waste. These issues have prompted policymakers and other industry stakeholders to seek more production systems that are sustainable.

3.4.2 Circular Initiatives in Indian Textile Clusters

Figure 10: Textile Clusters and Circular Practices in India

Source: Ministry of Textiles, Government of India (2023)

India in terms of textile production is mostly located in industrial clusters based on regions which have specialised in a particular portion of the textile value chain. These clusters are significant in facilitating the economic growth besides providing avenues of executing the circular economy in local supply chains. During the recent years, a few textile clusters in India have started to implement circular initiatives that would enhance the efficiency of using the available resources, decrease the amount of waste generated and lead to more sustainable production methods (Elroi et al., 2023).

The article shows that circular supply chain models are getting increasingly investigated in Indian textile industries to overcome the environmental consequences of a conventional linear production system (Chourasiya and Malviya 2025). Circular projects in textile clusters are based on the strategies of recycling textile wastes, better management of water, and recycling of raw materials in the production. Such activities assist in cutting back on the reliance on the virgin resources and decreasing environmental effects linked with massive production of the textile industry. Introducing a circumferential principle into the management of the supply chain, the textile clusters will be able to enhance the efficiency of the operations and achieve long-term sustainability objectives (Barakat et al., 2023).

Some of the established textile clusters in India have already established practises that capture the aspects of circular production systems. As an illustration, there are clusters that have

adopted wastewater treatment and water recycling technologies to cut down on the industrial water used in dyeing and finishing. Others have given attention on recycling of pre-consumer textile wastes produced during fabrication and production of garments. These practises are useful to decrease the waste disposal, in addition to enhancing the use of material in production system (Abul Kalam Azad et al., 2024).

Besides the industrial recycling projects, the practises of the circular economy have come up in craft-based textile communities, too. According to Tiwari et al. (2025), rural textile clusters are more using sustainable production methods focusing on resource conservation, traditional craftsmanship and the re-use of textile materials. Craft clusters may utilise the models of smaller-scale production, which are inherently compatible with the principles of the circular economy such as repair, reuse and upcycling of textiles (Prescott, 2026). Such practises not only aid in the sustenance of the environment but are also known to keep traditional knowledge and culture alive among people in rural communities.

3.4.3 Government Policies Supporting Circular Economy

Government policy is very important in helping make the shift towards the practises of the circular economy in the industrial centres. The policy regime can be used to impact the corporate environmental policy in the textile industry, promote sustainable production practises and the implementation of circular supply chain designs. Sound policy interventions offer regulatory advice, monetary incentives as well as the institutional support which facilitates businesses in incorporating sustainability in their operation (Aragòn-Correa et al., 2020).

According to Kazancoglu et al. (2021), the policies of the circular economy are necessary to enhance the management of the environmental supply chains. These policies will be able to induce firms with sustainable production as it sets environmental standards, creates resource efficiency and resource records waste reduction. Such policies in the textile industry could involve an act like wastewater treatment, use of chemicals and dismantling of waste materials. Governments can compel manufacturers to adopt cleaner technologies to produce goods as well as minimise environmental side effects of textile production to make the industry comply with environmental regulations.

Besides the regulatory systems, governments also facilitate the transition to the circular economy via strategic development programmes and sustainability programmes. De Melo et al. (2022) state that the principles of the promotion of the idea of the circular economy are often reflected in the public policies created to stimulate the innovation specifics and promote the green technologies to rely on and encourage the cooperation between the governmental and the

business organisations. Such policies may consist of funding initiatives, research collaborations, infrastructure investments to allow the industries to switch into sustainable production systems.

There are various government programmes that have been launched in India to help the textile industry in maintaining sustainable development. Such programmes aim at enhancing industrial infrastructure, manufacturing that is environmentally friendly and ensuring competitiveness in the supply chain.

3.4.4 Role of Industry and Private Sector in Circular Transition

The effective movement towards a circular economy heavily relies on the involvement of industry players and the headquarters of the business sector, although they can be affected by government policies to a small degree (Kazancoglu et al., 2020). Businesses can be in the middle of the implementation of circular production models through investing into sustainable technologies, reengineering the supply chain and implementing resource-efficient production processes. Incorporation of the private sector is thus imperative in the transformation of concepts of the circular economy to applicable industrial solutions.

Eckert (2023) cuts to the point that the elements of sustainability transitions in industries are largely dependent on the role of private finance and business investment. By investing in technology in the production in a way that is environmentally friendly, companies can go a long way in ensuring that the number of resources consumed and the effect on the environment is as minimal as possible while enhancing the efficiency of such operations. Firms in the textile industry are focusing more on new developments like fibre recycling technologies, waste cutting tools and environmentally friendly production mode. The efforts will empower the creation of circular supply chains which will reduce waste and make the best use of resources.

Collaboration and institutional backing of actors within an industry are also significant in facilitating the circulation of an economy. Henrysson and Nuur (2021) point out that sustainable industrial ecosystems may be developed in institutions, industry networks, and regional alliances. With cooperation, companies will be able to exchange knowledge, experience best practises and come up with joint projects to help in circular production systems. Indeed, as an illustration, manufacturers and recycling firms can reach an agreement to boost the amount of waste that is collected and processed to recycle and reuse the material in new production cycles.

