

Repurposing Plastic Waste into Circular Production: A Model for Sustainable Textile Manufacturing

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Abstract— The global textile industry is a major contributor to environmental degradation, particularly through plastic waste generated from packaging, chemical containers, and production processes. Teejay Lanka PLC, Sri Lanka's first multinational textile manufacturer, has addressed this challenge through an innovative plastic waste management initiative aligned with its Abhivarah 2030 sustainability roadmap. By adopting the 10R circular economy principles, Teejay has implemented a comprehensive strategy to reduce, reuse, and recycle plastic waste, with a special focus on converting hazardous chemical barrels into usable infrastructure components. A key breakthrough was the introduction of high-performance plastic tubes from recycled chemical barrels to serve as the central core for fabric rolls. These recycled tubes underwent rigorous testing for mechanical strength and chemical safety, meeting the standards set by the AFIRM Group's 2025 Packaging Restricted Substances List. Produced tubes demonstrated performance comparable to virgin materials and passed all regulatory checks for heavy metals, phthalates, APEOs, and PAHs. This initiative has led to a substantial reduction in virgin plastic use and improved operational efficiency. Furthermore, Teejay's success has strengthened its brand reputation, fostered community partnerships, and established a scalable model for circular innovation within the textile sector.

I. INTRODUCTION

The textile industry is among the most environmentally damaging sectors globally, responsible for approximately 1.2 billion tons of greenhouse gas emissions annually exceeding those from international aviation and maritime shipping [4]. Beyond emissions, the sector faces mounting challenges from improper disposal of wastewater, fiber waste, and plastic packaging, which contribute significantly to land and marine pollution [3].

As industry continues to grow, its reliance on virgin materials and single-use plastics underscores the urgent need for scalable, sustainable solutions rooted in circular economic principles. Teejay Lanka PLC

(Teejay), a leading multinational textile manufacturer based in Sri Lanka, has positioned itself at the forefront of this transformation. Through its Abhivarah 2030 strategy, the company is actively reducing environmental impact by integrating circular practices into its operations. A key initiative involves recycling plastic waste generated during production such as packaging and chemical containers into new products, thereby minimizing landfill contributions and promoting resource circulation. This approach not only aligns with SDG 12 (Responsible Consumption and Production) but also supports broader legal and industrial reforms aimed at sustainable waste management [1].

II. BACKGROUND

A. Company Overview

Teejay Lanka PLC, headquartered in Avissawella, Sri Lanka, is the country's first multinational textile manufacturer, specializing in weft knitted fabrics. Since its establishment in 2000 as Textured Jersey Lanka Pvt Ltd, the company has evolved through strategic rebranding and expansion, now operating facilities in both Sri Lanka and India. Teejay's product portfolio includes a wide range of fabric types such as single jersey, interlock, rib, pique, fleece, terry, and technical textiles tailored for lingerie, active wear, sleepwear, and intimate wear. The company also offers value-added services including yarn and lace dyeing and fabric printing. With a workforce of over 2,600 professionals, Teejay supplies to key global markets including Africa, the Dominican Republic, Bangladesh, and Indonesia, and partners with leading international brands such as PVH, Oniverse, L Brands, Decathlon, Marks & Spencer, Nike, Uniqlo, and Lidl [6].

Teejay's commitment to sustainability and innovation is embedded in its ESG framework and supported by strategic collaborations with industry leaders like Brandix Lanka and Pacific Textiles. The company has received multiple accolades, including recognition at the CMA Excellence in Integrated

Reporting Awards 2023, for its transparent and globally benchmarked reporting practices. Teejay is certified under ISO 14001, ISO 14064, ISO 50001, ISO 9001, and ISO 45001, and holds additional eco-conscious certifications such as OEKO-TEX Standard 100, GOTS, Bluesign, GRS, and OCS. Notably, it is among the first Sri Lankan companies to achieve Eco Labeling Type I certification. These credentials reflect Teejay's dedication to minimizing environmental impact, enhancing manufacturing efficiency, and maintaining high standards of quality and safety across its operations [6].

