



FASHION FOR GOOD
SORTING FOR CIRCULARITY: INDIA

WEALTH IN WASTE

**INDIA'S POTENTIAL TO BRING
TEXTILE WASTE BACK INTO
THE SUPPLY CHAIN**

JULY 2022

TABLE OF CONTENTS

Credits	03
About the study	05
How to read the report	06
Executive Summary	07
Part 1 - The untapped potential of textile waste in India	15
1.1. The vibrant textile industry of India	16
1.2. History of textile waste management in India	17
1.4. India's competitive advantage: deriving value from waste	18
Part 2- The state of textile waste in India	20
2.1 Types and quantity of textile waste	21
2.2 Treatment of textile waste	25
2.3 Composition of textile waste	27
2.4 Geographical flows of textile waste	29
Part 3- Unlocking textile waste value chains and end-use	34
3.1 Overview of textile waste value chain	35
3.2 Deep-dive into pre-consumer waste value chain	37
3.3 Deep-dive into domestic post-consumer waste value chain	45
3.4 Deep-dive into Imported waste value chain	51
3.5 Use Cases for Textile Waste: Reuse, recycle and downcycle	57
Part 4- Perceived hierarchy of textile waste in India	64
4.1 Perceived hierarchy of textile waste based on types, size, colour, composition and condition	65
4.2 Moving waste up the hierarchy - anticipating the upcoming demand of recycling technologies	72
Part 5- Becoming a circular sourcing region - Key Levers	74
5.1 Valorising waste to full potential: bringing waste back into the textile supply chains	75
5.2 Taking action - How to futureproof our businesses?	88
Annexure	89

CREDITS

AUTHORS

LEAD AUTHORS

Sattva Consulting

Aarti Mohan, Nidhi Bali, Palagati Lekhya Reddy,
Mansha Balecha, Manasvita Dubey, Anushka Sureka

Fashion for Good

Priyanka Khanna,
Khushbu Maheshwari

CONTRIBUTING AUTHORS

Reverse Resources

Nin Castle, Harshitha Venati, Maxime Bourland,
Ranjit Sasi

Saahas Zero Waste

Wilma Rodrigues, Astha Khubele,
Priyanka Jariwala

ACKNOWLEDGEMENTS

We would like to extend our thanks to more than 700 stakeholders in the Indian textile waste ecosystem, consisting of manufacturers, brands, recyclers, waste handlers, sorters and other industry stakeholders who have helped us to develop this report. Their patient input has allowed us to dive into and explore the landscape of textile waste in India and substantiate our findings with detailed insights. We would also like to acknowledge the efforts of the data collectors in gathering the information and observations from the field. Our hope is that this report will (re)capture the value of textile waste while driving circularity in the Indian textile industry and further enhance innovation partnerships between different stakeholders in this space.

The authors would also like to thank the following industry experts, who gave their time and contributed their expertise to this report: Lakshmi Poti and Karan Kumar (Laudes Foundation), Vincent Delalandre and Tejas Sampat (PVH Corp.), Drishti Madan and Avnish Dwivedi (adidas), Liz Lipton-McCombie, Anuja Ojha, Venkatraman Raman (Levi Strauss & Co.), Heather Canon and Manisha Pattanayak (Target), Carmen Chan and Sirajudeen Ali (TESCO), Nicole Morarescu and Adarsh Immanuel (Primark), Abhishek Bansal and Snehit Kumar Rahul (Arvind Limited), Surya Valluri and Vivek Khare (Birla Cellulose), Rajender Sharma and Animesh Laha (Welspun India), Valerie Langer (Canopy Planet), Traci Kinden (Revolve Waste), Hilde Van Duijn (Circle Economy), Dr. Siva Rama Kumar Pariti (Sustainable Textile Solution), Stefanie Bauer and Vaibhav Rathi (GIZ, Deutsche Gesellschaft für Internationale Zusammenarbeit), Holly Syrett (Global Fashion Agenda), Anurag Gupta (Usha Yarns), Martin Stenfors (Renewcell), Steven Bethell (Bank & Vogue), Gigi Mathews and Tanushri Shukla (Enviu).

The authors also wish to thank Prachi Chauhan Kanwar for her work on the design and layout of this report, along with Earl Singh, Lana Miller, Brittany Burns and Camilla Rama for their editing assistance.

DISCLAIMER

This report has been produced by a joint team from Fashion for Good, Sattva Consulting, Reverse Resources and Saahas Zero Waste. The authors take full responsibility for the contents and conclusions. The participation of the industry experts and affiliates who were consulted and acknowledged here, does not necessarily imply endorsement of the report's contents or conclusions. To quote this report, please use the following reference: Fashion for Good, Sattva Consulting, Reverse Resources and Saahas Zero Waste, Wealth in Waste: India's potential to bring textile waste back into the supply chain, July 2022. Use of the report's figures, tables or diagrams, must fully credit the respective copyright owner where indicated. Reproduction must be in original form with no adaptations or derivatives. For use of any images in the report please contact the respective copyright holders directly for permission.

The images used in this report belong to the authors, with the consent of the individuals photographed.

This work is licensed under the Attribution-Noncommercial-Share Alike 4.0 International License:



Ergo, they are subject to the laws of copyright and intellectual property.

Attribution - You may give appropriate credit, provide a link to the licence, indicate if any changes were made.

Non-Commercial - You may not use the material for commercial purposes.

Share A Like - If you remix, transform, or build upon the material, you must distribute your contributions under the same licence as the original.

ABOUT STUDY PARTNERS

FASHION FOR GOOD is the global platform for innovation. Fashion for Good unites the entire fashion ecosystem, from brands, manufacturers and suppliers, to consumers, to collaborate and drive the change towards a circular industry. At the core of Fashion for Good is its Global and Asia Innovation Programme. The Innovation Programme supports disruptive innovators on their journey to scale, providing hands-on project management, access to funding and a robust ecosystem of mentors and experts. Fashion for Good also initiates Foundational Projects, consortium projects that bring innovators, brands, manufacturers and funders together to validate technologies and processes, to accelerate supply chain implementation. The Good Fashion Fund catalyses access to finance for manufacturers in India, Bangladesh and Vietnam to shift at scale to more sustainable production processes. To activate individuals and industry alike, Fashion for Good houses the world's first interactive museum dedicated to sustainable fashion and innovation to inform and empower people from across the world, a Circular Apparel Community co-working space, and creates open-source resources and reports to action change.

Fashion for Good's programmes are supported by founding partner Laudes Foundation, co-founder William McDonough and corporate partners adidas, BESTSELLER, C&A, CHANEL, Inditex, Kering, Levi Strauss & Co., Otto Group, Patagonia, PVH Corp., Reformation, Stella McCartney, Target and Zalando, and affiliate and regional partners Arvind Limited, Birla Cellulose, Norrøna, Pangaia, Teijin Frontier, Vivobarefoot, Welspun and W. L. Gore & Associates.

To learn more about Fashion for Good, visit fashionforgood.com

SATTVA CONSULTING is a leading consulting firm in the social impact sector and works with corporate CSR, foundations, multilaterals, non-profits, and social enterprises on scalable and sustainable solutions for social impact. Sattva works on the ground in India, Africa and South Asia and engages with 500+ organisations across the globe through service offerings in the space of strategic advisory, implementation, CSR advisory, research advisory, impact evaluation, and co-creation of sustainable models. Sattva works to realise inclusive development goals in emerging markets, across thematic areas, including in education, skill development and livelihoods, healthcare, water and sanitation, digital and financial inclusion, environment and climate action, among others.

To learn more, visit www.sattva.co.in

REVERSE RESOURCES is an impact driven company with a fundamental mission to reduce the industry's dependency on our planet's finite natural resources. RR's software-as-a-service platform enables mapping, digital steering and tracing circular textile flows. Established over eight years ago, RR has been intently focusing on investigating market barriers and best use cases of textile waste streams. Having done extensive research and on-ground work (across Europe, Asia and parts of North Africa), RR has a demonstrated core competency in establishing textile waste feedstock routes for existing and emerging textile recycling companies. Till date RR has mapped waste across 20 countries for large fashion brands and organisations such as United Nations Industrial Development Organisation, Global Fashion Agenda, Accelerating Circularity, and now Fashion for Good.

To learn more, visit <https://www.reverseresources.net/>

ABOUT SAAHAS ZERO WASTE (SZW) is a socio-environmental enterprise that believes in a circular economy, where all waste is recovered as resources. SZW provides comprehensive waste management solutions including onsite waste management, Consultancy services, Extended Producers Responsibility for plastic and e-waste. As a true demonstration of circularity, SZW offers recycled products such as stationary, building material like roofing sheets, Ricron boards, upcycled textile products. SZW currently handles over 100+ MT of waste per day across India while supporting dignified and safe employment to more than 250 bottom of the pyramid staff (where approximately 60% are women). SZW is one of the first movers in formalising the waste management industry in India.

To learn more, visit www.saahaszerowaste.com

ABOUT THE STUDY

This study has been commissioned as part of Fashion for Good's Sorting for Circularity; India Project. This project was launched in October 2021 by Fashion for Good supported by project partners: Laudes Foundation as catalytic funder, PVH Corp., adidas, Levi Strauss & Co., TESCO, Target, Primark, Arvind Limited, Birla Cellulose and Welspun India and technology partner Reverse Resources. The project is also supported by SU.RE project - An initiative by CMAI & RBL - RISE Worldwide. Sorting for Circularity is a framework conceived by Fashion for Good, with the aim to (re)capture textile waste and drive circularity within the fashion value chain. The consortium projects have been developed with scalability in mind, encompassing many geographies across the globe, starting with projects in Europe and India, where textile waste presents opportunities for new streams of revenue and new materials, reducing dependency on virgin materials and diverting waste from landfill and incineration.

The Sorting for Circularity; India project aims to organise the Indian textile waste market in a three phase approach so as to streamline, strengthen and foster the Indian waste market to drive the transition to a more circular economy that recaptures value to its maximum potential. The three phases of this approach aim to a) address the data gaps in textile waste supply chain; b) identify and pilot technologies which can organise the industry; c) build a roadmap to scale such technologies. This approach was designed to facilitate access to post-and pre-consumer feedstock that meets the quality requirements of advanced recycling technologies, giving these technologies an incentive to scale in India.

To enable an effective transition towards circularity, India needs to take into consideration the on-ground challenges backed by data. This study is a first-of-its-kind attempt to fill the data gaps that exist in the textile waste landscape in India and help the ecosystem players to orchestrate actions and devise solutions and interventions accordingly. It presents information on the extent of textile waste being generated in India and the complexity of the textile waste value chain processing it, by presenting evidence from both primary and secondary research.

A diverse set of stakeholders were targeted to ensure that perspectives of each were accurately represented. Surveys and in-depth interviews were administered with 157 manufacturers and interviews were conducted with 70 waste collectors and aggregators, 11 importers, 46 recyclers, 522 tailors and boutiques and 27 ecosystem players. A waste assessment study of ~8000 garments collected from Bengaluru was conducted, along with a consumer study with ~570 consumers, across Bengaluru and Delhi.

HOW TO READ THE REPORT?

In addition to the executive summary, the report is divided into five key parts. Each part of the report talks about a critical aspect of the textile waste ecosystem in India, further divided into subsections. We have tried illustrating our insights throughout the report by highlighting the statement in black bold font followed by a key visual which summarises the messaging in the sub-section.

All Levels of Heading

- Section Header

Wealth in Waste

- Title

Wealth in Waste

- Sub - Title

Wealth in Waste

- Insight Line

Wealth in Waste

Icons



Pre - Consumer Waste



Low Grade Recycling



Post - Consumer Domestic Waste



Downcycling



Imported Waste



Incineration



Reuse



Disposal

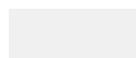


Repair



High Grade Recycling

Boxes



Summary of the part/sub section - Must read



Case studies of successful/innovative interventions



Additional information regarding the section

Part 1 of the report highlights the need and potential of circularity in the Indian textile and apparel industry. This section is based on desk research, including data points from various journals, global reports and newspaper articles on the Indian recycling industry. Newspaper articles have been used as secondary sources in certain sections, where there are no credible reports or datasets available for the textile recycling industry of India.

Part 2 through 5 of the report includes insights from primary research conducted by Fashion For Good, Reverse Resources, Saahas Zero Waste and Sattva Consulting teams over the past nine months. Detailed calculations and assumptions involved in the quantitative estimates can be found in the technical appendix here. Further, the report attempts to provide an aggregated and waste stream-specific view of the textile waste industry. Part 3 of the report delves deeper into each waste stream value chain, while all other parts of the report provide a broader view of the sector.