3.5 Barriers to Circular Economy Adoption

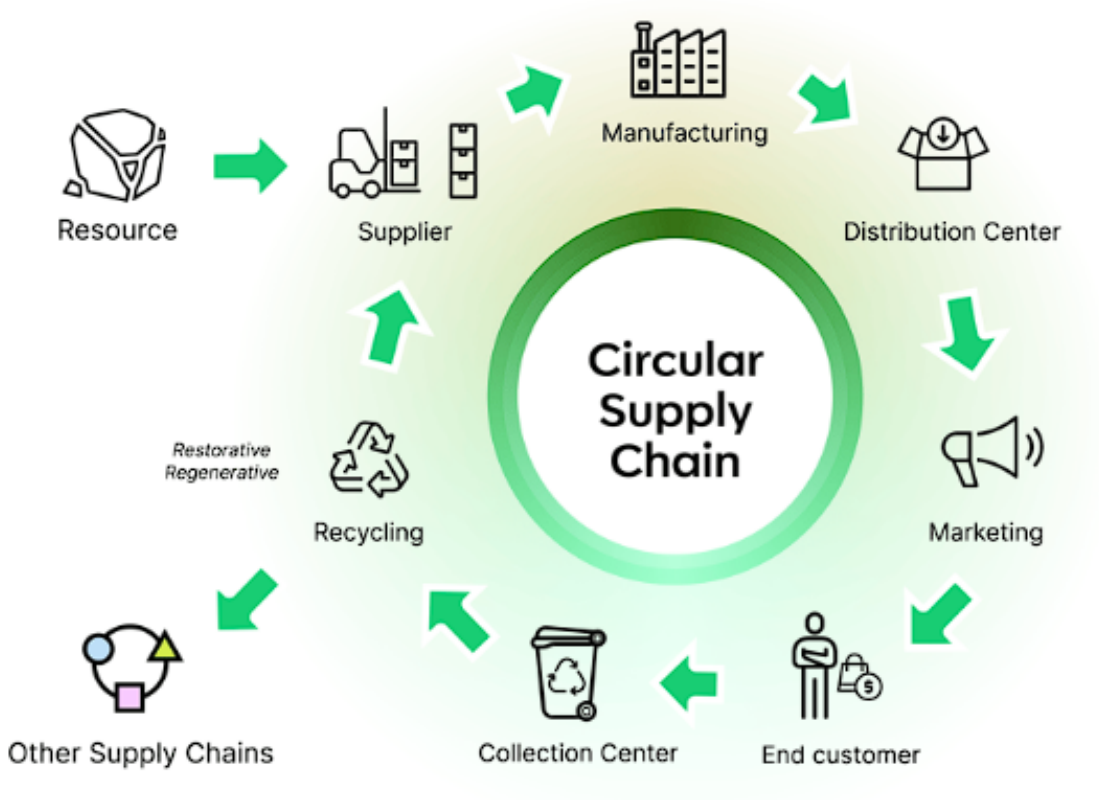

Figure 11: Barriers to Circular Economy Adoption

Source: European Environment Agency (2020)

3.5.1 Technological Barriers

Although principles of a circular economy are increasingly being seen as the way forward in the quest to achieve a sustainable industrial development, there are still several technological passages which impede their rampant use in the manufacturing industries. Shifting towards the use of the traditional linear production models to a circular system needs pinpointed technologies, enhanced infrastructure, and improved resource management systems. Nevertheless, there are numerous industries that do not have technology to accomplish these changes. Badhotiya et al. (2022) note that one of the most crucial challenges to the realisation of the principles of the circular economy in manufacturing sectors is technological restrictions. Among the major technological issues is the fact that there is a scarcity of sophisticated recycling technologies that have the capacity to handle tricky textile materials. Most of the clothes is being made with mixed fabrics that are made up of numerous fibres including cotton, polyester and elastane. The mixed-material textiles are not easily undivided and cannot be

recycled effectively in the recycling technologies available today. Consequently, huge amounts of textile waste cannot be properly used up to be recycled in production loops.

Along with the issues with recycling, utilisation of the digital technologies which facilitate circular supply chain management is low in most of the developing economies. Kumar, Mangla and Kumar (2024) point out that technologies relating to the many aspects of Industry 4.0, such as the digital tracking systems, smart manufacturing and data supply chain monitoring are crucial elements that facilitate the use of circular production model. Nonetheless, implementing these technologies can be very demanding about technical skills and organisational capabilities which most companies may lack.

3.5.2 Economic and Cost Barriers

The barriers to circular economy practises being introduced in industrial sectors are also economic and financial barriers. The procedure of implementing the circular systems of production usually demands significant investments in new technologies, redesign of infrastructure and processes. This is because in most companies, especially those that are small or medium sized, the cost of implementing these changes may beat away others due to the cost involved in making these changes. Badhotiya et al. (2022) also underline that not everyone can move to sustainable production models even in cases when long-term environmental and economic opportunities are noted due to the lack of financial resources to change the situation. Among the key issues connected with costs is the upfront expense of opening recycling plants, waste management systems and resource-saving production technologies. Creating a circular economy usually presupposes a redesign of existing manufacturing processes to allow retrieving the materials and using them again. The change can involve installation of modern recycling devices, installation of water treatment systems or introducing energy saving production technology. This kind of investments can cause serious financial implications on companies having low funds resources.

Also, market uncertainties and a change in the price of raw materials can potentially influence the economic safety of circular economy practises. According to Kumar, Mangla and Kumar (2024), the firms might not find it easy to invest in the circular technologies because of uncertainty about financial returns or when recycled materials cannot compete economically with the cheaper virgin materials. The market value of recycled materials on most occasions can be less compared with the newly created materials hence decreasing the confidence of firms in recycling and recovery of materials as a priority.

3.5.3 Supply Chain Complexity

Another significant obstacle to introducing the practise of a circular economy into industrial industries is caused by the complexity of modern supply chains. The supply chains of textile and apparel can easily be found to be very fragmented and have various stakeholders working in different geographical locations. These supply chains usually involve the suppliers of raw materials, manufacturers, distributors, retailers and recycling organisations. The organisation of these actors may complicate the adoption of the circular systems especially.

According to Ghag et al. (2025), complexity of the supply chain can be approached when companies strive to combine progressive technologies, sustainability goals and joint production frameworks. There is a need to have more transparency and coordination in the supply chain so that the materials can be successfully extracted as a means of recovery, reusing or recycling. Nonetheless, attaining this coordination may be challenging as the supply chain partners may differ in their operational approaches, technological aptitudes as well as business priorities.

Huang, Han and Macbeth (2020) also point out the fact that the interaction in the complex supply chain networks frequently anticipates much organisational work and confidence among the involved companies. In the absence of communication and information exchange, it will be hard to control the flow of circular materials or build an effective reverse logistics system.

3.5.4 Consumer Behaviour and Awareness

The issue of consumer behaviour and awareness of people also influences the success of the circular economy in terms of the fashion industry (Carvalho et al., 2020). Despite the growing popularity of the topic of sustainability in the recent years, most consumers focus on affordability, convenience and fashion trends, disregarding the impact on the environment. Consequently, the fast fashion model based on high consumption frequency and short life cycles of the products is frequently supported by the consumer buying behaviour.

According to Han (2021), consumer attitudes and behavioural patterns play a significant role in ensuring that environmental responsible practises are adopted in different industries. At all times, consumers may not settle on the green alternatives even when they exist because they are considered as being not as fashionable as traditional products, costly, and inconvenient. Such a discrepancy in behaviour between environmental consciousness and real buying behaviours is one of the primary problems of any company that tries to promote a circular fashion model.

Furthermore, the contribution of marketing and communication strategy plays a vital role in forming the consumer thinking on sustainability. Zeqiri et al. (2025) emphasise that social media networks and digitally based marketing campaigns are dominant as tools to create brand awareness and influence the mode of consumer interaction. It is possible to make consumers change their ways towards consumer-prone behaviour by means of communication of the sustainability initiatives completed by companies.

Nevertheless, the lack of consumerism awareness of the ideas of the circular economy is also an important barrier. Most consumers are not used to such measures like garment recycling, product take-back programme or cloth repair. Having more consumer education and awareness is thus critical to making sustainable consumption patterns and the successful execution of the strategy of the circular economy to the fashion industry.