B. Abhivarah 2030 - Sustainability Overview

Sustainability is a cornerstone of Teejay's long-term vision. The company is guided by the Abhivarah 2030 roadmap, its strategic framework to achieve sustainable manufacturing through operational excellence, speed, service quality, and cost-efficiency. The term "Abhivarah" signifies ecological harmony, reflecting the organization's philosophy of nurturing nature to restore ecosystem balance [6].

Abhivarah 2030 aligns with global SDG targets and comprises three key pillars:

- Responsible Consumption - "Doing more with less"
- Responsible Discharge - "Waste to wealth"
- Support for a Thriving Planet - "To Earth with love"

Plastic waste management is embedded within responsible consumption, with the goal of minimizing virgin plastic usage in every level design, logistics, and internal infrastructure. However, the circular economy operates on the principle of transforming waste into wealth. Our ultimate goal in this project is to enhance the value of all types of waste and maximize circularity.

C. Project Overview

Without structured interventions, in most textile companies, this plastic would enter conventional waste disposal methods. Aligned with the responsible discharge pillar of Teejay's sustainability roadmap, Abhivarah 2030, the company has implemented a comprehensive plastic waste management strategy to mitigate environmental impacts and promote circularity. However, Kirchherr et al. discussed circular economic frameworks including the 10R model, which Teejay has adopted as a plastic waste management strategy [2].

TABLE I. 10R PRINCIPLES APPLIED AT TEEJAY

10R Principle	Application at Teejay
Refuse	Avoid unnecessary packaging and hazardous plastic inputs
Reduce	Minimize plastic usage via precision inventory and lean operations
Reuse	Reuse dye barrels and wraps where contamination is controlled
Repair	Maintain plastic-based infrastructure like recycled pipelines

10R Principle	Application at Teejay
Refurbish	Refurbish packaging units and containers for extended use
Remanufacture	Convert used plastic into utility components
Repurpose	Design-based reuse of plastic waste into functional items
Recycle	Extensive recycling of containers and packaging
Recover	Recover usable materials from discarded plastic
Redesign	Rethink supply chains to reduce plastic dependency

Adapted from [2]

This holistic approach ensures minimal landfill contributions and maximum resource efficiency. Among that the recycling principle employed under two approaches:

- Upcycling: Creative redesign into higher-use items.
- Downcycling: Conversion into lower-grade products like flooring or non-structural components [5].

Each level serves a distinct role from decreasing reliance on virgin materials to fostering innovation through sustainable design and engineering. Generally, in Teejay's plastic waste is generated from both hazardous (chemical barrels, lubricant containers) and non-hazardous (plastic pallets and containers) chemicals. Non-hazardous plastic waste can be easily reused, whereas hazardous plastics are not suitable for such processes. On average, our facility utilizes approximately 94,200 kg of plastic chemical barrels annually. The current practice for managing the resulting plastic waste involves downcycling, where the material is used to produce electrical components. As a new approach, it has been proposed to recycle this waste into plastic tubes. Teejay has already adopted the 10R principles in its plastic waste management strategy. These include replacing small bulk purchases with larger bulk quantities to reduce waste, monitoring daily waste generation, returning used chemical barrels to suppliers for refilling, and using plastic chemical barrels for sludge storage. Even after implementing the 10R principles, a portion of plastic waste remains. For this residual waste, it has been suggested to apply circular economy practices by converting it into raw material for use within the plant.

A groundbreaking achievement in Teejay's sustainability efforts is the development and successful implementation recycled plastic tubes which serve as the central core for fabric rolls used in textile production. Recognizing the environmental burden of plastic waste generated from daily operations, particularly from discarded chemical barrels Teejay initiated a bold plan to transform this waste into a valuable internal infrastructure component. The project involved shredding and reprocessing plastic waste into a usable form, which was then molded using high-pressure extrusion systems to create durable, high-performance plastic tubes. This initiative was not only a technical success but also a strategic one. The newly

developed tubes underwent comprehensive quality assurance testing, including evaluations for tensile strength, abrasion resistance, and flexibility, ensuring they could withstand the mechanical demands of fabric roll handling. Furthermore, given the stringent compliance requirements of Teejay's global clients, the tubes were subjected to detailed chemical composition analyses to verify that no harmful or residual chemical substances remained. These tests confirmed that the tubes were completely safe, non-toxic, and free from any hazardous materials, meeting both internal standards and international customer expectations.