The value hierarchy, challenges and recommendations provided in Part 4 and Part 5 of the report are based on the subjective understanding of the field teams during the research. These findings were actively discussed and iterated based on expert consultations to provide as comprehensive a view as possible. However, these are based on the current state of the industry and are subject to change as the market dynamics and technological innovations come into play.

EXECUTIVE SUMMARY

India's untapped potential for circularity of textile waste

India is one of the largest textile and apparel sourcing regions in the world due to abundant availability of raw materials and skilled workforce.

The Textile and Apparel industry is one of the largest contributors to India's economy constituting 2% of total GDP, 12% of total exports, 7% of industry output in value terms¹², while employing over 45 million individuals.^{3,4} India is also one of the largest producers of cotton, jute and silk. Over 25% of the global cotton production comes from India.⁵ Further, India has processing infrastructure and skilled workforce for all activities ranging from spinning to apparel production, making it a competitive key sourcing destination for most global brands.

The textile industry all over the world leads to substantial waste generation* during production and consumption of textiles and apparel. This waste can be classified across three waste streams: pre-consumer, domestic post consumer and imported waste.

Pre-consumer waste is generated during and post-manufacturing across Cut-Make-Trim (CMT) units, fabric mills and spinning; domestic post-consumer includes garments/ textiles discarded by domestic consumers. waste includes second-hand clothing and mutilated rags imported to India. India's decades-old embedded culture and history of reusing, remaking and redesigning garments has enabled informal trade routes for textile waste and infrastructure to process it.

While India is one of the leaders in mechanical recycling in the world, it has not yet established a circular approach for textile waste.

The concept of circularity advocates for a regenerative system wherein textile is used as long as it retains its value and is recycled to its full potential within the textile industry, minimising leakage, waste and pollution.

To date, the value chain remains largely unorganised with limited visibility, leading to leakage of waste at multiple levels. There has been minimal external support for technological advancement and process standardisation.⁶ Consequently, the recycled yarn produced is of low quality and is deemed unfit for the global supply chain. This, coupled with the stiff competition from inexpensive synthetic fibres, is limiting the economic growth and viability of the recycling industry in India.

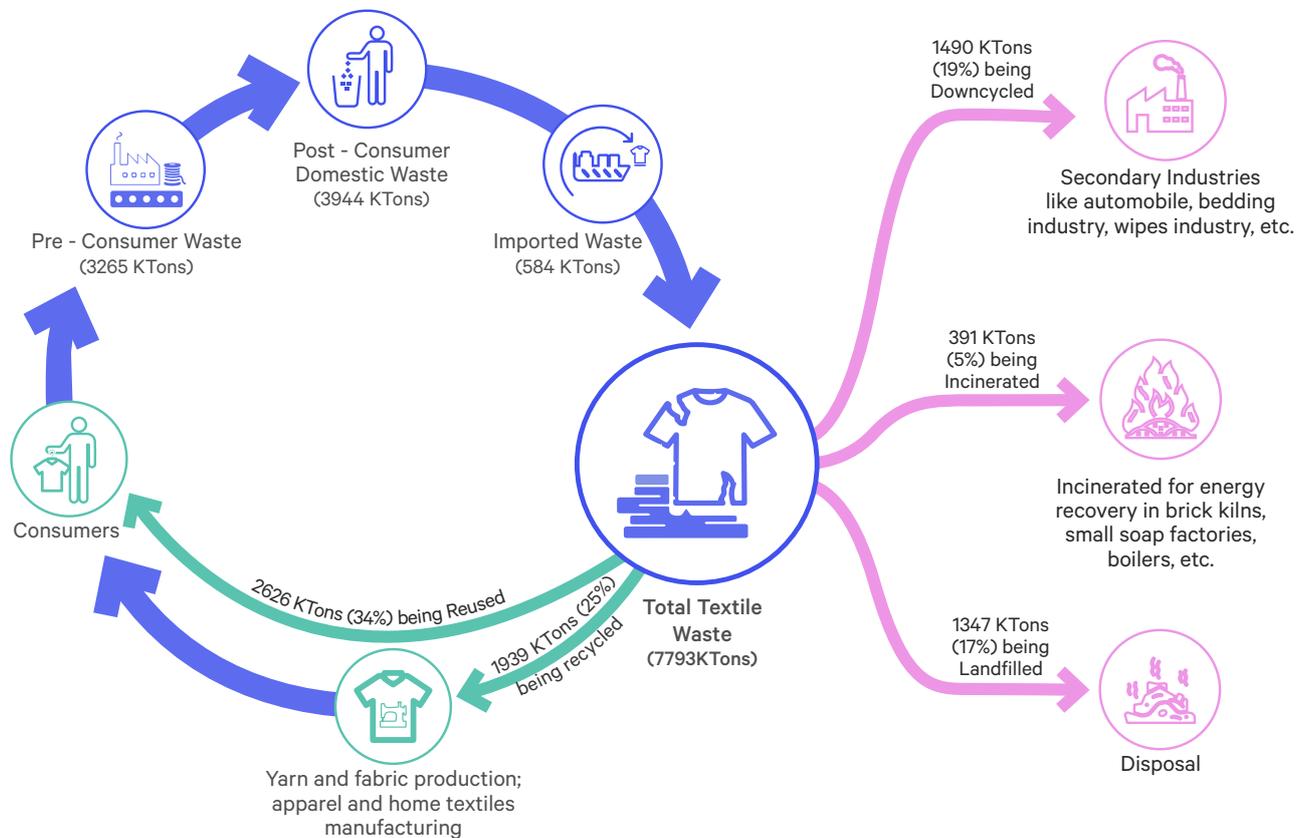
The growing need of circularity in the textile industry globally provides India with a unique opportunity to leverage existing infrastructure and resources to emerge as a leading circular sourcing region.

Over the years, despite the absence of technology, the Indian textile recycling ecosystem has established a strong hold in mechanical recycling by way of manual sorting, combining specific colours and fibres to reach desired quality. By doing so, they have been able to extract economic value even from non-recyclable waste. However, this infrastructure and expertise has been handled by informal channels. Value chains can be formalised to establish circularity of textile waste in India if this infrastructure and technical know-how is supported by brands, governments and investors.

Understanding Indian textile waste landscape

Approximately 7793 ktons, or 8.5% of global textile waste⁷, is accumulated in India every year. 59% of this waste finds its way back into the textile industry through reuse and recycling but only a fraction of this makes it back into the global supply chain due to quality and visibility challenges. The remaining 41% is downcycled (19%), incinerated (5%) or ends up in a landfill (17%).

Furthermore, 34% of the total waste is reused directly or repaired and converted into new products, while 25% gets recycled into yarns. India is a global leader in mechanical recycling; however, a significant portion of the recycled yarns are made through a low-grade recycling process. These recycled materials end up in the domestic markets as opposed to the global textile supply chain. The study was unable to estimate the exact proportion of low-grade recycling due to multiple material compositions and market factors affecting the end use.



Material Composition:

- 60% of waste made of cotton and cotton rich materials
- 19% made of synthetic rich materials

Geographical Locations:

- Key manufacturing locations across 10 states in India
- Import through sea and land routes
- Three key recycling locations- Panipat, Amroha, Tamil Nadu

Key allied industries using this waste:

- Wipes industry
- Automobile for seat filling
- Bedding industry for mattress and quilt filling
- Paper and pulp industry
- Incinerated for energy in small scale industries

Illustration 1: Total quantity of textile waste in India, end-use and destination of textile waste

India has a well-networked textile waste value chain, though unorganised, enabling transfer of waste across the country. However, the lack of traceability systems, excessive cost competitiveness, limited infrastructure to process certain waste types, and worker wellbeing concerns has limited the potential of a circular value chain.

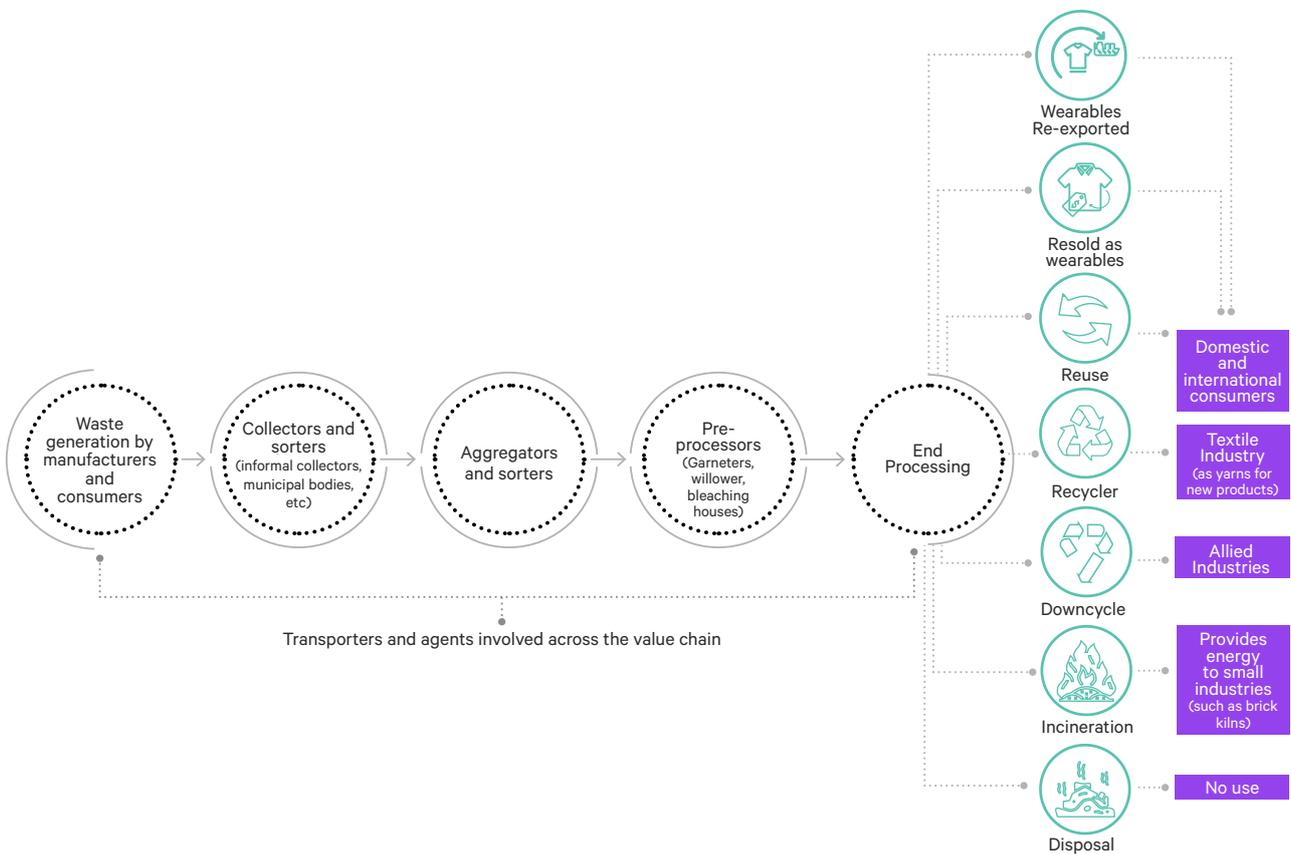


Illustration 2: Snapshot of textile waste value chains in India

“ The textile sector contributes hugely to the economy, there is a need to bring it up to speed with the growing circularity demands while upskilling the people it employs. By bringing textile waste back into use we could preserve national capital and reduce the dependency on virgin resources. ”

Wilma Rodrigues, Saahas Zero Waste

Perceived hierarchy of waste based on types, size, colour, material composition and condition

Using the EU waste hierarchy framework⁸, this study has developed a first-of-its-kind textile waste value hierarchy for India that provides a consolidated view of how the ecosystem currently perceives the value of the different waste types

The waste value hierarchy framework was developed to understand the current use of various waste types and identify materials that can be valorised. This hierarchy, though not exhaustive, acts as a toolkit to understand material types that require interventions to realise their value potential. Beyond positioning the waste types within each textile waste stream, the industry also compares waste types within the three waste streams as demonstrated in illustration 3.

100% white cotton waste has the highest value in the industry. Additional attention should be placed on printed and synthetic materials as the current infrastructure and technologies are limited in their capabilities to process them.