3.6 Research Gap

3.6.1 Weaknesses of Current Studies

The current literature on the aspects of circular economy in the textile and apparel sector offered important data regarding the sustainability issues and ways to address them (Saha et al., 2022). Most of the literature is however either theoretical or studying the developed economies with little empirical studies being conducted on the developing ones. Numerous studies focus on numerous general circular strategies, which include recycling, reuse and eco-design and fail to adequately measure their effects on economic performance or on environmental results in a particular industrial context. Also, a few studies are highly qualitative in their methodologies that might not entirely reflect quantifiable associations of circular practices, and the matter of key performance indicators e.g. cost efficiency, resource use or export competitiveness. The other weakness is the isolated character of the current research whereby environmental, economic and social issues have tended to be studied independently instead of being studied as an integrated system. As a result, existing studies have not provided any comprehensive studies that would combine quantitative analysis with industry-specific data to assess the suitability of the circular economy strategies in the real textile systems.

3.6.2 Requirement of Circular Economy Studies in India

Indian textile and apparel industry is a particular case where the analysis of the circular economy adoption is supposed to be carried out. One of the major textile producers in the

world, India is rather troubled by the environmental issues as high rates of water consumption, waste generation and emission of carbon. Though an ever-growing relevance of the concept of sustainability is observed, there has been a lack of literature to investigate the way the concept of a circular economy is being exercised vis-a-vis its performance in Indian textile cluster and how it is objectively translating into the performance of the industry. The literature available is largely based on global trends or the developed markets which cannot be a precise gauge of the structural characteristics of the Indian textile industry such as disjointed supply chains, factory-intensive manufacturing and level of technological penetration. More than that, there is the need to assess the effects of the circular initiatives, which will affect the sustainability of the environment and the economic competitiveness in the Indian context. Therefore, more empirical and regionally oriented studies are needed to make the policy formulation process easier and drive actors in the industry towards an environmentally friendly change.

3.6.3 Value addition of the Current Research

It is based on this that this paper attempts to address the above research gaps by providing a quantitative discourse of the concept of circular economy being applied in the textile/ apparel industry in India. It integrates the environmental and economic perspective to reflect on the effect of circular strategies on the resource patterns, waste reduction and outcome in the industry. The method of secondary data and statistics would also give empirical data on the relationship between the circular adoption and the sustainability results as provided by the study. It is also an input to the literature, as it has specifically zeroed in on the Indian situation such that it provides information, which could be utilised by policy makers, industry actors, among others, who are researching on the significance of effective implementation of the circular economy in the textile industry.

Chapter 4: Practical Part

4.1 The Textile Industry in India

4.1.1 Industry Importance

Textile and apparel industry is an essential component of the Indian economy as it contributes a lot in GDP, employment and manufacturing. It constitutes a significant portion of the Gross Domestic Product (GDP) of the country, and it contributes significantly to manufacturing production. It provides direct and indirect jobs to millions of people, and it is one of the largest

jobs producers. It is labour-intensive, which enables it to be developed to benefit not only urban industrial areas but also the rural areas hand-loom weavers.

The textile industry is also an important part of global trade besides having a serious economic contribution to the Indian economy. Another, large exporter of textiles and garments, India does not lack variety with a few products like cotton textile: ready-made garments and synthetic textile (Dutta & Bansal, 2022) among others. India possesses a long-established value chain, including raw material up to the finished product and an enormous number of highly skilled workforce, artisans, and manufacturers. This will assist in increasing the exports of the textile industry in India.

4.1.2 Fast Fashion and Environmental Pressure

Another factor that has impacted the textile and apparel industry in the recent years is the emergence of fast fashion. Fast fashion entails short production periods, appearance of new collections after intervals, and low-priced products that are to be worn rarely. This has made production and consumption more accessible and affordable to the consumers and has increased. This has resulted in huge environmental impact by textile industry. The emergence of fast fashion has created an increase in resource use in the duration of water, energy and materials. Dyeing and finishing involved in the production of textiles are also water-consuming processes that could even contain toxic chemicals. Besides, there has been the growth in the consumption of synthetics fibres leading to the emissions of greenhouse gases and microplastics. It is further aggravated by the fact that the issue of clothing, being disposable, produces greater amounts of textile waste (Prakash et al. 2020).

4.1.3 Need for Circular Economy

The sustainability issues arising from fast fashion have underlined the need for more sustainable practices in production and consumption. The "take-make-dispose" approach, which is a linear model, is unsustainable and results in over-consumption of resources and generation of waste. In this regard, the circular economy is a potential solution to achieve sustainable textile production. The textile industry in India is beginning to embrace circular economy principles in response to growing environmental laws and a growing market for eco-friendly products. So, moving toward circularity is not only important from an environmental perspective but also from a business point of view, in terms of increasing competitiveness (Prakash et al. 2020).

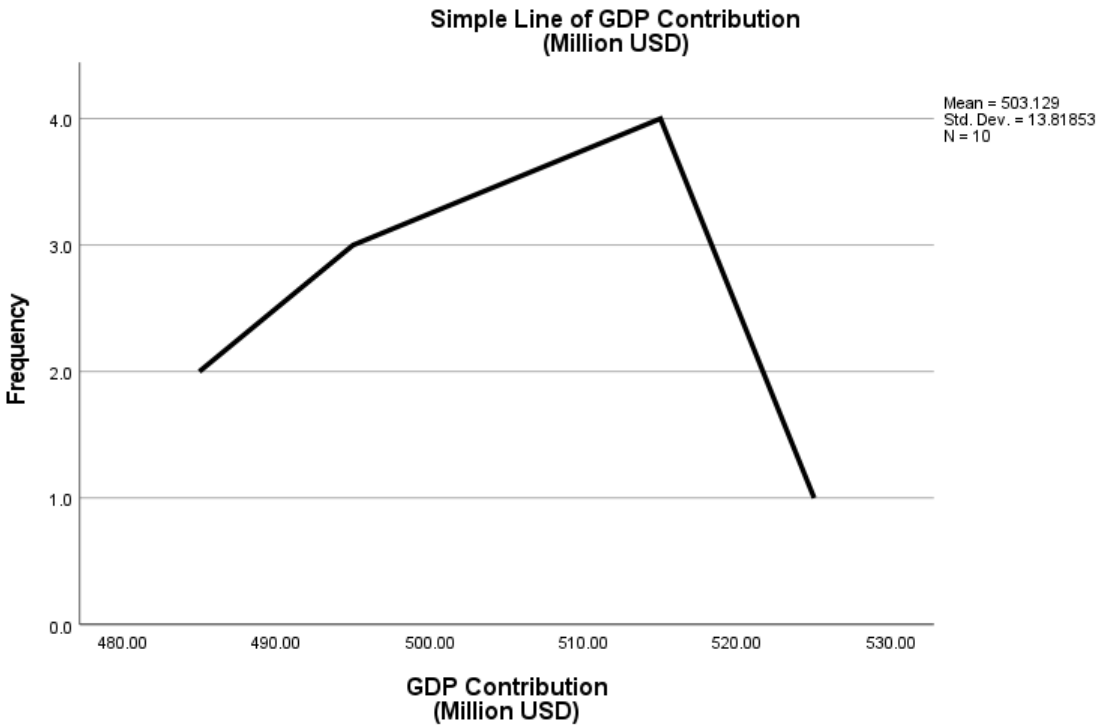

Figure 12: Trend of GDP Contribution in India's Textile Industry (2015–2024)