The results were remarkable, the recycled plastic tubes demonstrated performance comparable to virgin polymer systems, while achieving zero reliance on virgin plastic. This innovation not only reduced Teejay's environmental footprint but also showcased the power of cross-functional collaboration, involving engineering, sustainability, and production teams working together toward a circular solution.

In addition to internal reuse, Teejay has extended its impact by donating surplus plastic waste to local communities, enabling small-scale manufacturers and entrepreneurs to use it as raw material for producing new products. This community-focused approach not only supports local economies but also reinforces Teejay's broader vision of environmental stewardship and social responsibility.

D. Reasons for Project Implementation

The plastic waste management plan is pivotal to Teejay's objectives of environmental stewardship, operational efficiency, and regulatory compliance. It consists of the following key drives:

- **Innovation & Circularity:** Designing factory utilities (like fabric roll pipelines) from upcycled plastics.
- **Compliance:** Aligning with global waste management benchmarks and ISO frameworks.
- **Brand Positioning:** Demonstrating leadership in sustainable textiles to global customers.

This model reduces Teejay's carbon footprint while showcasing its ability to turn environmental challenges into competitive advantages. In addition to that, the implementation of Teejay's recycled plastic pipelines has delivered multiple lifecycle benefits. It has significantly reduced dependency on external suppliers by utilizing in-house plastic waste, effectively transforming hazardous materials into durable infrastructure. The project also fostered collaboration between engineering and sustainability teams, showcasing the power of cross-disciplinary innovation. This pioneering infrastructure has attracted interest from global partners across the energy, automotive, and apparel sectors, who are exploring similar circular solutions inspired by Teejay's success.

III. METHODOLOGY

This experimental study focuses on mitigating the high volume of plastic waste generated during Teejay's manufacturing processes, particularly from chemical barrels used in dyeing and finishing operations. These barrels represent the largest source of plastic waste compared to packaging and logistics materials. The initiative aimed to identify a viable solution for repurposing residual plastic waste by applying circular economy principles transforming waste into raw material for internal use. The selected application was the development of plastic tubes to serve as central cores for fabric rolls, replacing virgin plastic alternatives.

Teejay collaborated with a third-party supplier to design and manufacture prototype fabric roll tubes using recycled plastic sourced from in-house chemical barrels. Each prototype was engineered to match the specifications of conventional fabric roll cores, with two distinct tube sizes: one measuring 2-inch inner diameter (ID) and 1380 mm in length, and another measuring 1¼-inch ID and 1180 mm in length. To ensure performance and safety, the prototypes underwent mechanical strength testing based on ASTM D790 (Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics) and ASTM D638 (Tensile Properties of Plastics). Chemical safety was assessed under the Apparel and Footwear International RSL Management (AFIRM) Group Packaging Restricted Substances List, Version 8 (2025). Comparative analysis was conducted against conventional virgin plastic tubes to evaluate durability, load-bearing capacity, and chemical residue levels.

Results confirmed that the recycled plastic tubes met all mechanical and chemical safety standards, with no detectable restricted substances. Following successful validation, a pilot batch of 500 tubes was produced and integrated into the plant's fabric rolling operations. No adverse effects on product quality or customer compliance were observed, supporting continued use and demonstrating the feasibility of circular resource utilization.

To manufacture the recycled plastic tubes, we begin by thoroughly cleaning the used chemical barrels through a triple-wash process using an automated washing machine. This ensures all residues are removed effectively. Once cleaned, the barrels are crushed into smaller pieces and then converted into plastic pellets. These pellets serve as the raw material for producing the final recycled plastic tubes.

The following image illustrates this process step-by-step.