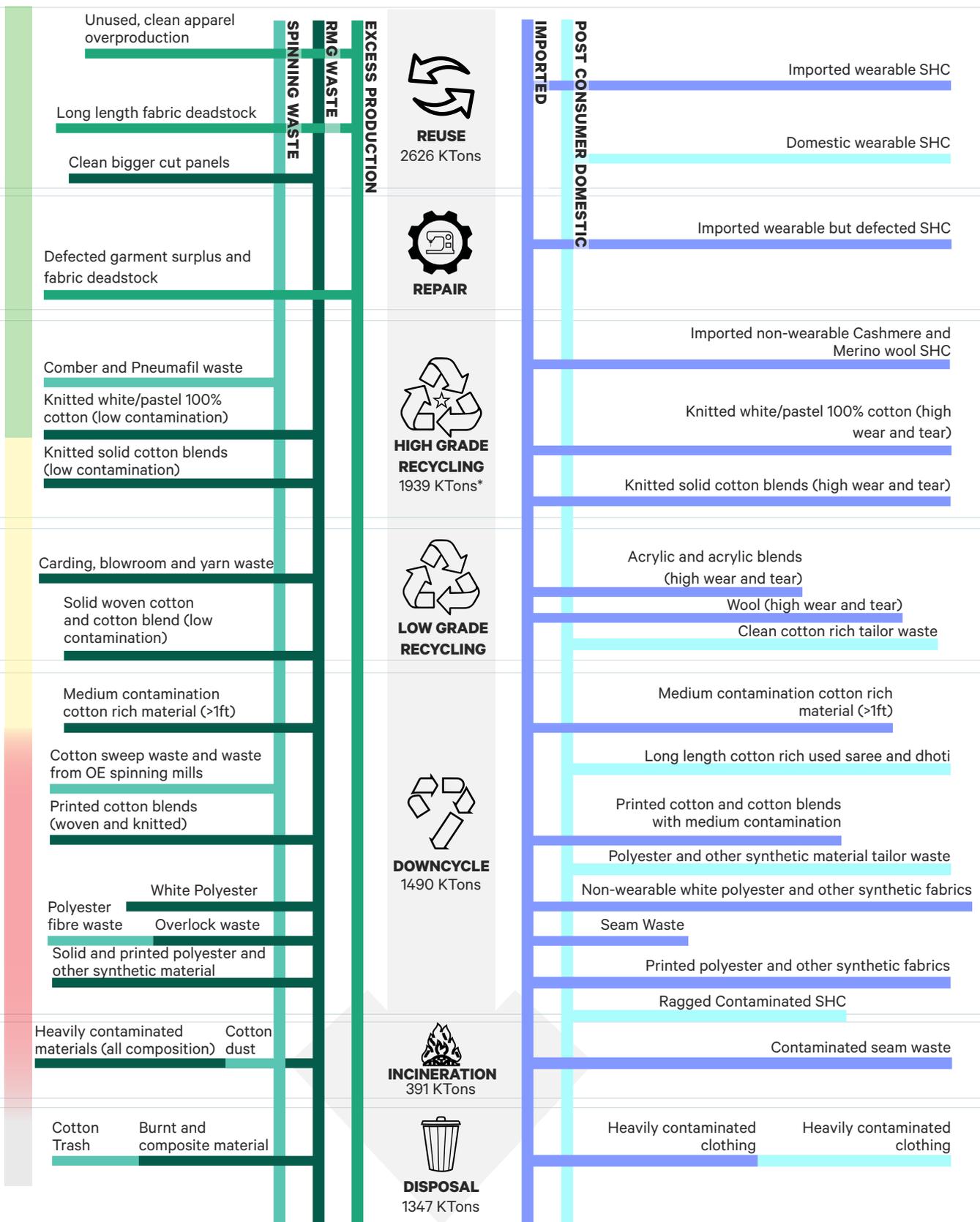
Less than 50% of the textile waste in India is currently being reused, repaired or undergoing high grade recycling. These materials include fabric deadstock, re-wearable clothing, apparel overproduction and white-knitted 100% cotton waste. On the other hand, solid coloured cotton, MMCF blends and printed textiles form a significant volume of total waste generated in India but are not being utilised to the fullest potential as the current recycling technologies are limited in their capabilities to process them. Low volume waste including certain spinning waste types and printed materials have very little value being retrieved currently but hold a high value potential. Further, heavily contaminated and ragged materials which have reached the end of their life are difficult to retrieve and they end up being incinerated/ landfilled. From a circularity perspective, one can work to reduce generation of waste at consumers' end and manufacturers' end to reduce waste going to landfills/ incineration and identify use cases to retrieve them back into textile value chains to achieve full potential of all textile waste types.

“

Recycling Textile waste can be the answer to the increasing amount of waste generated in India. We need to understand waste characteristics in order to develop a circular economy to bring back textile waste into the global supply chain. Recycling IS the Future and we can no longer avoid it!

”

Dr. Siva Rama Kumar Pariti , Sustainable Textile Solution



* The figure is total value for high grade and low grade Recycling

■ High value realisation
 ■ Low value realisation, significant volumes
 ■ Low value realisation, small volumes
 ■ Low value potential

Illustration 3: Hierarchy of different textile waste types across waste streams in India⁹

Moving waste up the hierarchy and valorising waste to full potential

Traceable and higher quality feedstock is required to meet the demands of advanced recycling technologies being adopted across the industry.

The global textile industry is moving towards decarbonisation and there is momentum in the industry to reach net-zero within the next three decades. To achieve this, the industry must reduce the use of virgin materials, avoid waste leakage, and circulate waste through reuse and recycling.

To enable this circular approach, high-grade mechanical and chemical recycling technologies that recycle cotton and polyester blends must be implemented. As these innovations develop large scale capacity, they require large volumes and high quality textile waste as feedstock. However, achieving high quality feedstock requires visibility across the supply chain, as well as traceability of materials and their composition. India's large volumes of cotton, cotton rich (~4700 ktons) and polyester waste (~1400 ktons) can be fed into the recycling innovations to meet demand.

However, achieving high quality feedstock will require visibility across the supply chain, as well as traceability of materials and their composition. The exponential growth of recycling technology requires uncontaminated waste and a system to acquire traceable waste. High quality feedstock and supply chain traceability enable waste to move up the hierarchy and scale higher value realisation.

To transition from linear to circular economy, the industry needs to transform all stages of production to reduce waste generation and consumption of virgin materials, while valorising waste to its fullest potential. Further, this transition should account for the well-being of all stakeholders across the value chain and their interests.

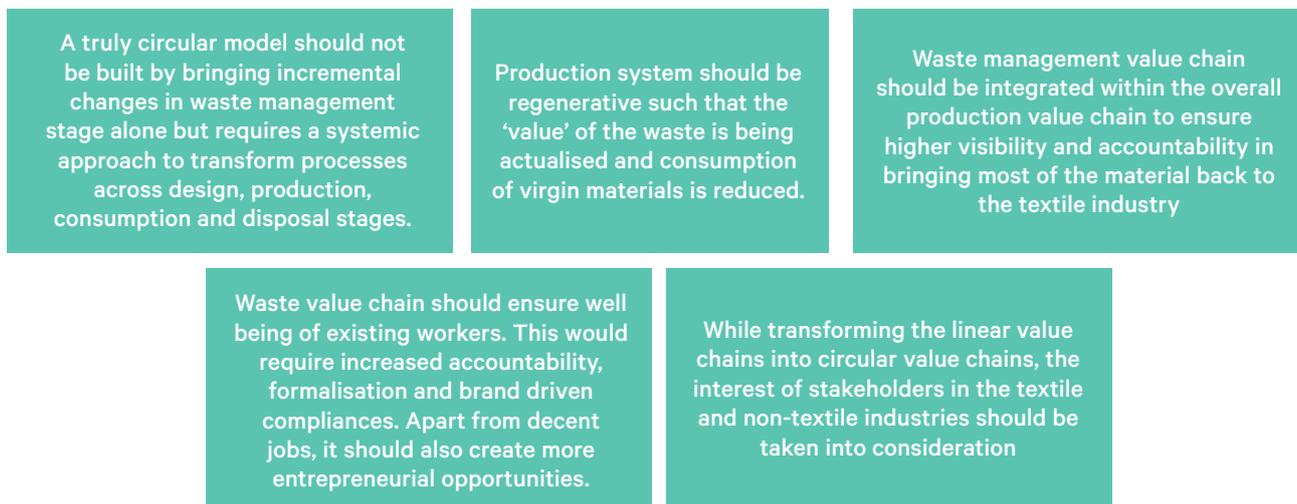


Illustration 4: Key principles for circularity of textile waste in fashion industry

The current recycling industry in India caters to primarily natural fibres (~60% of the waste), but also has a huge uptick on synthetics and covers mostly all fibres in the market. New age technologies have an advantage to enter the market with proximity to the waste, spinning and manufacturing ecosystem.

To realise the full potential of textile waste in India and achieve circularity, various bottlenecks need to be overcome. The study identifies four bottlenecks that the industry faces and calls for collaborative, systemic interventions to build circularity in the textile industry.

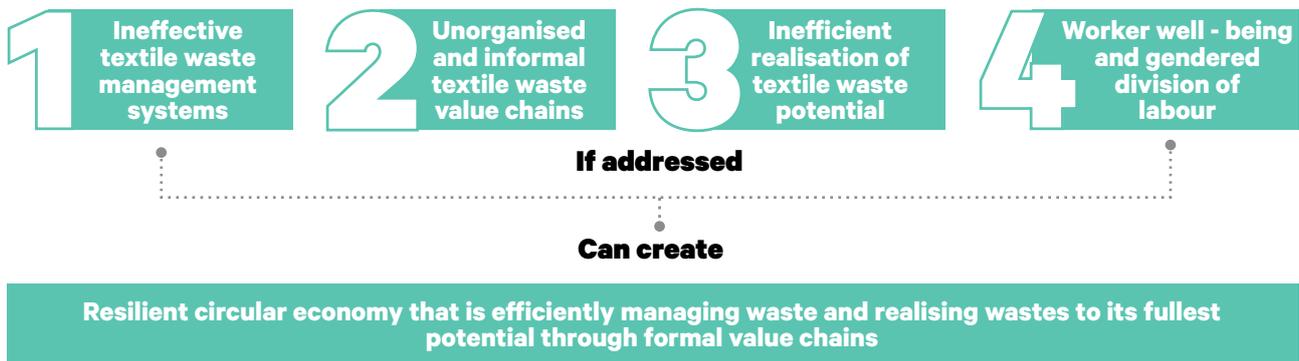


Illustration 5: Key bottlenecks in Indian textile waste industry

This report identifies the pathways of intervention that have been categorised in the following short term and long term reforms.

Pathways of intervention	Short Term Wins	Long Term Interventions
Enabling visibility and access to waste	<ul style="list-style-type: none"> Generating lesser or better quality waste in production Sorting and segregating waste at factory floor 	<ul style="list-style-type: none"> Waste mapping and traceability technologies adopting blockchain Advanced sorting technologies for post-consumer waste
Harnessing recycling potential of India	<ul style="list-style-type: none"> Pilot existing global high-grade recycling technologies in India Invest in piloting chemical recycling technologies in India Re-evaluate and standardise minimum price for recycled yarns 	<ul style="list-style-type: none"> Support and scale new recycling technologies for polyester and other blended materials Investments in developing newer recycling hubs
Establishing systems, infrastructure and regulations for waste management	<ul style="list-style-type: none"> Formalise textile waste value chain, ensuring worker well-being and high value returns for all stakeholders 	<ul style="list-style-type: none"> Establish an Extended Producer Responsibility (EPR) policy, similar to that of plastic packaging, to bring economic incentives for all stakeholders and ensure transparency Create material identification and sorting standards in the industry

Illustration 6: Suggested recommendations to enable circularity of textile waste in short and long-term

The textile waste value hierarchy presented in this report is a starting point for the industry to look at the various types of waste available and reassess their utility to enhance value realisation. The recommendations are a call-to-action to build a resilient circular economy that efficiently manages waste to its full potential.

“ Industry stands to gain with a clear map of the textile waste value chain in India, armed with a robust set of recommendations for action. This now forms a strong basis to move forward collaboratively to scale the investments, infrastructure and innovation needed to make circularity in fashion a reality in India. ”

Anita Chester, Managing Director, Laudes India LLP

PART 1

THE UNTAPPED POTENTIAL OF TEXTILE WASTE IN INDIA

Talks about the vibrancy of textile manufacturing and recycling industry in India and the untapped potential for circularity

The vibrant textile industry in India

India leads in both the production and consumption of textile and apparel. Availability of raw materials and skilled workforce makes it a significant contributor to both the domestic and global textile supply chain. Given this, India has a vast quantity of textile waste.