(Source: SPSS)

4.2 Data Descriptions and Variables

4.2.1 Data Sources

This study is founded on a second-hand quantitative data derived through a combination of various sources. The principal dataset will be used to merge the India-specific waste management and recycling data with environmental and production related indicators obtained using global fast fashion datasets (Singh, 2025). The combination of such datasets makes it possible to analyse the processes of the so-called circular economy practices in terms of sustainability and their effects on economic performance. The India-specific data will be helpful to analyse the waste production, recycling, and efficiency indices in the framework of the local textile industry. This information reflects the operating and environmental environments of the industry on a national level. To the contrary, fast fashion data set provides informative pointers concerning carbon emissions, water use, and sustainability in an index, which in most cases cannot be easily found on one combined dataset of India. A hybrid approach and composition could be made up of the sources that could be used to cultivate a balanced analytical approach in which macro-level trends in India are backed by micro-level environmental indicators. This method is very valid in the problem of overcoming the

limitations of data and being able to conduct a solid empirical analysis of the strategies of circular economies.

4.2.2 Dataset Structure

The last dataset that will be analysed includes a time-series structure that will be analysed over a period of ten years between the years 2015 and 2024. Individual observations reflect summed up annual values of important variables under environmental impact, practises of circular economy, and economic performance. The number of observations and variables in the dataset is 10 and 10 respectively, with all the variables being continuous and quantified on a numerical scale. The time-series design enables analysing the tendencies throughout the time and it enables identifying the patterns that relate to the transformation toward the movement toward the circular economy practises. All the variables were standardised and brought into line to allow commonality with various sources of data. The statistical analysis based on the dataset was carried out with the help of SPSS so that the descriptive statistics, correlation analysis, and regression modelling could be conducted.

4.2.3 Variable Classification

To analyse, the variables in the dataset are grouped into dependent variables, independent variables and a control variable.

Dependent Variables

The dependent variables are the consequences that are affected by the circular economy practises. There are three major dependent variables that are considered in this study:

- **Carbon Emissions (tCO 2e):** The variable concerns the impact of textile manufacturing on the environment in greenhouse gaseous emissions.
- **Water Usage (Million Litres):** This is an indicator of the amount of resource use in relation to the textile processing processes.
- **GDP Contribution (Million USD):** It is a variable that is used to measure economic performance and industry competitiveness.

Independent Variables

The independent variables reflect the level of practises of the circular economy developed inside the industry:

- **Recycling Rate (%):** Refers to the rate of textile waste that is recycled, indicating the degree of the recyclability of material use.

- **Sustainability Score (0100):** Measures how much the company is using sustainable practises, such as eco-friendly production processes and responsible sourcing.
- **Environmental Cost Index:** The index is a measure of investment and allocation of costs that are distributed in environmental protection and compliance.

Control Variable

Year: The variable Year is a control variable, which takes into consideration the trends in time and policy changes. It assists in bringing out the incremental changes in sustainability practises and industry performance throughout the study period.

Variable Name	Type	Role	Description
Year	Numeric	Control Variable	Represents time (2015–2024) used to capture trends over time
Carbon Emissions (tCO_2e)	Numeric	Dependent	Measures environmental impact in terms of greenhouse gas emissions
Water Usage (Million Litres)	Numeric	Dependent	Indicates resource consumption in textile production
GDP Contribution (Million USD)	Numeric	Dependent	Represents economic performance of the textile industry
Recycling Rate (%)	Numeric	Independent	Shows proportion of textile waste recycled
Sustainability Score (0–100)	Numeric	Independent	Reflects adoption of sustainable practices
Environmental Cost Index	Numeric	Independent	Measures environmental cost control and compliance efforts
Monthly Production (Tonnes)	Numeric	Independent / Control	Indicates production output of the industry
Waste Generated (Tons/Day)	Numeric	Supporting Variable	Represents volume of textile waste generated
Municipal Efficiency (1–10)	Numeric	Supporting Variable	Reflects efficiency of waste management systems
Waste Management Cost (₹/Ton)	Numeric	Supporting Variable	Indicates cost of waste handling and processing

Table 1: Variable Description Table

4.2.4 Data Preparation

Before analysing, the data was taken through various stages of data preparation to enable accuracy and uniformity. There was no investigation of the value of variables that were not filled, the analysis was only done on complete cases. Data types were checked to make sure that all variables were correctly defined as a numeric value and measured at the scale level in SPSS. Also, the variables of various datasets were aligned and subsequently combined into one set of structured data. Measurements were normalized, and extraneous variables was eliminated to keep things straight and on point. The following measures were taken to ensure that the dataset was clean, reliable and fit to be statistically analysed.

4.3 Descriptive Analysis

4.3.1 Summary Statistics

The descriptive analysis will start by an analysis of summary statistics to gain an insight into the broad features of the dataset. The statistical factors calculated like the mean and the standard deviation are applied to determine the central tendency and variability of the variables. The mean cost of carbon emission reflects the general environmental cost of producing textiles in the period of the research. Likewise, the average water use is the estimated value of the resource used, and an average contribution to the GDP is the measure of the economic performance of the industry. The rate of recycling and sustainability score can talk about the degree of the implementation of the circular economy. The values of the standard deviation determine the extent of change of each variable with time. Greater standard deviation means more fluctuations and the less value the more stable. In this data the variables of environment and economy vary with moderate changes indicating not sudden changes, but progressive changes during the study period.

4.3.2 Distribution Analysis

To get more insight into the nature of the data, the key variables are subjected to the analysis of histogram. Histograms will also be used to display the frequency distribution, and to indicate the adequacy of the data being distributed normally. The histogram of carbon emission indicates that the result is largely concentrated in a relatively small range hence there is a consistency in the levels of emission over time. Given that there is a bell-shaped curve, it implies that the distribution is normally approximated and therefore appropriate to perform regression analysis. As well, the histogram of water consumption demonstrates that the

distribution of values is mediocre, as the vast majority are concentrated around the mean. This indicates the comparatively steady water consumption trends in the textile sector. The distribution of the histogram of GDP contribution is more spread to the right, and therefore there are fluctuations in the economic performance of the different years. The distribution is however reasonably balanced which justifies the soundness of the dataset.

Comprehensively, the distribution analysis ensures that the variables are good and can be used in subsequent analysis of statistics.

