TEXTILE WASTE

The Leaky Loop: Why Global Recycling Cannot Keep Pace with Production, and Why Landfills Keep Filling

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Abstract

Global fibre production has reached record levels, rising from about 125 million tonnes in 2023 to 132 million tonnes in 2024 and an estimated 139 million tonnes in 2025 [3][7]. Over the same period, textile-to-textile recycling has remained below 1% of total fibre output [3][7]. This paper examines why. It argues that the textile system is a "leaky loop": material is recovered at some points but leaves the loop at nearly every stage through low collection, poor sorting, fibre blending, down-cycling and, above all, a persistent price disadvantage of recycled fibre over virgin fibre. We assemble the most recent published data at three scales (global, India and Bhopal) and introduce two simple ratios, the Recovery Ratio (RR) and the Loop-Closure Ratio (LCR), to separate material that is merely diverted from landfill from material that actually returns to textile production. Globally, roughly 87% of fibre input is landfilled or incinerated and under 1% returns to clothing [2]. India generates about 7.8 million tonnes of textile waste a year (about 8.5% of the global total), and reports a 59% reuse and recycling rate, but most of that is low-grade recovery rather than closed-loop recycling [8][9][15]. For Bhopal, no textile-specific waste audit has been published; we therefore present a transparent scenario model anchored to the city's documented 850 tonnes per day of municipal solid waste, all of which reaches the Adampur landfill [11]. We close with a four-lever strategy covering design, collection and sorting, price correction and policy that is aligned with India's Solid Waste Management Rules, 2026.

Keywords: Textile waste; circular economy; recycling gap; landfill; fast fashion; upcycling; extended producer responsibility; India; Bhopal

1 Introduction

Fashion is often described as a linear industry: take, make, use, dispose. What has changed in the last two decades is the speed of that line. Clothing production has roughly doubled since 2000 while the number of times a garment is worn has fallen, a pattern widely associated with fast fashion [1]. The result is a material flow that is large at the front and thin at the back: very large volumes of virgin fibre enter the system, while only a small fraction of discarded textiles ever re-enters it as new fibre.

This paper focuses on one question: if production operates at massive scale, why does recycling and upcycling remain so small, and what does that imply for landfills and the environment? Our contribution is not another statement that textile waste is large. It is a quantified, multi-scale account of where the loop leaks, and why the economics of the market keep it leaking.

The paper has four objectives:

1. To quantify the gap between fibre production and textile-to-textile recycling at global level.

2. To compare textile waste profiles at global, Indian and Bhopal scale using proportional (ratio) representation.
3. To explain why recycled and upcycled products carry a higher market price than virgin-based products, even as total production keeps growing.
4. To propose practical, evidence-based measures to reduce textile waste and landfill dependence.

2 Background and research gap

2.1 Existing literature

The foundational quantification of textile flows is the Ellen MacArthur Foundation's A New Textiles Economy, which estimated that 87% of fibre used in clothing is landfilled or incinerated after use, with under 1% recycled into new clothing [2]. Niinimäki and colleagues reviewed the environmental burden of fast fashion, including greenhouse gas emissions, water use and microfibre release [1]. Textile Exchange's annual Materials Market Report tracks production and the share of recycled inputs, and shows that recycled fibre's share has been stuck at around 7.6% [3], most of it recycled polyester made from PET bottles rather than from old clothes [3][4]. Policy and cost studies from Europe, notably by Systemiq and the T-REX project, have begun to quantify why recycled fibre costs more than virgin [5][6].

2.2 What is missing

Existing work tends to treat the problem at one scale, mostly global or European. Three gaps remain.

- **Scale gap.** Few studies place global, national and city-level waste in a single comparable frame. City-level textile data are almost absent for Indian cities, including Bhopal.
- **Metric gap.** "Recycling rate" is used loosely. A garment shredded into stuffing and a garment spun back into yarn are both counted as recycled, though only the second closes the loop.
- **Mechanism gap.** The price disadvantage of recycled goods is usually discussed separately from the landfill outcome. We link the two: the cost premium is what keeps the loop open.