From 2019-2020, the Indian Textile and Apparel industry was valued at USD 108.5 billion, forming 2% of total GDP, 12% of total exports, and 7% of industry output in value terms.^{10 11} The industry grew at a compound growth rate of 13.8% between 2010-2018, employing over 45 million individuals and nearly ~90 million in allied industries.¹²

The country is one of the largest producers of cotton, jute and silk and accounts for 25% of the global cotton production.¹³ With respect to production capacities, the Indian textile and apparel industry is able to conduct all activities ranging from spinning to apparel production. India also has the second-largest spinning capacity with 50 million spindles.¹⁴ Furthermore, the skilled workforce in the country has the capacity to work with diverse materials, both knit and woven fabrics apparel categories¹⁵ making India an important sourcing destination for global brands.¹⁶

Besides being a production hub, India is also a growing consumer of textile and apparel products with domestic consumption valued at USD 75 billion.¹⁷ This consumption is expected to increase as the economic growth brings 118 million additional households into the upper and upper-middle class between 2015 to 2025¹⁸ in India. This consumption growth is also visible in the total expenditure of Indians on clothes, which increased from USD 24.65 billion (INR 1,924 billion) in 2010 to USD 69.3 billion (INR 5,408 billion) in 2018.¹⁹ An increase in disposable incomes and changes in consumption pattern among Indians has led to a boom in the retail sector in the country.

Indian production and consumption growth patterns are also aligned with the global trends, with garment production doubling between 2000-2014 and per capita garment purchases increasing by 60%.²⁰ The growth in production and consumption is, however, leading to an increase in the quantity of textile waste generated. With India being one of the largest importers of textile waste, both domestic and global textile waste presents many challenges and opportunities.

Textile waste in India arises primarily in three waste generation streams: (1) pre-consumer, i.e. waste generated before the finished products reach the consumers and includes waste types such as spinning waste, fabric trimmings/cuttings, fabric deadstock, and unsold garment inventory; (2) domestic post-consumer, i.e. garments/ textiles discarded by domestic consumers; and (3) imported waste stream, which includes second-hand clothing and mutilated rags imported to India.

History of textile waste management in India

India’s decades-old culture and history of reusing, remaking and redesigning garments has enabled informal trade routes for textile waste and infrastructure to process it.

Indigenous communities in different parts of the country, especially in Jammu and Kashmir, Gujarat, and Rajasthan have been involved in traditional and cultural practices to preserve and reuse old textile for decades.²¹ With the emergence of recycling processes and synthetic fibres, these conventional and cultural practices were replaced by machine-based recycling. Since the 1980s, Panipat, a town in the Haryana state, flourished to become the largest textile recycling hub in India²². Consequently, newer and more efficient recycling hubs like Tirupur have also emerged with significant potential. These hubs work with different types of wastes from various sources to meet domestic and international demand for recycled products, while continuously finding various reuse and downcycling use cases.²³

While India possesses a huge mechanical recycling infrastructure and potential, the country has not been able to establish complete circularity of textile wastes.²⁴ This is largely due to the lack of visibility and understanding of the underlying potential of this industry. To date, the value chain managing it remains largely unorganised, leading to leakage of waste at multiple levels. The industry functions with minimal support for technological advancement and process standardisation.²⁵ Consequently, the yarn produced is lower in quality and is deemed unfit for global apparel manufacturing. This, coupled with the stiff competition from inexpensive synthetic fibres, is limiting the economic growth and viability of the recycling industry in India.

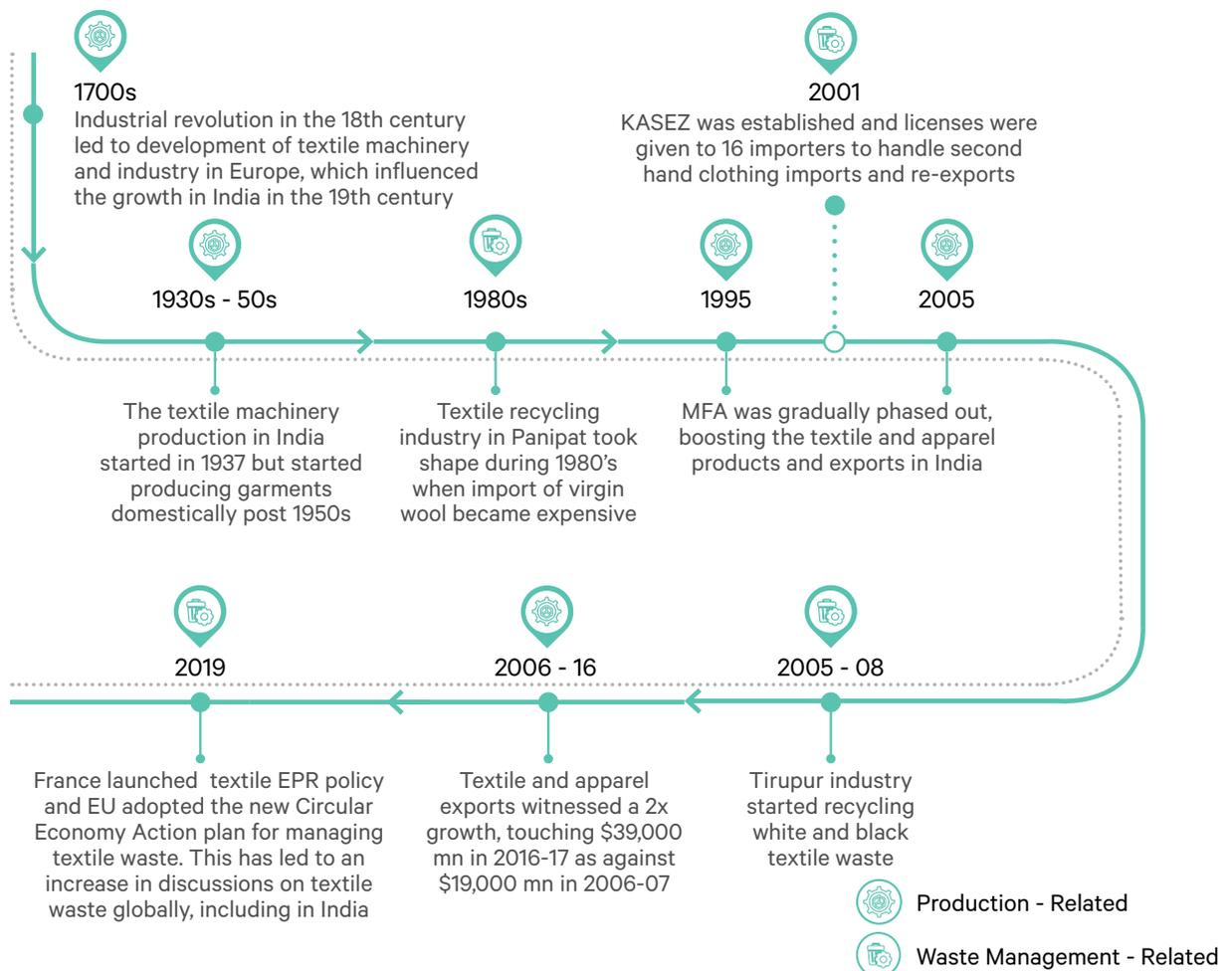


Illustration 7: Timeline of textile and textile waste management industry in India^{26 27 28 29 30 31}

India's competitive advantage: deriving value from waste

In recent years, the fashion industry has garnered attention due to sustainability concerns in the sector. With the 'take-make-dispose' model of the industry resulting in increased waste generation and the production and processing of (virgin) materials contributing to global GHG emission and high water consumption, the industry is taking active steps to close the loop and introduce as much of waste as possible back into the production process.³²



Illustration 8: State of Textile waste globally^{33 34 35 36 37 38}

'Circularity in textile' refers to systematically devising a regenerative system where textile is circulated until its maximum value is retained for as long as possible by reusing or recycling, while simultaneously minimising the production of waste at every stage to ensure social, economic, ecological, and environmental benefits as well as the well-being of those employed in the industry.³⁹

The global movement towards circularity in textile waste can provide the Indian recycling industry with a unique opportunity to leverage and grow its existing capabilities to make it one of the largest circular textile regions.

India is one of the largest mechanical recycling hubs in the world, with over 900 recycling units⁴⁰ and ~4 million informal workers processing textile waste.⁴¹ The country has expertise in sorting, using the right combination of colour and fibres to reach the desired quality, and identifying an economic value for non-recyclable waste. Further strengthening this infrastructure requires increased focus from brands, government, philanthropic investments, technological advancements and value chain formalisation to strengthen the recycling industry in India at a low economic cost.



The Indian textile sector is a key driver for employment in India, especially for women. A circular textile economy has the potential to address environmental challenges and at the same time provide better livelihood and income opportunities. Transitioning towards a close loop textile value chain includes a combination of technology and business model innovation, improved sorting infrastructure and skilling interventions.



Stefanie Bauer, Focal Point Private Sector Cooperation GIZ India

India's competitive advantage in textile waste

1. The past decade has seen a huge growth in both production (CAGR 13.8% between 2010-2018) and consumption of textile and apparel products (national expenditure increased from USD 24.65 billion in 2010 to USD 69.3 billion in 2018) in India.
2. India is one of the largest mechanical recycling hubs in the world, with over 900 recycling units and ~4 million informal workers processing textile waste. While India possesses a huge mechanical recycling infrastructure and potential, the country has not been able to establish the complete circularity of textile wastes.
3. Over the years, the country has successfully built its expertise in manual sorting of waste, using the right combination of colour and fibres to reach the desired quality, operating the recycling machines and identifying an economic value for non-recyclable waste.
4. With the organisation of the value chain and visibility on the journey of waste, India has the edge in deriving larger and consistent value out of the textile waste.

PART 2

THE STATE OF TEXTILE WASTE IN INDIA

Provides estimates for textile waste in India, its end use and material composition. Also highlights the flow of waste within and outside India.

Types and quantity of textile waste

8.5% of global textile waste, or 7793 ktons, is accumulated (generated and imported) in India annually. Illustration 9 demonstrates the total quantity of textile waste in India in three main waste categories: domestic post-consumer (51%), pre-consumer (42%), and imported post-consumer (7%).

