

CASE STUDY



Digital tools and circular economy in Indian textiles: A case study from Surat

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ABSTRACT

The Indian textile industry, a cornerstone of the country's economy, is facing increasing pressure to shift towards sustainable practices. This case study explores how circular economy principles, focused on waste reduction, material reuse, and resource efficiency, are being implemented within a medium-sized textile cluster in Surat, Gujarat. Emphasis is placed on the role of digital tools such as cloud-based inventory systems, IoT-enabled tracking, and automated quality control in facilitating this transition. Data for the study was collected through direct interviews with local entrepreneurs, supported by secondary insights from policy documents and sustainability reports. The findings indicate that digitalization not only enhances operational efficiency but also helps overcome barriers like supply chain fragmentation and compliance documentation. The study highlights a practical pathway for Indian MSMEs in textiles to adopt circular business models while remaining competitive. This case serves as a reference for policymakers, business incubators, and aspiring green entrepreneurs aiming for scalable sustainability in India.

KEYWORDS

Circular economy; Digital tools; Sustainable entrepreneurship; Green technology adoption; Textile manufacturing innovation; Indian textile sector

ARTICLE HISTORY

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Introduction

The textile industry holds a prominent place in India's economic and social fabric, being the second-largest employer after agriculture and contributing significantly to export revenue. With deep historical roots and a widespread presence across urban and rural regions, the sector supports millions of livelihoods, especially among women and marginalised communities [1]. However, this growth has come with serious environmental consequences, including excessive water consumption and chemical usage, as well as the large-scale generation of textile waste. In recent years, both global and domestic stakeholders have raised concerns over the long-term sustainability of this vital industry [2].

In this context, the concept of a circular economy has emerged as a necessary alternative to the traditional linear "take-make-dispose" model [3]. Circular practices such as textile recycling, reuse of fabric, and responsible sourcing not only help reduce the ecological footprint but also create new avenues for innovation and entrepreneurship. For Indian textile businesses, especially micro, small, and medium enterprises (MSMEs), the adoption of circular models is no longer optional but a matter of survival in an increasingly conscious global market [4].

Digitalization plays a key enabling role in this transition. From supply chain transparency using blockchain to automated inventory management and AI-based quality checks, digital tools offer practical solutions for efficiently implementing circular practices at scale [5].

This case study focuses on a medium-sized textile unit located in Surat, Gujarat, one of India's major textile hubs. The aim is to examine how circular economy principles are being applied on the ground, and how digital technologies are supporting this shift towards sustainability. The study offers insights that could inform

broader adoption across similar industrial clusters in India.

Literature Overview

The textile sector is one of the largest contributors to India's manufacturing output and employment. However, it is also a significant consumer of water, energy, and chemicals, generating vast quantities of waste and pollution. As environmental regulations tighten and international buyers become more sustainability-conscious, the industry faces mounting pressure to transition toward more eco-resilient models [6]. In this context, the circular economy (CE) approach has gained traction. CE promotes the reduction, reuse, and recycling of materials across the product lifecycle, offering a viable alternative to the conventional "take-make-dispose" paradigm that currently dominates Indian manufacturing [3].

Globally, several textile-producing countries have already made considerable progress in embedding CE principles into their industrial strategies. In India, however, while awareness is increasing, actual implementation, particularly among micro, small, and medium enterprises (MSMEs), is still limited due to financial constraints, lack of technological access, and weak policy incentives [7].

A growing body of literature highlights the critical role of digital innovation in enabling circular models. Technologies such as blockchain, enterprise resource planning (ERP) systems, the Internet of Things (IoT), and artificial intelligence (AI) are helping firms enhance efficiency, improve traceability, and minimize waste [8]. These tools not only support operational goals but also enable firms to meet sustainability standards demanded by global supply chains. A summary of these technologies and their specific functions in supporting circular practices is provided in Table 1 below.

Table 1. Digital technologies supporting circular economy in textiles [8].

Technology	Function in Circular Economy Implementation
Blockchain	Enables traceability of raw materials and supply chain transparency
ERP (Enterprise Systems)	Manages real-time inventory, material usage, and production flow
IoT Sensors	Tracks water, energy, and emissions in real-time
Artificial Intelligence	Supports defect prediction, quality control, and waste reduction

Despite their proven value, there is a noticeable gap in India-specific empirical studies documenting how digital tools are being used to implement CE models in textiles [9]. This case study from Surat seeks to address this gap by offering insights from a local textile enterprise that is actively integrating sustainability with digitalization.