This paper addresses these gaps by combining a three-scale comparison, a two-ratio metric that separates recovery from loop closure, and an explicit link from market price to landfill outcome.

3 Methodology

This is a secondary-data synthesis. We collected figures from (a) Textile Exchange's Materials Market Reports for 2025 and 2026 [3][7]; (b) the Ellen MacArthur Foundation [2]; (c) India's textile waste mapping studies, including the Fashion for Good study and the Ministry of Textiles' 2026 mapping as reported in the trade and national press [8][9][10]; (d) Bhopal municipal waste data from municipal statements, Supreme Court and National Green Tribunal proceedings, and local reporting [11][12][13]; and (e) cost studies on recycled versus virgin fibre [5][6][4][14].

We define two indicators:

- Recovery Ratio (RR) = share of textile waste diverted from landfill or incineration to any further use (reuse, repair, down-cycling or recycling).
- Loop-Closure Ratio (LCR) = share of textile waste that returns as fibre for new textiles (textile-to-textile).

An RR that is high while the LCR is low signals a leaky loop: materials are diverted, but value is lost and virgin production is not displaced.

Data quality note. Figures differ by source and year. Where sources conflict we report both. For Bhopal, where textile-specific data do not exist, we present a clearly labelled scenario model rather than a measured value.

4 Results

4.1 The production–recycling gap (global)

Table 1 presents the global production–recycling gap.

Table 1. Global production–recycling gap.

Indicator	Value	Source
Global fibre production, 2023	~125 million tonnes	[3]
Global fibre production, 2024	~132 million tonnes (+6.5%)	[3]
Global fibre production, 2025 (est.)	~139 million tonnes	[7]
Projected production, 2030	~169 million tonnes	[3] (as summarised in secondary reporting)
Polyester share of production, 2024	59% (78 million tonnes)	[3]
Cotton share, 2024	19% (24.5 million tonnes)	[3]
Recycled fibre share, 2024	7.6%	[3]
Fibre from pre- and post-consumer textile recycling	< 1%	[3]
Textile-to-textile recycled share, 2025	0.76% (0.61% in 2021)	[7]
Estimated annual textile waste	~92 million tonnes	[15]

Three observations follow. First, the growth in output is overwhelmingly virgin and fossil-based: virgin fossil-based fibre rose from about 81 to 86 million tonnes between 2024 and 2025, roughly 71% of the total increase [7]. Second, recycled polyester is growing in tonnage (about 9.3 to 9.7 million tonnes) but is shrinking in share, and about 98% of it comes from plastic bottles rather than textiles [3]. Third, textile-to-textile recycling is moving at a pace of tenths of a percentage point over four years [7].

A simple comparison shows the size of the leak. If textile-to-textile output is 0.76% of 139 million tonnes (about 1.06 million tonnes), set against roughly 92 million tonnes of annual waste, then only about 1.1% of waste returns to textiles. (This is an indicative ratio: the production and waste figures are from adjacent but not identical years.) Waste is projected to keep rising because production is projected to keep rising.

4.2 What happens to textiles after use (global)

The Ellen MacArthur Foundation's widely cited material-flow estimate shows that, of fibre going into clothing, about 87% is landfilled or incinerated, about 12% is recycled into lower-value uses (insulation, wiping cloths, stuffing), and less than 1% becomes new clothing [2]. In our terms, the global RR is about 13% and the global LCR is below 1%. These are 2017 estimates; Textile Exchange's 2026 data suggest the closed-loop share has improved only marginally [7].

Figure 1 (global fibre mix, 2024) and Figure 2 (global fate of clothing fibre) are shown in Section 4.5.

4.3 India

Table 2 presents the textile waste profile of India.

Table 2. Textile waste profile of India.