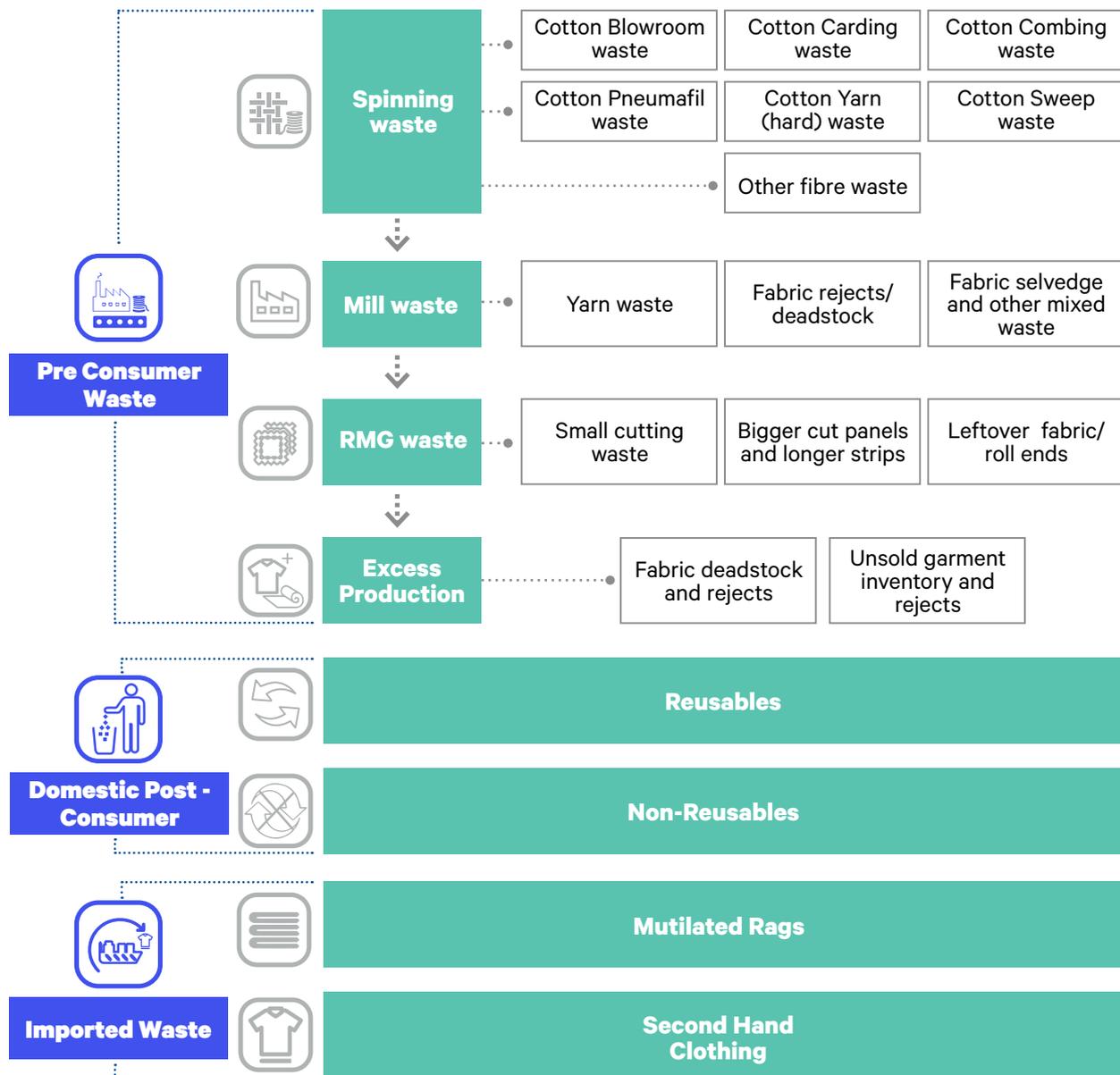


Illustration 9: Types of textile waste in India

Certain textile waste types included in this study (spinning waste, unsold or re-wearables garments, and fabric deadstock) are not considered textile waste as per GRS and RCS⁴² certifications. This study took a broad approach, as many stakeholders in the value chain consider these waste types as 'textile waste', and the value chain of reusable materials intersects with that of non-reusables and the process of handling these waste types also influences its end-use.

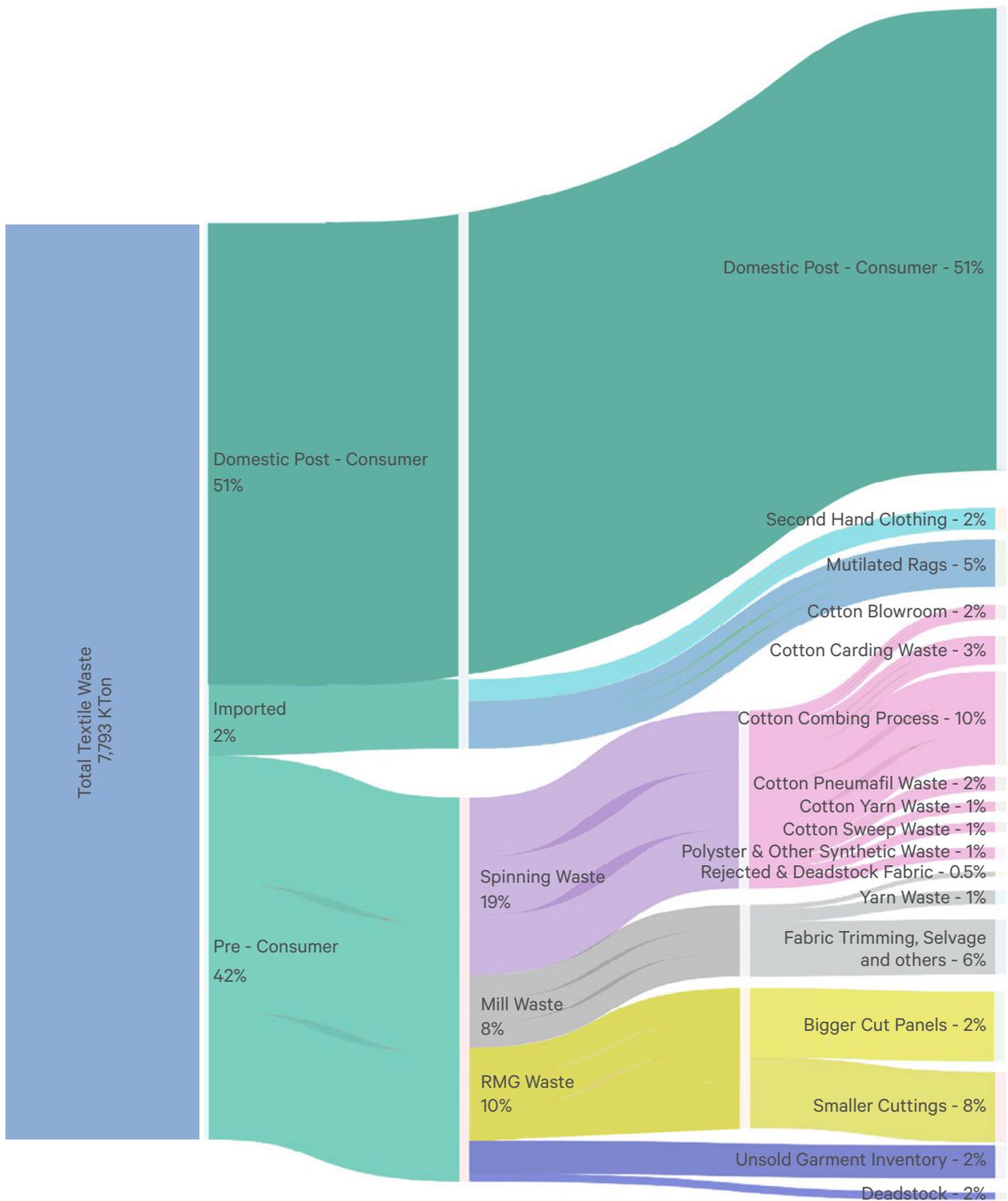


Illustration 10: Total quantity of textile waste in India and quantities by waste streams and types

Note:

1. The values represented above are measured in KiloTon (KTon)
2. Base value for % is total waste (7793ktons)
3. All The figures have been rounded off to the nearest whole number



Domestic Post-Consumer Waste

Domestic post-consumer textile waste refers to the textile waste generated at the end of an apparel or textile's use by consumers. It could be discarded for a number of reasons such as a change in fashion trends, being worn out, damaged, or outgrown.

Domestic post-consumer waste consists of reusable and non-reusable components and is the largest contributor to the total waste generated in the country with 3943.3 ktons discarded annually. Local municipal bodies collect a majority of this waste through door to door collections, with support from the *Waghri* Community, who collect roughly 30%, or 1190 ktons of waste annually.



Reusables consist of used clothes and linens discarded from households that are still in good condition for reuse.



Non-Reusables consist of two types of waste. Firstly, it includes a share of household waste if they are heavily soiled or have significant wear and tear. Secondly, it includes waste generated from commercial setups, including fabric cuttings from tailors and industrial textile waste (such as soiled and oil-soaked wiping cloths, etc). Though these materials are not generated after the consumption of textiles, they are collected along with the household waste and hence, have been grouped under domestic post-consumer waste.



Imported Waste

Imported textile waste forms 7% of total textile waste and falls within two categories- Mutilated Rags (HS Code: 6310) and Second-Hand Clothing (HS Code: 6309). Used clothing with signs of mutilation and wear and tear also fall under code 6310 and hence demarcation between the two categories is often very difficult. According to import policies, the used clothing category is a restricted trade in India and its import is only allowed in the Kandla Special Economic Zone (KASEZ). The KASEZ has 16 units which were set up to sort and grade imported used clothing and re-export them to other countries.⁴³ The import of mutilated rags, on the other hand, is a free trade allowed at all ports of India.



(69%) Mutilated rags consist of textiles that are slashed into smaller pieces for exporting. This can also include pre-consumer cutting waste.



(32%) Second-Hand Clothing has higher economic value than mutilated rags and is most often imported from developed regions such as the USA, Japan, Canada and the EU. These countries have community bins and active collection from charities who then ship to importers in India.



Pre - Consumer Waste

Pre-Consumer waste accounts for 3265 ktons annually, spinning waste forms the largest share, followed by Mill Waste and Ready-Made Garments (RMG) waste.



(46%) Spinning waste is generated during yarn production. 75% of yarn production in India is cotton and cotton blends, 19% of those yarns produced waste. The cotton spinning waste further consists of six types of waste- blow room waste, carding waste, comber noils, pneumafil waste, yarn waste and sweep waste. Hence, cotton spinning waste forms 94% of the total spinning waste in India. In man-made fibre spinning processes, waste generation is limited and forms only ~6% of the total spinning waste in India.



(18%) Mill waste contributes 612.2 ktons to the total pre-consumer waste generated and includes defect fabric rolls, yarn waste and other smaller cutting waste. Yarn waste forms 18% of the mill waste, while rejected and deadstock fabrics only form 6% of the mill waste. The remaining 76% consists of smaller cuttings, fabric and selvedge waste generated during the weaving, knitting and fabric finishing processes.



(24%) Readymade Garments (RMG) Waste or cutting waste is generated at the stage of garment production and forms a total of 792.2 ktons. It consists of both smaller cut pieces (referred to as 'katran/chindi' in local languages), bigger cut panels and end rolls (referred to as 'marbet/thapki/patti'). A majority of the cutting waste consists of smaller cut pieces as opposed to larger cut panels.



(6%) Fabric deadstock is generated due to extra fabric orders, rejected fabric rolls, faulty construction/finishing defects, or order cancellation. This waste has high economic value.



(5%) Unsold garment inventory and rejects consists of clothing that is discarded during apparel quality checks, sampling, export surplus at manufacturer's end, or unsold inventory. This category has high economic value and utility.



Circularity is the future, understanding and organising waste within the supply chain enables us to loop resources back to the system.



Senior Sustainability and Fabric Manager, Tesco Clothing Technical

Treatment of textile waste

There are four options for the treatment of textile waste: Recycle, Reuse, Downcycle, and Landfill/Incineration. Recycling and Reuse account for 59% and the remaining 41% is downcycled for use in other industries or incinerated/landfilled.

Of the textile recycled, much of it moves through low grade recycling processes. Estimates suggest that 60-90% of recycled material is used for domestic markets but it is difficult to estimate the exact proportion of low-grade recycling due to multiple material compositions and market factors.