Methodology

This study adopts a qualitative case study approach to explore the intersection of circular economy practices and digital innovation in India's textile sector. A single firm based in Surat, Gujarat, a key textile manufacturing hub, was selected for in-depth examination [10]. The rationale for this selection lies in the firm's early adoption of sustainable practices and use of digital tools such as ERP and IoT to monitor resource efficiency and waste reduction.

Data was collected from multiple sources to ensure triangulation and reliability. Semi-structured interviews were conducted with the firm's operations manager and sustainability officer to gain insights into implementation strategies and day-to-day challenges. Additionally, internal company reports, audit documents, and publicly available secondary data (e.g., trade board publications, industry white papers) were analysed to understand the broader business environment and compliance landscape [11].

While this single-case design enables rich, context-specific analysis, it also limits generalisability. Nevertheless, the study offers practical insights relevant to other MSMEs in similar industrial settings across India. The findings are intended to serve as an exploratory step toward developing scalable frameworks for circular digital transformation in Indian textiles [12].

Case Description

Background of the business and location

The selected case is Shree Vastra Innovations Pvt. Ltd., a mid-sized textile manufacturing unit based in Surat, Gujarat, widely regarded as the "Textile Capital of India." Established in 2009, the company specializes in synthetic fabrics, catering to both domestic and international markets. Until 2018, the firm followed conventional production processes but gradually faced challenges due to rising raw material costs, water shortages, and increasing environmental scrutiny from global buyers. This pushed the management to explore more sustainable

alternatives aligned with circular economy principles.

Circular strategies adopted

In response to both ecological and economic pressures, the firm began restructuring its value chain using circular economy strategies. These included:

- **Recycling of dye wastewater** using advanced filtration systems.
- **Upcycling of fabric waste** into marketable home décor products.
- Establishment of a **closed-loop production system**, where manufacturing offcuts are reintegrated into pre-processing cycles.
- Implementation of **internal benchmarks** for resource efficiency, with set targets for reducing energy and water usage by 20% over three years.

These practices significantly minimized production waste, enhanced material efficiency, and opened new revenue streams.

Digital tools and technologies employed

To support these circular initiatives, Shree Vastra invested in several digital tools that enabled accurate monitoring and timely decision-making:

- A **custom-built ERP system** was developed to track live data on chemical inputs, production timelines, and inventory turnover.
- **IoT-enabled flow meters** were installed across dyeing units and energy systems to measure real-time water and power consumption.
- An **AI-powered analytics dashboard** was introduced for quality control, capable of predicting pattern-based defects before they impacted output.
- Additionally, **RFID tagging** enabled full traceability of raw materials, from procurement to post-production.

These tools created an integrated data environment that improved accountability, reduced inefficiencies, and allowed for early corrective actions.

Challenges and mitigation strategies

The transition was not without obstacles. Initial resistance from machine operators and supervisors was a major issue, mostly due to low digital literacy. The company mitigated this through structured training programs and peer-led learning sessions. The financial burden of technology adoption was managed via phased investments and collaboration with local tech startups offering affordable solutions. Limited government support was also a concern, which the company navigated by aligning their practices with the sustainability expectations of international buyers, thus securing premium contracts.

Observed impact

Within two years, the firm recorded notable environmental and operational benefits:

- **28% reduction in water consumption** per unit of output.
- **35% reduction in defective fabric output**, thanks to AI-based predictive tools.
- **₹14.6 lakh in annual savings** from reduced energy and chemical use.

- Enhanced brand image and **access to high-value European markets**, driven by verifiable sustainability credentials.

The integration of circular economy practices with digital tools not only enhanced the company's ecological footprint but also delivered measurable financial and reputational returns. The overall digital-enabled circular workflow of the company is visually represented in Figure 1, highlighting the application points of ERP systems, IoT sensors, AI modules, and RFID tracking across the closed-loop textile production cycle.