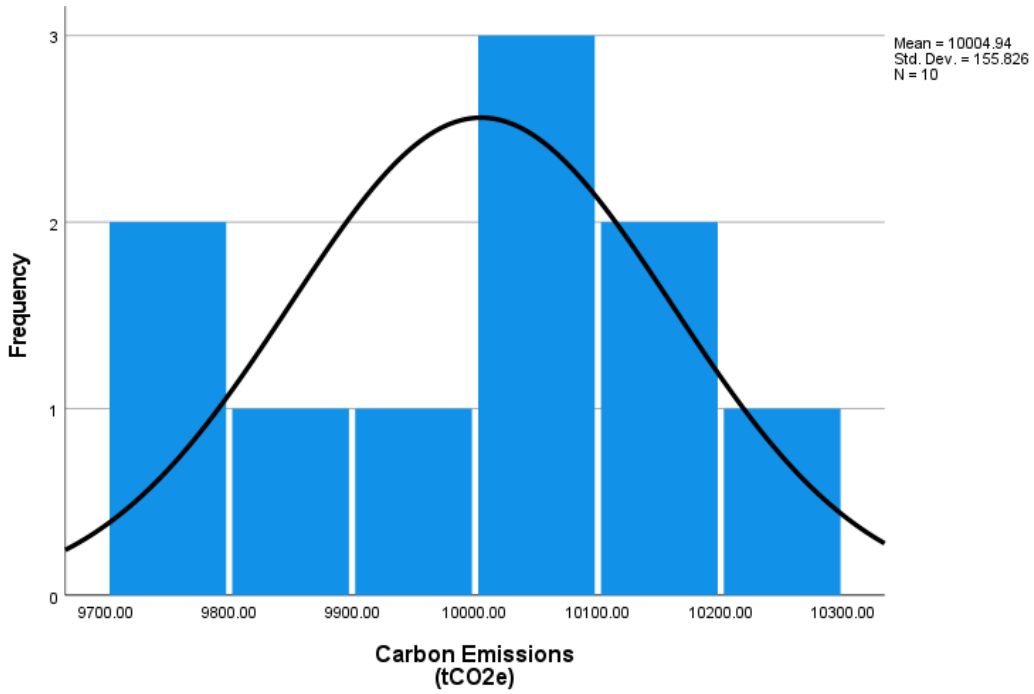

Figure 13: Histogram of Carbon Emissions

(Source: SPSS)

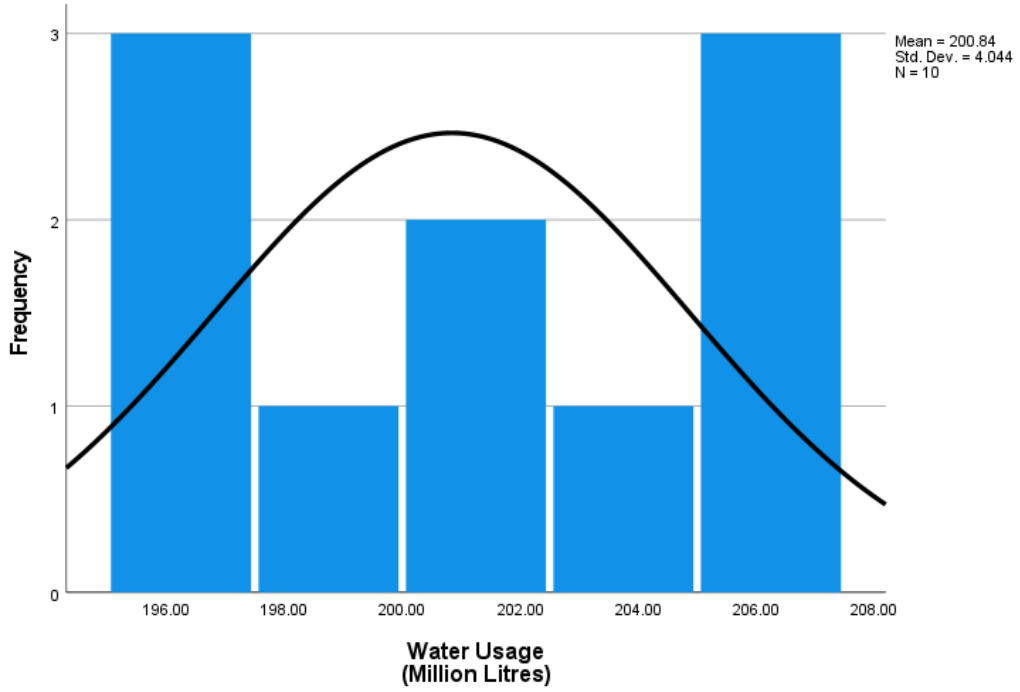

Figure 14: Histogram of Water Usage

(Source: SPSS)

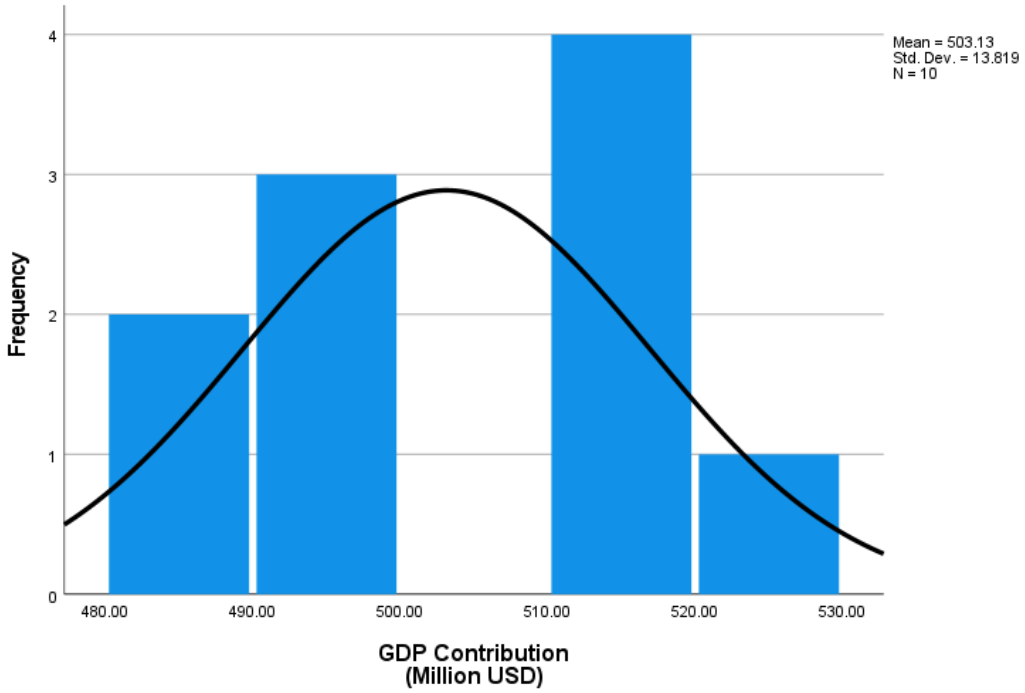

Figure 15: Histogram of GDP Contribution

(Source: SPSS)