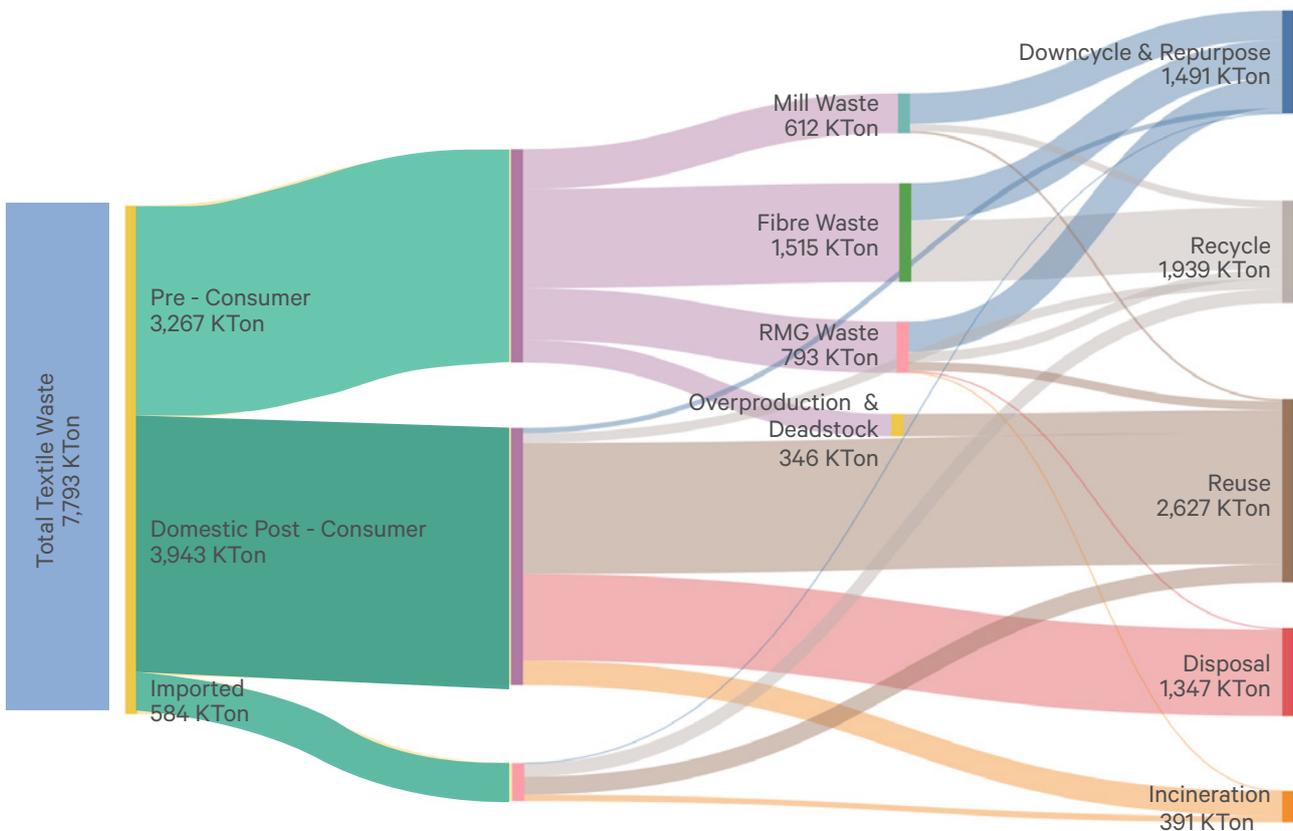


Illustration 11: End-use of textile waste in India

The treatment of waste across the three types; pre-consumer, post-consumer, and imported, varies greatly depending on the use case. Of the total pre-consumer waste, only mill waste and overproduction waste is being reused, while cutting waste appears to have multiple applications depending on its quality. More than 50% of the domestic post-consumer waste consisting of second-hand clothing is sold for reuse in the Indian domestic market. Recycling and downcycling use cases for this waste type are limited, and a large proportion (39%) is diverted to incineration for energy and landfill. Further, 64% of the imported textile waste is either being recycled into yarn or exported for reuse. While recycling of imported waste mostly takes place within India, second-hand clothing can be re-exported to Africa and Europe for reuse post sorting processes in India.

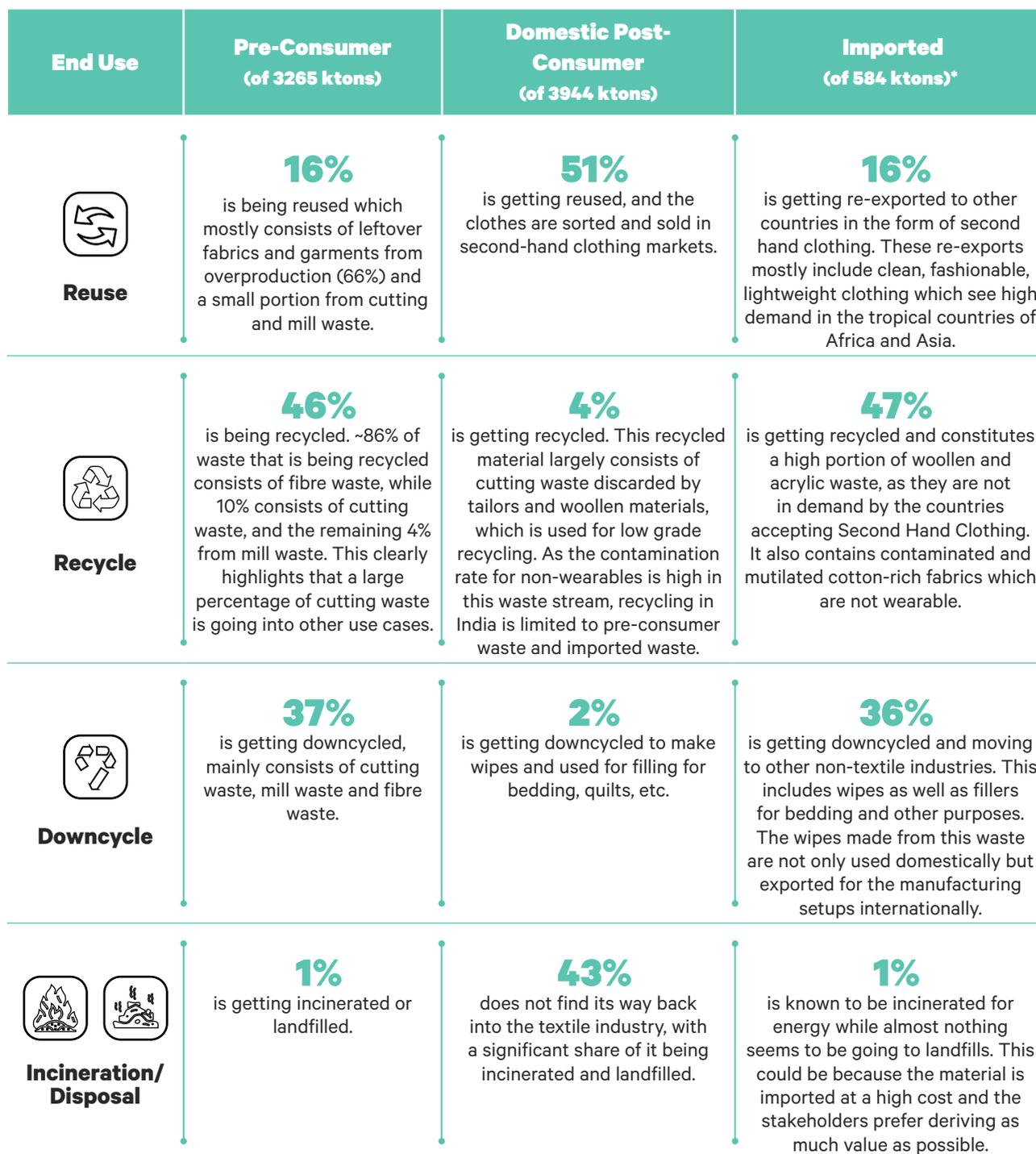


Illustration 12: End-use of textile waste split by waste streams

* A sizable share of the total imported waste, while not permitted, is known to be leaked into the domestic market for repair and resale in local markets. This quantity was difficult to estimate as there are multiple points of leakages across the value chain. Additionally, due to the highly informal nature of this value chain, the study could not access stakeholders dealing with this waste and estimate its quantity.

Composition of textile waste

61% of textile waste mainly consists of cotton and cotton blends in India, however, there is a growing trend of polyester and other synthetic blends, which currently forms approximately 19% of total waste generated.

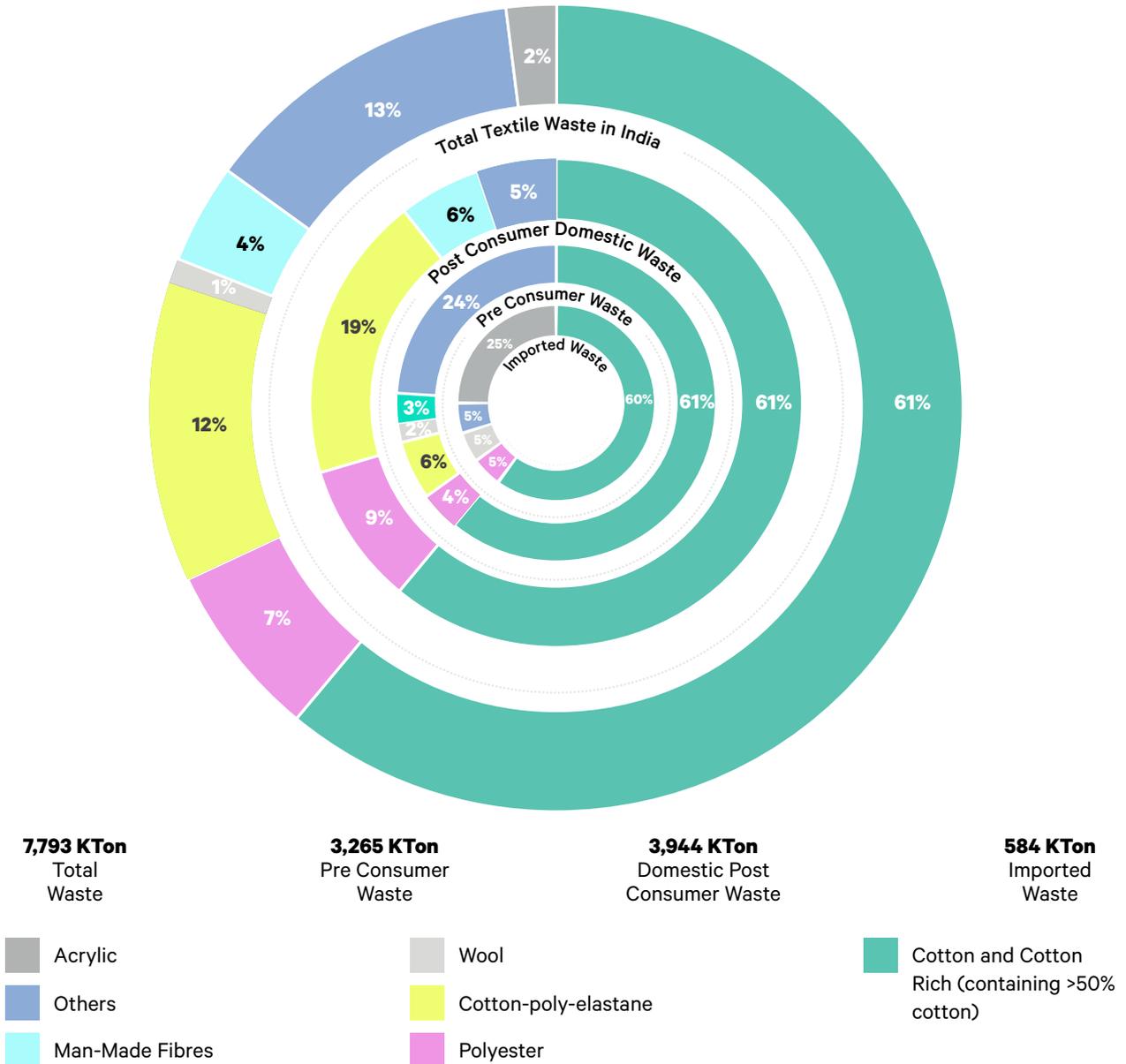


Illustration 13: Material composition of textile waste in India

The Indian textile industry uses a wide variety of fibres, ranging from natural fibres such as cotton, jute, silk, and wool, to synthetic fibres such as polyester, elastane and man-made cellulosic fibres (viscose, for example) among others. ⁴⁴

While a majority of fabrics and garments in India are cotton and cotton rich blends (blends with at least 50% cotton composition), 24% of total apparel produced is comprised of other blended fibres. While these fibres individually do not form a large share, they collectively form 1018 ktons (13%) of total textile waste

generated, denoting the need to institute waste management processes for waste beyond cotton and cotton rich blends.

Over the last five years, there has been a considerable increase in the quantity of synthetic textile waste, specifically polyester.⁴⁵ Currently synthetic fibres account for 19% of the total textile waste, but this is anticipated to increase given market demand.

Polyester's high stain resistance and low economic cost has made it a desirable raw material for the fast fashion industry.⁴⁶ Global estimates suggest that polyester formed 52% of total fibre manufacturing in 2020 and between 2000 to 2015, polyester production increased by 157%.^{47 48}

In addition to increasing production of fabrics and garments made out of polyester domestically, India also imports man-made filament yarns, fabrics and apparel. Between 2016 to 2018, the import of polyester yarns increased by 94% and that of apparel made out of polyester increased by 30%.⁴⁹

While synthetic materials already represent a higher proportion of domestic post-consumer waste (28%), compared to other waste streams, its share in imported waste streams has risen over the last five years, with importers in the KASEZ increasing as high as 10% in some cases.⁵⁰ In the pre-consumer waste stream, approximately 10% of the production and subsequently textile waste consists of synthetic materials. This highlights the need for dedicated efforts towards devising and investing in recycling technologies that will enable suitable recycling of these materials.

Geographical flows of textile waste

Most of the textile waste that is generated domestically and imported to India converges at Panipat and Tirupur, which are major recycling hubs in the north and the south of the country, respectively. Additionally, medium and small scale recycling facilities are prominent in Amroha and parts of Rajasthan, Madhya Pradesh, Punjab and Gujarat which have medium to small-scale recycling facilities.