Indicator	Value	Source
Textile waste generated per year	~7.8 million tonnes	[8] [9]
Share of global textile waste	~8.5%	[8] [9]
Composition: post-consumer / pre-consumer / imported	51% / 42% / 7%	[8]
Reused or recycled	59%	[8] [9]
Landfilled or incinerated	~1.7 million tonnes (~22%)	[8]
Remaining unclassified fraction	~19%	derived: 100 - 59 - 22
Pre-consumer waste recycled (Ministry of Textiles, 2026)	~97%	[10]
Ministry of Textiles 2026 estimate of annual textile waste	~7,073 kilotonnes	[10]

Two cautions apply. First, sources differ on the landfill share: one national report puts it at about 17% [9] while the Fashion for Good study implies about 22% [8]. Second, the 59% "reused or recycled" figure should not be read as loop closure. Panipat, the best-known hub, processes over a lakh (100,000) tonnes of textile waste a year but mainly converts it into low-grade yarn and products [15]. The Ministry of Textiles has defended the sector's circularity and stresses that more than 90% of waste is of domestic origin [10]. We therefore interpret India's RR as high (about 59%) and its LCR as low and unmeasured.

The high pre-consumer recovery rate reflects offcuts that are easy to collect clean; post-consumer garments, which are blended, dyed and dirty, are the harder 51% of the stream.

4.4 Bhopal

No published audit isolates textiles in Bhopal's waste stream. What is documented is the following.

- Bhopal generates about 850 tonnes per day (TPD) of municipal solid waste (earlier estimates range from 600 to 900 TPD), and the municipal corporation states that all of it is taken to the Adampur landfill [11].
- About 750,000 tonnes of legacy waste are piled up at Adampur; at current processing rates the December 2026 deadline set by the NGT and Supreme Court is expected to be missed [11].
- Inspection reports found groundwater near the landfill that did not meet potability parameters, with leachate flowing beyond the boundary wall [12].

- The Supreme Court has directed further compliance by the Bhopal Municipal Corporation under the newly notified Solid Waste Management Rules, 2026 [13].

Scenario model. Because textile share is unknown, we model three cases: textiles at 1%, 2% and 3% of the 850 TPD municipal stream. These are assumptions, not measurements, and are intended to show order of magnitude and to motivate a field audit.

Table 3 presents the scenario estimates of textile waste in Bhopal's municipal solid waste.

Table 3. Scenario estimates of textile waste in Bhopal's municipal solid waste.

Scenario	Textile share of MSW	Textile tonnes per day	Textile tonnes per year
Low	1%	8.5	~3,100
Central	2%	17	~6,200
High	3%	25.5	~9,300

Textile waste is bulky, slow to degrade and, when it is synthetic, sheds microfibres and leaches dyes and finishing chemicals; in a landfill that is already failing to contain leachate, that matters. If we apply India's national fate ratios to the central scenario (17 TPD), about 10 TPD would be recovered, about 3.7 TPD landfilled and about 3.2 TPD of unclassified fate. This is a proportional assumption, not an observation of Bhopal.

4.5 Comparative ratio figures

The figures below place the global, Indian and Bhopal profiles side by side in proportional form so that readers can compare the structure of each stream.

5 Why higher cost? The price paradox

A central puzzle is that the market keeps producing more virgin material even though recycled and upcycled goods are environmentally preferable. The answer is that the cost of recovery is borne inside the market, while the cost of disposal is mostly borne outside it.

5.1 The measurable premium

In Europe, rPET traded about EUR 686 per tonne above virgin PET (about EUR 994 per tonne) at the time of one 2025 comparison, and in the US the rPET premium was estimated at 30 to 35% through early 2025 [4]. For recycling from used clothes rather than bottles, Systemiq estimates European polyester produced by chemical depolymerisation of post-consumer textiles to be about 2.6 times more expensive than virgin polyester from Asia [5]. French cost studies find that sorting and trim removal, largely manual, drive recycled yarn costs above virgin, especially when virgin prices are low [14].

5.2 Why recovery is expensive

- **Collection and sorting.** Garments are blended (for example cotton and polyester), carry zips, labels and dyes, and must be sorted by fibre and colour. Sorting is mostly manual. In Europe, collection of post-consumer textiles is around one-third and sorting for recycling is lower still [16].

- **Quality loss.** Mechanical recycling shortens fibres and lowers yarn quality, which limits end uses [6].
- **Capital intensity.** One modelling exercise estimates EUR 8 to 11 billion of capital expenditure would be needed to recycle about 15% of European post-consumer textile waste into new fibre by 2035 [16].