4.3.3 Trend Analysis

An analysis of trends is done to determine how the important variables have changed with time. The graph of carbon emissions changes, water consumption, and the recycle rates during the study time are represented by line graphs. The trend that has been followed with respect to carbon emission has a stable values exhibiting minor variations over time. It means that the rate of emission is not very high, but more serious sustainability responses are required to make a substantial decrease. The analysis of the water usage pattern indicates a slow decrease in the intensity rate as the years go by and with this, there is an indicator of efficiency in the utilisation of resources and the use of technologies that consume less water. This is an indication of the good effect of carrying sustainability efforts at the industry level. The recycling rate shows an upward dynamic, which means that there is greater adoption of practises within the cyclical economy. The gradual increase in recycling is the indication of shift towards more sustainable waste management in the textile industry. All these trends together indicate that the industry is slowly transforming into one that is not only sustainable, but it is uneven in this change with various indicators changing at different rates.

4.3.4 Correlation Analysis

The correlation analysis is carried out to study the relationship among the important variables. Pearson correlation matrix can also shed some light on what as well as how strong and in which directions the association between the indicators of the environmental, economic, and circular economy are. These findings demonstrate that environmental cost index and carbon emissions have a negative relation which falls strongly, thus higher environmental cost management is related to a low carbon emission. Also, recycling rate has a positive correlation with the sustainability score which implies that the higher the levels of recycling, the better the sustainability practices are represented. There is a positive relationship which is strong between year and recycling rate, pointing to the progressive socialisation of the practises of a circle economy. The result helps to reinforce the trend analysis and supports the assumption of the increasing relevance of the concept of sustainability in the textile industry. Taken all together, the correlation analysis gives a rough picture of how the variables relate to each other, further discussed in the regression analysis.

Correlations

		Year	Carbon Emissions (tCO2e)	Sustainability Score (0–100)	Env Cost Index	Recycling Rate (%)
Year	Pearson Correlation	1	.369	.399	-.151	.812**
	Sig. (2-tailed)		.293	.253	.677	.004
	N	10	10	10	10	10
Carbon Emissions (tCO2e)	Pearson Correlation	.369	1	.204	-.782**	.350
	Sig. (2-tailed)	.293		.571	.008	.321
	N	10	10	10	10	10
Sustainability Score (0–100)	Pearson Correlation	.399	.204	1	-.346	.434
	Sig. (2-tailed)	.253	.571		.328	.210
	N	10	10	10	10	10
Env Cost Index	Pearson Correlation	-.151	-.782**	-.346	1	-.311
	Sig. (2-tailed)	.677	.008	.328		.382
	N	10	10	10	10	10
Recycling Rate (%)	Pearson Correlation	.812**	.350	.434	-.311	1
	Sig. (2-tailed)	.004	.321	.210	.382	
	N	10	10	10	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation Matrix

(Source: SPSS)

4.4 Regression Analysis

4.4.1 Model 1 -Effect on Carbon Emissions

A multiple regression model has been estimated to study the effect of circular economy practices on environmental performance, while carbon emissions are the dependent variable. Sustainability score, environmental cost index, and recycling rate are the independent variables. The model summary reveals that there is a good explanatory power, with the value of R^2 is 0.638. This means that the independent variables selected can explain about 63.8 per cent of the change in carbon emissions. The adjusted R^2 value despite being slightly lesser still indicates a moderate degree of reliability of the model due to limited sample size.

The results of ANOVA indicate that the general model is moderately significant indicating the collective effects of the independent variables on carbon emission. The most significant variable of predictors is the environmental cost index, in which the coefficient is negative. This implies that the higher the levels of investment on environmental cost management, the lower the carbon emission. Conversely, the score on sustainability and recycling rate are not statistically significant factors in this model. Their coefficients however indicate that they have

a direction of relationship thus implying that these variables could be contributing to the reduction of emissions over time.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.799[a]	.638	.457	114.83174	.638	3.524	3	6	.088

a. Predictors: (Constant), Recycling Rate (%), Env Cost Index, Sustainability Score (0–100)

Table 3: Model Summary – Carbon

(Source: SPSS)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	139416.796	3	46472.265	3.524	.088[b]
	Residual	79117.971	6	13186.328		
	Total	218534.767	9			

a. Dependent Variable: Carbon Emissions (tCO2e)

b. Predictors: (Constant), Recycling Rate (%), Env Cost Index, Sustainability Score (0–100)

Table 4: ANOVA – Carbon

(Source: SPSS)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	17243.077	4022.398		4.287	.005		
	Sustainability Score (0–100)	-13.700	28.098	-.137	-.488	.643	.762	1.312
	Env Cost Index	-14241.099	4889.542	-.777	-2.913	.027	.849	1.178
	Recycling Rate (%)	23.903	39.465	.168	.606	.567	.782	1.279

a. Dependent Variable: Carbon Emissions (tCO2e)

Table 5: Coefficients – Carbon

(Source: SPSS)

4.4.2 Model 2 – Impact on Water Usage

The second regression model is dedicated to resource efficiency with the water usage as the dependent variable. The independent variables are sustainability score and recycling rate. The model explains away fairly 41.8 percent of the variation in water usage, which is a moderate power of explanation. The overall model does not have a statistically significant positive value, but the coefficients do refer to useful information on the direction of relationships. Sustainability score and recycling rate show negative values, indicating that the greater sustainability and recycling, the lower will be the consumption of water. It means that circular economic practises help to reach greater resource efficiency, although the statistical power of such model is weak. The findings indicate the possibility of sustainability programmes decreasing the use of resources in the textile industry.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.647[a]	.418	.252	3.49682	.418	2.517	2	7	.150

a. Predictors: (Constant), Recycling Rate (%), Sustainability Score (0–100)

Table 6: Model Summary – Water

(Source: SPSS)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	324.183	61.276		5.291	.001		
	Sustainability Score (0–100)	-1.144	.829	-.441	-1.379	.210	.811	1.232
	Recycling Rate (%)	-1.174	1.180	-.318	-.995	.353	.811	1.232

a. Dependent Variable: Water Usage (Million Litres)

Table 7: Coefficients – Water

(Source: SPSS)

4.4.3 Model 3 Impact on Economic Performance (GDP)

The third regression estimate measures the correlation between practises of the circular economy and economic performance with GDP contribution as the dependent variable.