According to the 2018-19 industry survey, Gujarat, Karnataka and Tamil Nadu are the largest textile and apparel hubs in India, collectively producing more than 56% of the textile production and 51% of annual apparel production in the country.⁵¹ Beyond these three states, medium to small-scale manufacturing clusters are present in multiple states as shown in illustration 16, leading to high waste generation across India.

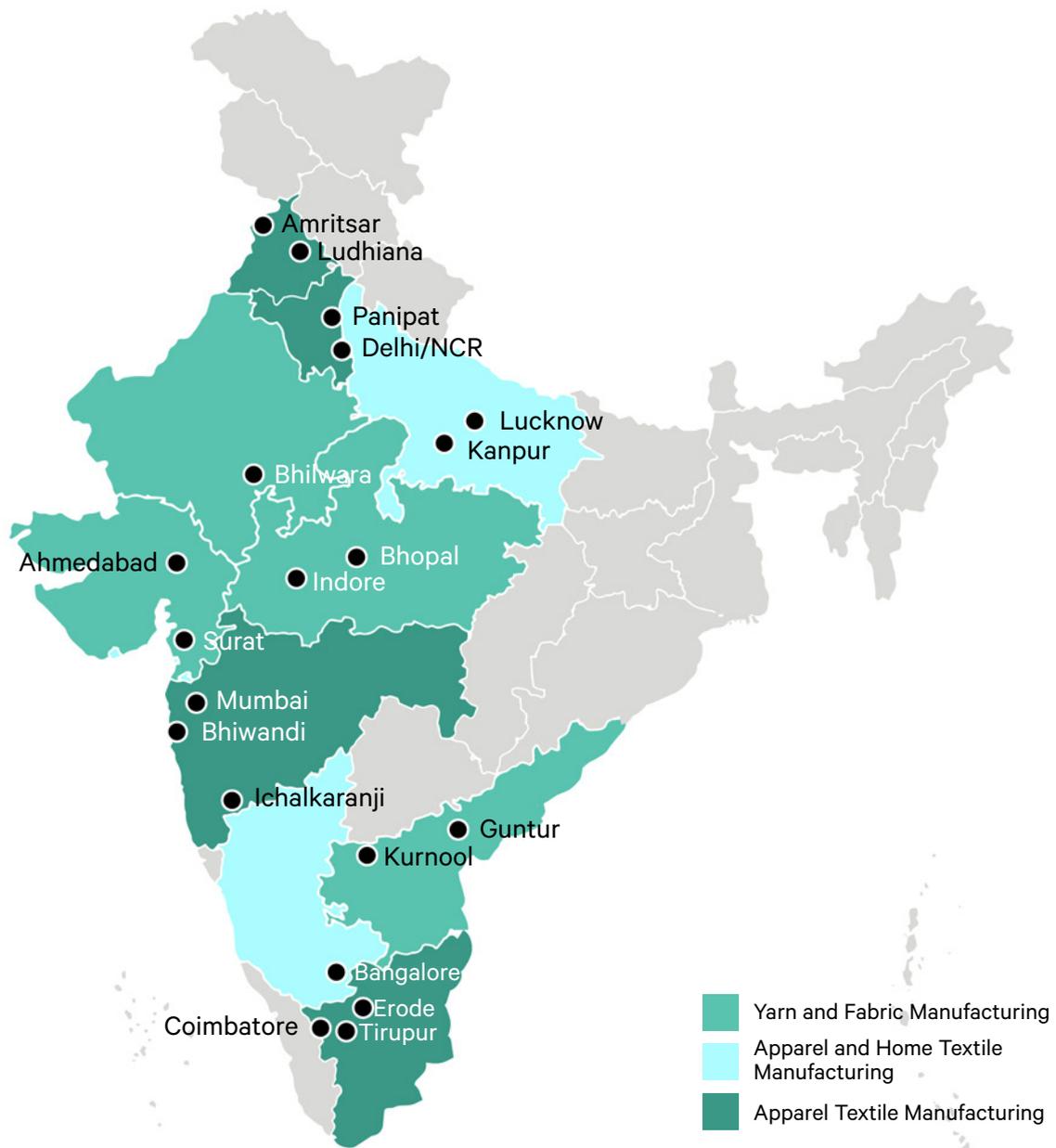


Illustration 14: Key manufacturing locations in India



Pre - Consumer Waste

Panipat, Haryana and Amroha, Uttar Pradesh serve as key recycling clusters for pre-consumer waste generated in North India, while most of the waste generated in South India is transported to the Tirupur-Coimbatore- Erode recycling belt.

The movement of textile waste between two locations is dependent on the type of waste available at source areas and the demand from the industry at the destination area that recycles or reuses it. Most of the cutting waste from Delhi-NCR, Uttar Pradesh, Punjab and Haryana is transported to Panipat and Amroha, given the capacities and capabilities of the recycling industry in these locations to deal with cotton, acrylic and wool waste. However, Panipat's recycling is preferred over Amroha, as Amroha's industry consists of shredding and garnetting infrastructure while Panipat has open-end spinning facilities as well. Due to the enhanced infrastructure, Panipat attracts high quality and high value waste and provides better recycler outputs. Panipat also has additional capacities to deal with polyester waste. Tirupur belt, on the other hand, recycles cotton rich waste. Cotton waste is transported from key manufacturing locations in Karnataka and Tamil Nadu, which are known for high production of textiles and garments made out of cotton due to increasing consumption of cotton in hot climatic conditions.

Most of the cutting waste generated in Gujarat, Maharashtra, Rajasthan and Madhya Pradesh is processed within the respective states by medium-to-small-scale recycling and downcycling players. Samana, in Punjab, is emerging as a new recycling hub processing locally produced cotton-rich fibre waste, cutting and mill waste.



Imported Waste

Panipat and Amroha are also the largest recycling hubs for imported second hand clothing, while mutilated rags flow to Panipat, Tirupur and Coimbatore for recycling.

Approximately, 70% of second hand clothing arrives at Kandla port from developed regions such as the USA, Canada, Japan, and EU. Additionally, India also imports mutilated rags from Korea, Vietnam and Bangladesh via Nhava Sheva port (in Maharashtra), the inland Patli port (in Haryana) and Petrapole land port (in West Bengal). The recyclable materials arriving at Kandla, Mundra (Gujarat), Nhava Sheva and Patli ports travel to Panipat, Halol (Gujarat) and Mohali (Punjab) for recycling. The imported waste from Bangladesh mostly consists of cutting waste and travels to the Panipat and Tirupur belts, while similar imports from Vietnam largely reaches Tirupur. However, the movement of such wastes is entirely dependent on the freight and the value of material that the importers derive out of it.

Panipat has emerged as a major recycling hub dealing with both pre-consumer and imported waste. The region started working with wool waste in the 1980s, which is used by smaller recyclers or 'shoddy mills', as they are called in the industry, to make coarser recycled yarns. This was because virgin wool became unaffordable for the industry and the demand for recycled wool yarns increased.⁵² Over the years, Panipat has found various use cases for all types of materials and their blends, with an industry consisting of multiple units generating recycled yarns and garments for exports.⁵³



Domestic Post-Consumer Waste

Within the domestic post-consumer waste stream, most of the wearables travel from urban to rural areas for reuse, while the non-wearables are landfilled or incinerated in urban areas.

Urban consumers generate most of the domestic post-consumer waste owing to increased buying patterns among them. The second-hand wearables are mostly sold in informal resale markets in the cities and the unsold ones move to second hand clothing markets in rural areas.

The domestic post-consumer waste study conducted by Saahas Zero Waste (SZW) in Bangalore and Delhi, revealed that the waste being collected across Bangalore is sent to markets like Shampura, Goripalya, K.R Market, Nayandahalli and other local Sunday markets or transported to Delhi and Surat for further sales in the second hand clothing markets. In Delhi, the collected waste is segregated by NGOs or informal collectors (Bartanwalas/ Waghri community members) in Raghbir Nagar, Swaroop Nagar, which is further sent to downcyclers within the city, second hand clothing local markets and Janpath area or transported to Uttar Pradesh and Gujarat. The non-wearable clothes do not have recycling potential as they are highly contaminated and torn and usually find their way to the landfills or incineration set ups in the vicinity.

Part 2: The State of Textile Waste In India

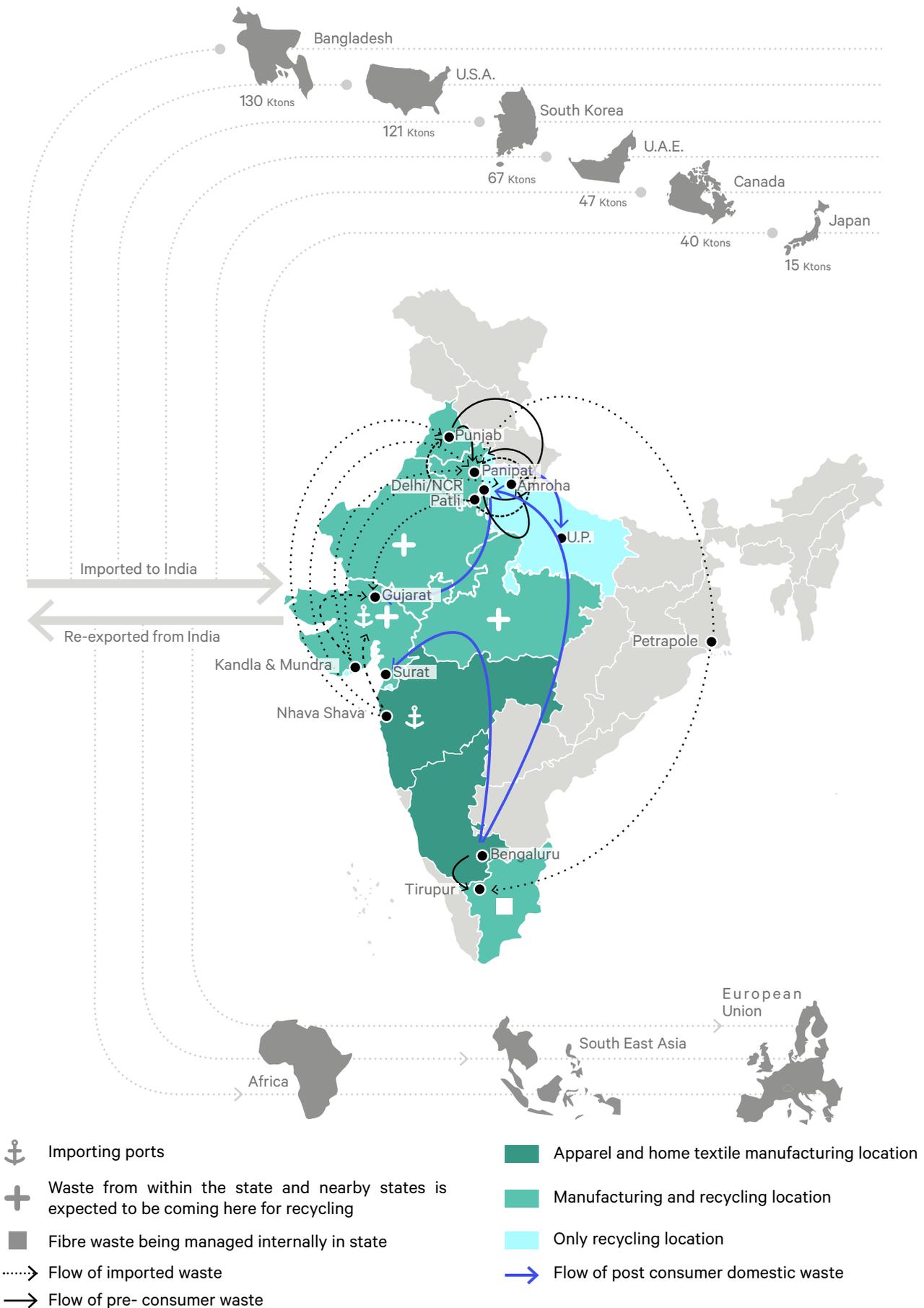


Illustration 15: Textile waste flows within and outside India

Extensiveness of textile waste in India

1. The pre-consumer, domestic post consumer and imported waste results in the generation of 7793 k tons of textile waste in India annually, forming 8.5% of global textile waste.
2. Out of the total waste generated, 59% is reused or recycled. However, out of this share, only 10-40% returns to the global supply chains. 43% of domestic post-consumer waste ends up in landfills as compared to 1% of pre-consumer and imported textile waste.
3. At present, nearly 61% of the total waste generated in India is cotton-rich material. However, there has been a considerable increase in the quantity of synthetic textile (especially polyester) waste over the last five years.
4. Panipat and Amroha serve as key recycling clusters for pre-consumer waste generated in Northern parts of the country and imported second hand clothing waste. Most of the waste generated in South India is transported to the Tirupur-Coimbatore- Erode recycling belt.