5.3 Why virgin remains cheap

Virgin polyester benefits from cheap fossil feedstock, large Asian scale and an established supply chain, while its environmental costs (emissions, microplastics, landfill burden) are not priced in. Brands also compete on speed and volume, so price-sensitive buyers default to the cheaper product [1][6].

5.4 The price-to-landfill link

Because recycled input costs more, brands buy less of it, so recyclers lack stable demand, so investment in collection and sorting stays low, so more used textiles are discarded to landfill. Each link reinforces the next. This is the mechanism behind the leaky loop. Importantly, the premium is not large per garment: Systemiq calculates that a 5% brand-level green premium, about EUR 0.15 on a 400 g polyester jumper, together with other levers could bridge over half of the cost gap in a scaled system [5].

6 Discussion: The leaky loop framework

We suggest that textile circularity fails at five points, each of which can be measured and targeted.

- **Design leak.** Blended, dyed, non-recyclable construction makes recycling hard from the start.
- **Use leak.** Short wear life and low-quality fast fashion mean garments enter the waste stream early [1].
- **Collection leak.** Used textiles are not separated from household waste, as is visible in Bhopal where all collected municipal waste goes to a single landfill [11].
- **Sorting and processing leak.** Manual, fibre-agnostic sorting and low-quality outputs push material into down-cycling [6][14].
- **Market leak.** Price premiums and weak demand for recycled content keep the loop open [5][4].

The India case shows why RR alone is misleading. A country can recover a large share of textile waste through informal reuse and down-cycling and still fail to reduce virgin production, because the recovered material does not displace new fibre. This is also an environmental-justice issue: Panipat's recycling industry has been criticised for pollution and for absorbing waste exported from richer countries [15], while the Ministry of Textiles rejects that characterisation as selective [10]. The debate itself underlines the need for transparent, comparable data.

7 Recommendations

We propose four levers, ordered from upstream to downstream.

1. **Reduce at source (design and consumption).** Promote mono-material, recyclable design, durability standards and repair. Longer garment life reduces waste more reliably than any recycling technology.

2. **Collect and sort.** Introduce textile as a distinct stream in city waste systems. India's Solid Waste Management Rules, 2026 (effective 1 April 2026) mandate stronger segregation, integrate circular economy and EPR principles and shift responsibility to bulk generators [17]. For Bhopal this opens the way to textile collection at transfer stations and with cloth banks and partnerships with existing recyclers and upcyclers. Automated near-infrared sorting should be piloted for blended fabrics.
3. **Close the price gap.** Use EPR fees, recycled-content targets and green public procurement to make recycled fibre competitive, as the EU's new textile EPR rules do [5][18]. In India, reporting indicates that a textile-specific EPR had not yet been notified [19]; this is a policy gap worth addressing.
4. **Measure.** Mandate fibre-flow reporting that distinguishes RR from LCR and require city-level audits. Bhopal should conduct a waste characterisation study at its transfer stations and at Adampur to replace our scenario estimates with measured data.

8 Limitations

This is a secondary-data study. Global fate percentages date from 2017 and are the most widely cited, but not the most recent, estimates [2]. Waste estimates differ across sources (for example, 7.8 million tonnes versus 7.07 million tonnes for India [8][10]). The Bhopal figures are scenario estimates and should not be treated as measurements. The cost data are drawn mainly from European studies and may not reflect Indian market conditions. Future work should include a primary waste audit and a consumer survey in Bhopal.

9 Conclusion

Production continues to grow because virgin fibre is cheap, scalable and does not pay for its end-of-life costs, while recycled fibre must cover costs of collection, sorting and processing. The result is a loop that leaks at every stage: globally under 1% of fibre returns to textiles; in India a high recovery rate masks a low loop-closure rate; and in Bhopal the absence of textile data leaves a growing landfill unexamined. Reducing textile waste requires acting on both sides of the gap: slowing the flow of virgin material and making the return flow cheaper and larger. With India's new waste rules in force, the policy window to do so is open.

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