Recycling rate, sustainability score and production levels are the independent variables. The model has a lower explanatory power as it has $R^2 = 0.301$. This is an indication that very little of the variation in the contribution to GDP is encapsulated by the chosen variables. Moreover, the model is statistically insignificant, which proves that the connexion between practises related to the circular economy and economic performance is weak in the short-term period. Production is among the variables to have a positive relationship with GDP, which is the kind of expected relationship between production and contribution to the economy. The rate of recycling and sustainability score, in turn, are not highly affected, which implies that the economic advantages of the circular practises might be less tangible. The implication of these findings is that circular economy initiatives can improve the environmental performance, but the economic effect can be realised in the long-term.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.548[a]	.301	-.049	14.15152	.301	.860	3	6	.511

a. Predictors: (Constant), Monthly Production (Tonnes), Recycling Rate (%), Sustainability Score (0–100)

Table 8: Model Summary – GDP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	581.222	489.041		1.188	.280		
	Recycling Rate (%)	-5.317	4.775	-.422	-1.113	.308	.811	1.232
	Sustainability Score (0–100)	.252	3.981	.028	.063	.952	.577	1.733
	Monthly Production (Tonnes)	.421	.627	.282	.672	.526	.662	1.509

a. Dependent Variable: GDP Contribution (Million USD)

Table 9: Coefficients – GDP

4.4.4 Diagnostic Tests and Model validation

To verify reliability of the regression models, such diagnostic tests are performed to verify the presence of multicollinearity between the independent variables. The values of Variance Inflation Factor (VIF) of all variables are provided to be within reasonable ranges meaning that the problem of multicollinearity does not exist.

This proves that the independent variables do not have high interdependence and the regression outcomes are consistent and valid. Besides, there are also tolerance values, which support also the validity of the models.

In general, the regression analysis demonstrates valuable information regarding the correlation of the research variables on circular economy practises and sustainability outcomes, which will be the foundation of the further interpretation.

4.5 Interpretation of Results

4.5.1 Environmental Impact

The amount of regression analysis results shows that there is a significant influence of circular economy practices on the environmental sustainability in the textile industry. One of the most important variables considered is the environmental cost index, as the factor that makes the biggest impact on carbon emissions. The correlation showed that the environmental cost and environmental emissions are associated negatively implying that, as the investment in environmental protective measures increases, the emissions of greenhouse gases also decrease. Even though sustainability score and recycling rate do not indicate statistically significant values in the regression model, the developmental research of the recycling rate and sustainability score suggests the prospects of long-term benefits. This observation is also enhanced by the trend analysis whose indicators have gradual increases in environmental indicators with time. Besides, the water usage model shows that sustainability as well as recycling depends positively on reduced resource usage thus showing that they contribute to resource efficiency. All in all, the results indicate that the all-encompassing performance in terms of the environmental wish is strongly shaped by the cost-based regulatory and managerial strategies, whereas the extended circular description implies sustainability with a slower approach.

4.5.2 Economic Impact

Economic performance analysis, presented as a contribution to GDP, suggests that the practises of a circular economy does not produce a significant immediate effect on financial results. The regression estimates demonstrate weak and insignificant connections among the recycling level, sustainability measure, and contribution towards GDP. This implies that the economic advantages of circular economy projects may not be seen any time soon. Rather, these benefits would likely become apparent in the long term, as sustainability practises become increasingly

integrated into production and supply chains. The relationship between production rate and the GDP is evident in the positive relationship that confirms that in the textile industry, output continues to be a major key to the performance of the economies. Thus, although the practises of a circular economy help to improve environmental sustainability, their short-term contribution to the development of the economy does not seem substantial.

4.5.3 Circular Economy Trends

The correlation analysis also suggests that there is a strong positive relationship between year and recycling rate, which shows the high rate of adoption of best practices to the circular economy with time. The trend indicates the increased focus on sustainability as a concern in the textile industry, which was promoted by the regulatory systems, demand, and overall technological progress. The increased recycling rates prove that the industry is slowly moving towards becoming more sustainable. This change can also be justified by the fact that the sustainability scores and the decrease in resources utilisation become better over the years.

Chapter 5: Results and Discussion

The chapter shows and critically analyses the results of the regression analysis of the study that has investigated the correlation between the measures of the circle economy and the sustainability in Indian textile and apparel industry. The discussion combines both empirical findings and literature to offer a holistic idea on effects of circular practises on both environmental and economic performance.

5.1 Overview of Empirical Findings

The purpose of the regression analysis in the present research was to evaluate how significant circular economy variables, i.e. recycling rate, sustainability adoption score and resource efficiency influence dependent variables, i.e. carbon emissions and economic performance indices. The findings have revealed a moderate explanatory power, and general R2 indicates that the variables of the circular economy explain a significant but not comprehensive percent variation with the environment outcomes.

Although some of the variables were found to be positively related to sustainability performance, the level of statistical significance on the same varied. Specifically, the effect of infrastructure investment and technological adoption showed a more significant and robust impact on the results compared to individual circular practises' existence like recycling alone.

This indicates that circular economy policies can be more effective when put in place as a part of a wider system change as opposed to a standalone initiative.

5.2 Circular Economy Practises on the Environment

A major aim of this paper was to determine whether the practise of a circular economy leads to environmental sustainability, in relation to carbon emission and waste production. The results show that the overall trend of better environmental performance observed in the companies with the adoption of circular strategies, the level of impact is not equal.
It can be explained by the fact that this can be confirmed by the study conducted by Repp et al. (2021), who have stated that the processes of transitioning to the circular economy can have complex and highly unequal environmental consequences because of the differences in the value chains of the implementation process. Likewise, Thinakaran et al. (2022) point out that a deficiency in infrastructures, technological constraints, and regulatory loopholes can be key limiting factors to the efficacy of a circular initiative in the Indian fashion sector.
The somewhat small statistical significance of some variables of the regression model indicates that circular practises cannot only be referred to as the source of environmental improvements. Rather they are affected by a set of interplay between a range of factors, such as regulations enforcement, integration of supply chains as well as capabilities at the levels of firms. It means that, to obtain tangible environmental advantages, the implementation of the principles of the circular economy should be backed by institutional and technological systems.

5.3 Economic Consequences of Circular Strategies

Besides the environmental results, this paper also looked at the economic consequences of adopting the circular economy and considering the cost efficiency, profitability and competitiveness in the market. These results imply that although circular practises can be economically beneficial, these impacts are usually indirect and they can be delayed. As an example, investments in recycling infrastructure, as well as sustainable production processes can ensure the enhanced profits of the operation in the short run, thus decreasing operational costs. These investments however with time may result in cost saving in terms of resource efficiency as well as material wastage. It agrees with the results of Akter et al. (2022), who suggest that circular business models have the potential to strengthen economic resilience in the long-term perspective by reducing reliance on virgin resources.