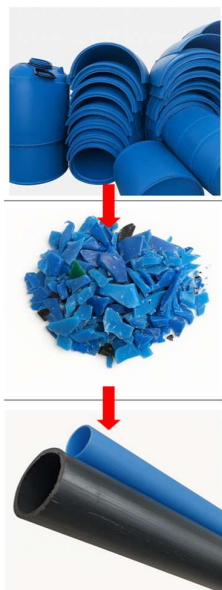


Figure 1. Recycled plastic tubes production process

IV. RESULTS

Teejay conducted a pilot study to evaluate the feasibility of using recycled plastic tubes as a sustainable alternative to virgin plastic components in its manufacturing operations. A batch of 500 recycled plastic tube samples was produced and tested within one of the plant's departments. These samples were assessed for key quality parameters including mechanical strength, durability, and reusability, and were benchmarked against virgin plastic tubes traditionally used in fabric rolling processes. The recycled plastic tubes demonstrated strong mechanical integrity, reliably withstanding up to 25 kg of fabric load, matching the performance of virgin plastic tubes. Both tube types exhibited equal durability and strength, making them suitable for standard production requirements. In terms of reusability, recycled tubes maintained their structural integrity through eight reuse cycles, matching the performance of virgin tubes, which are typically reused up to eight times in actual plant operations. Notably, when fabric bulk is delivered to customers, the plastic tubes are often returned to the plant, allowing them to be reused again. This return-and-reuse practice further enhances the overall reusability and efficiency of the recycled tubes within the production process. Reusability was high, with 80% of recycled tubes remaining functional after repeated handling, confirming their suitability for continuous use.

The most significant advantage of using recycled tubes lies in their environmental impact. By repurposing plastic waste specifically from in-house chemical barrels Teejay effectively reduces the volume of plastic entering the waste stream. This approach aligns with circular economic principles and contributes to more sustainable manufacturing practices. To ensure safety and compliance, the chemical composition of the recycled tubes was tested under the AFIRM Group

Packaging Restricted Substances List (Version 8, 2025). Parameters assessed included total heavy metals, organotin compounds, phthalates, alkylphenols (APs), alkylphenol ethoxylates (APEOs), and polycyclic aromatic hydrocarbons (PAHs). All results fell within acceptable regulatory limits, confirming that the recycled tubes contained no harmful chemical compounds.

In the long term, Teejay has strengthened its reputation as a pioneer in circular manufacturing, earning recognition from international apparel brands for its commitment to sustainability. The initiative has ensured full regulatory compliance with waste management laws, eliminating risks associated with hazardous material handling. It has also opened avenues for innovation, enabling the development of scalable upcycled components across various operations. Teejay's proactive engagement with local communities and suppliers has fostered stronger collaborative networks, driving collective progress toward a more sustainable and inclusive industrial ecosystem.

V. DISCUSSION AND CONCLUSION

Teejay's plastic waste management initiative illustrates the transformative potential of circular economy practices in the textile industry. By adopting the 10R framework, the company has successfully converted hazardous and non-hazardous plastic waste into durable recycled tubes for fabric rolls, achieving performance levels comparable to virgin plastics while surpassing them in durability and reuse cycles. Compliance with international safety standards ensures both product quality and customer acceptance, reinforcing Teejay's reputation as a sustainability leader in South Asia. Beyond environmental gains, the initiative reduces reliance on virgin materials, lowers dependency on external suppliers, and contributes to social value creation through surplus waste donations to local communities.

Although the higher cost of recycled tubes compared to conventional alternatives posed financial challenges, Teejay's long-term commitment to sustainability has delivered broader benefits, including regulatory compliance, enhanced brand positioning, and opportunities for innovation scalability. The project underscores the importance of cross-functional collaboration and strategic investment in sustainable technologies, demonstrating that environmental stewardship can also strengthen operational efficiency and market competitiveness. Looking ahead, future steps should focus on scaling up implementation, improving the performance of the recycled plastic tubes, and working towards achieving cost parity with virgin plastic tubes. Additionally, exploring applications across other textile processes and industrial sectors will be key to maximizing the impact of this sustainable innovation. Such measures would further validate the scalability and replicability of Teejay's model, offering a practical blueprint for industries worldwide seeking to transition toward circularity and sustainable growth.

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