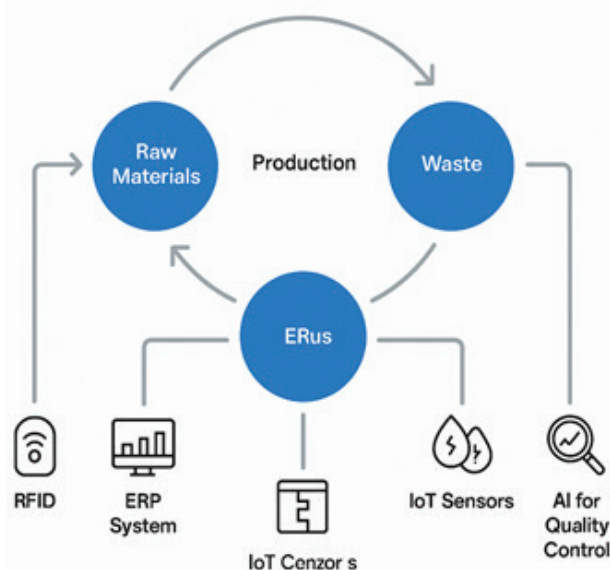


Figure 1. Digital-enabled circular production flow at Shree Vastra Innovations Pvt. Ltd., showing closed-loop textile manufacturing stages integrated with ERP, IoT, AI, and RFID systems for sustainable operations.

Discussion

The journey of *Shree Vastra Innovations Pvt. Ltd.* illustrates how digital technology can drive circular economy (CE) adoption even within India's traditional textile sector. Existing literature often emphasizes the theoretical advantages of CE and the potential of digitalization, but practical examples from Indian MSMEs remain limited [13]. This case fills that gap by showing how targeted digital interventions can help firms transition to circular models.

By integrating tools like AI-based quality control, IoT-driven monitoring, and ERP systems, Shree Vastra successfully minimized waste and optimized resources. These align with Lacy and Rutqvist's (2015) findings that digital tools help close material loops and enhance traceability. For Indian entrepreneurs, the case proves that CE is not reserved for large firms; digitally guided innovation can be achieved even with modest investment.

This experience offers three key insights:

- MSMEs can adopt circular practices gradually using cost-effective technologies.
- Digital tools reduce compliance burdens and improve supply chain coordination.
- Circular models can be profitable—evidenced by reduced defects, water savings, and improved market access.

Moreover, by embracing sustainability and innovation together, the firm boosted its competitiveness in export markets, where traceability and green credentials are highly valued.

For policymakers and MSME clusters, the case reinforces the need for digital literacy programs, simplified access to sustainability grants, and stronger partnerships between tech providers and local industries [14]. The integrated circular strategy pathway is visually summarized in Figure 2, highlighting the link between digital tools, circular goals, and business performance in the textile sector.

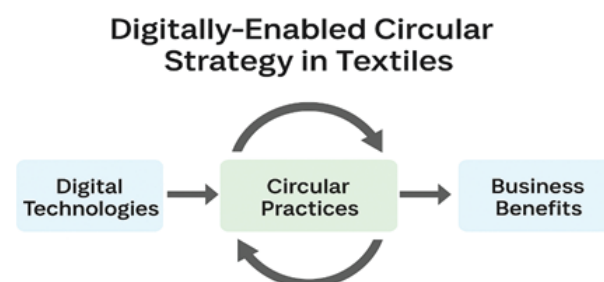


Figure 2. Digitally-enabled circular strategy in textiles illustrating the integration of digital technologies (e.g., IoT, ERP, AI) to support circular practices like recycling and resource efficiency, leading to measurable business benefits such as reduced waste, cost savings, and improved compliance [15].

Conclusion and Implications

This case study of *Shree Vastra Innovations Pvt. Ltd.* demonstrates how digital technologies can significantly enhance the implementation of circular economy principles in India's textile sector. By integrating tools like ERP systems, IoT monitoring, and AI-driven quality control, the firm successfully reduced waste, optimized resource use, and improved operational transparency.

The key implication is that circular entrepreneurship is achievable for Indian MSMEs, especially when digital tools are tailored to specific operational needs. The economic benefits, reduced material loss, enhanced efficiency, and better market positioning, prove that circular models are not only environmentally necessary but also financially viable.

For policymakers, the study highlights the importance of incentivizing digital adoption in sustainability initiatives, particularly through schemes for MSMEs in industrial clusters. Skill development programs in digital and green technologies should also be prioritized.

Future entrepreneurs are encouraged to adopt a phased approach, starting with one or two digital systems that align with their sustainability goals. Collaboration with technology providers and sustainability consultants can accelerate this transition toward a resilient, circular economy.

Disclosure Statement

The authors declare no competing interests affecting this research.

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