Additionally, the emerging consumer need of sustainable goods has generated additional business prospects to companies that have embraced the circle of practises. According to Hora et al. (2023), sustainability is now an important competitive factor in the global textile and apparel business. Leading with the ideas the circular economy, companies that implement the major idea correctly are better equipped to be able to reap the benefits of consumers who are attentive to their environment and meet the stricter environment regulations that are getting enforced daily. Nevertheless, these findings also show that Economic rewards are not evenly distributed amongst firms. Smaller companies especially might experience a lot of financial and technological challenges towards discarding circular practises. This shows the necessity of specific policy measures and financial support system to ensure that more industries take part in the process of transitioning to the circular economy.

5.4 Support of Infrastructure and Policy

An important guide to come out in the analysis is the fact that infrastructure and policy support play a very important role in ensuring the success of the strategies dealing with the circular economy. The infrastructure investment variables showed greater explanatory power in the regression model hence showing that systemic enablers are essential in realising sustainability outcomes. This observation highlights the need to have the government intervene in ensuring the shift to a circular economy. Policymakers in the division of India can foster more favourable circumstances around the practise of circularity by creating arguably more effective policies like extended producer responsibility (EPR) and textile waste management. Nevertheless, Thinakaran et al. (2022) mention that the introduction of this kind of policies is not uniform, which restricts their effectiveness.

Moreover, the fact that standard metrics and reporting frameworks of the circular economy performance are not established is a major challenge to researchers and those working in the area of practise. Having no trustworthy measurable data and tools in place, it will be rather challenging to evaluate the efficiency of circular strategies and find optimal practises. This indicates that more transparency and standardisation of sustainability reporting should be implemented in the textile industry.

5.5 Comparison of Global Practises

To put the findings into perspective, it is important to compare the India developments to world developments of how it should embrace the circular economy. Developed markets, particularly

in Europe, have made a long distance to implement circular practises using high regulatory laws and technological advancement. On a pointer, other projects such as the European Union Circular Economy Action Plan have provided an elaborate map in the direction of sustainable production and consumption.

The Indian textile industry, in its turn, is only starting to go circular. Despite the existence of promising initiatives and pilot projects, social mass implementation has not been conducted in the large scale. The difference in regulatory capacity, technological infrastructure and finances may explain this difference. But nevertheless, that India can be regarded as one of the largest producers of textile in the world creates an alternative opportunity in making the world a better place to live. By developing new projects which revolve around the circular business concept, using the capabilities of manufacturing, India has a magnificent chance to change the world of fashion.

5.6 Limitations of the Analysis

Even under the light of the insights obtained, this study is limited in a few ways that should be considered. To begin with, secondary data means that one cannot capture the firm level variations and the dynamics in the industry in real time. Second, the result might be limited in terms of the overall limitations of the regression analysis based on the rather small sample that has been utilised. Secondly, simplified statistical models can also not be entirely adequate to explain the intricate interactions between circular economy variables and sustainability results. These limitations might be resolved in future studies by using primary data, increasing the number of data, and more sophisticated methods of econometric analysis.

5.7 Synthesis of Findings

Overall, the findings allow if the strategies related to the circular economy could help to make the textile and apparel industry in India more sustainable, yet the successful results are conditioned by various factors in the context. Only environmental advantages are clear but not equally noteworthy whereas economic advantages are usually indirect and long-term in nature. The results support the significance of following a technical implementation of the circular economy, or the implementation that involves technological advancement, the policy support, and the cooperation of the stakeholders. Devoid of such an integrated approach the shift towards sustainability is most likely to stay in pieces and remain insignificant.

6. Conclusion

This research was aimed at analysing the importance of circular economy approaches in promoting sustainability in the textile and apparel sector in India and its environmental and economic impacts. The research, using secondary quantitative data and regression analysis, was to offer empirical evidence in the effectiveness of circular practises in dealing with the issue brought by fast fashion.

According to the research findings, although circular economy strategies can provide substantial possibilities of enhancing the sustainability results, they have no homogenous and immediate consequences on the industry. Reforms to the environment, especially lower carbon emissions and waste production, can be seen but require enormous support of the magnitude and unification of the circular practises. Individual measures, including recycling, cannot change the tremendous momentum without structural reforms.

Economically, the implementation of the principles of the circular economy has opportunities and challenges. Although the benefits that are felt in the long term like cost effectiveness, optimization of resources and increased competitiveness in the market are felt, short-term financial constraints and implementation obstacles usually tend to dampen these benefits. This is especially concerned with the small/ medium-sized business, as those might not cover the resources and technology needed to shift towards the realm of the circular business.

One of the most important contributions of the research is the focus on the importance of infrastructure and policy support as the necessity to implement the circular economy strategies successfully. It is shown in the analysis that the variables associated with infrastructure investment and technological adoption have a greater influence on the achievements of sustainability in comparison with the single circular practises. This drives the need to have coordinated efforts among government, industry stakeholders, and policymakers in developing an enabling environment towards circularity.

Moreover, the researchers show that the textile and apparel sector in India is only yet half-way into embracing the idea of the circular economy. Although there are positive changes, it is still slow compared to leaders in the rest of the world. It is a gap that creates a challenge and an opportunity. India can surge ahead in the quest of a more sustainable and resolute textile industry by learning the international best practises and adapting them to the local realities.

Nevertheless, the research is not deficient. The use of secondary data and a comparatively limited dataset could limit the soundness of the results. Moreover, the volatility of the systems of the circular economy might not be well reflected by the professional approaches that will be

used. Additional studies in this area should thus be done to include primary data, broaden the area of analysis and the role of new technologies, like digitalization, in enabling circular transitions.

Conclusively, the process of becoming circular in the Indian textile and apparel sector is not only possible but also required, however, it should be approached thoroughly and mind-rewardingly. The circular strategies should be incorporated in the wider industrial system that can be reinforced by effective policy framework, technological advancement, and partnership. It is only under such an integrated approach that the industry can successfully deal with the environmental issues of fast fashion and still have a sustainable economic growth.

Finally, the study adds to the existing literature on circular economy practises and offers some important lessons, which can be utilised by policymakers, industry participants, and scholars. It clarifies that sustainability is not only a regulatory necessity but a strategic compulsion that have the potential of stimulating the creation of long-term value of the textile and apparel industry.

Furthermore, the results indicate the necessity to move towards a linear production philosophy and towards a systems-based strategy which incorporates circularity throughout the entire value chain, with the sources of raw materials all the way to the disposal of the products. This change will not only entail an innovation of technology but behavioural change of both the consumers and the businesses. Raising awareness, facilitation of sustainable consumption patterns and promotion of responsible production practises will play a key role in accelerating the transition. Also, among the stakeholders, cooperation, such as manufacturers, policymakers, and consumers, will be a decisive factor in the scaling of circular solutions. In the absence of this multi-level coordination's the effects of the circular initiatives would be seen to be very disjointed and narrow as well. Thus, the further development will be attached to the capacity of the industry to incorporate environmental goals as balanced and strategical as the economic priorities.

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Appendix 1: List Of Figures

Appendix 2: List Of Tables