PART 3

UNLOCKING TEXTILE WASTE VALUE CHAINS IN INDIA

This section deep dives into pre-consumer, import and domestic post-consumer waste streams. Additionally, it also highlights the end-use processes of textile waste in India

Overview of textile waste value chain

India has a well integrated, albeit unorganised industry to deal with textile waste leading to informality and difficulties in traceability of waste

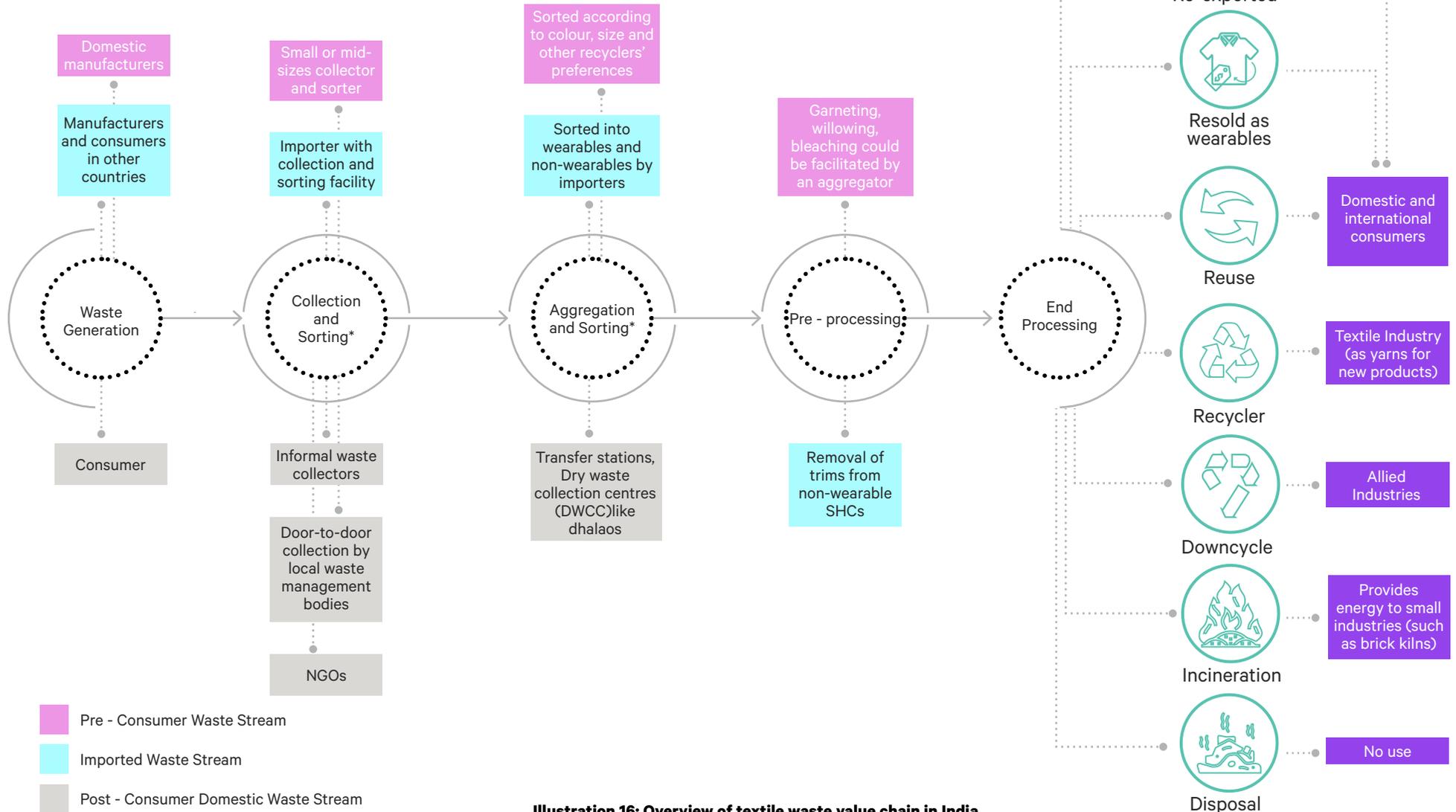


Illustration 16: Overview of textile waste value chain in India

Sorting is performed manually by workers through touch and feel, based on specifications from recyclers on size, colour and composition of waste. Two to three levels of sorters and aggregators exist in the value chain and the role of the last level aggregator is not only to sort the waste but also to store the waste until adequate demand comes in. However, due to the unorganised nature of the value chain, transparency and communication on availability and requirement of waste becomes challenging, leading to leakage or under-utilisation of waste.

“

There is no problem in demand and supply of textile waste in India except the lack of communication between stakeholders in the value chain due to absence of common platforms and systems. For example, a recycler in Panipat today does not know how and where to get rayon waste from.

”

Founder of a waste collection and sorting startup, present in key apparel manufacturing locations

Deep-dive into pre-consumer waste value chain

Overview Of The Value Chain

Two parallel value chains exist for pre-consumer waste in India; fibre and yarn waste generated during spinning and mill processes travel through the fibre waste value chain, while the fabric waste generated during mill and apparel production travel through the cutting waste value chain.

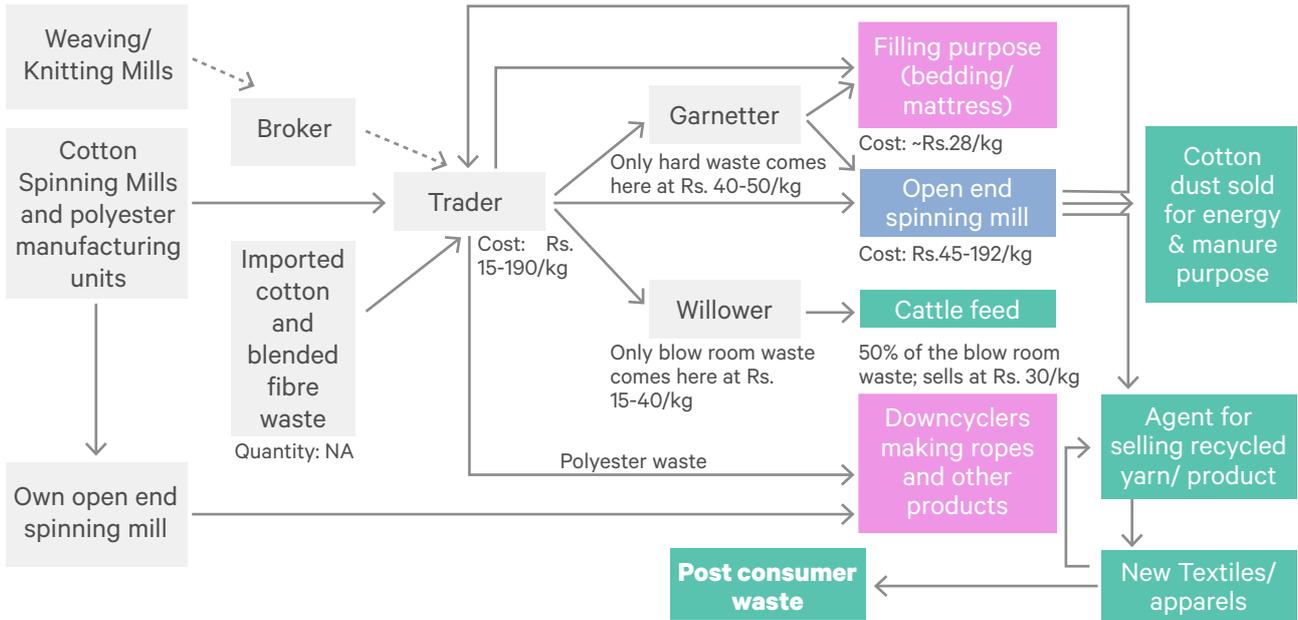


Illustration 17: Fibre waste value chain

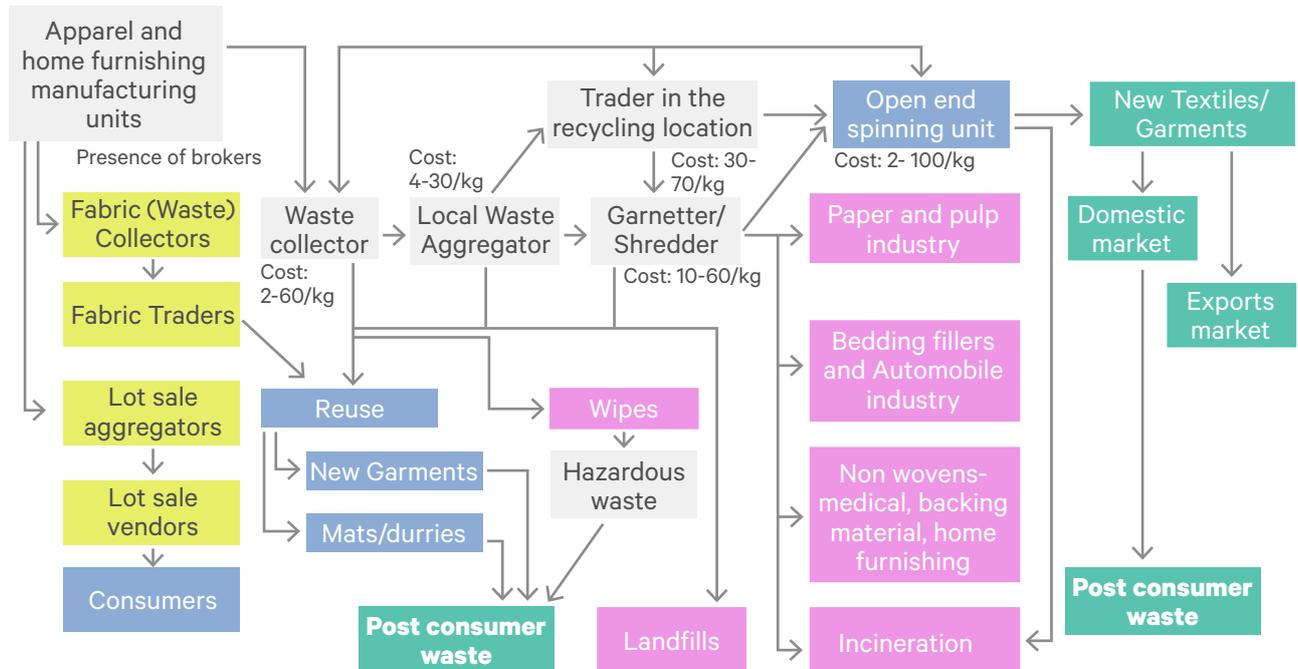


Illustration 18: Cutting waste value chain

- Enable transport of material through information flow
- > Material flow
- Blue box: Reuse & Recycling
- Pink box: Downcycling
- Green box: Outside recycling value chain
- Yellow box: Fabric deadstock and overproduction value chain

Collection, Aggregation And Sorting Processes

Waste generated in the pre-consumer waste stream is collected and aggregated by an unorganised, small-scale industry consisting of brokers, agents and other middlemen. This trade is decentralised in nature but enables management of all types of waste.

“

I collect textile waste from factories in the Delhi NCR region. I then do manual sorting on the basis of size since very small pieces are not of use. Then I sell it to an aggregator. I have employed 3-4 people who help me do this.

”

Collector

Name: Saurav
Gender: Male
Age: 27
Occupation: Collector and sorter
Location: Delhi
Number of employees: 3-4

Saurav collects waste from different factories and sorts them out with the help of his workers



“

I procure waste from different collectors in the city. I sort them on the basis of colour and material, and only deal in materials that have to be transported to other cities after this. I do not make a very high profit on these transactions.

”

Aggregator

Name: Seema
Gender: Female
Age: 52
Occupation: Aggregator and sorter
Location: Bangalore
Number of employees: 5

Seema aggregates waste from different collectors, for further sorting, storage and transportation



“

I procure waste from cities in India like Bangalore, and from countries like Bangladesh and Vietnam. I sort it out based on the specifications of recyclers who I sell these too. I have wastes of different kinds of materials, colors, prints, compositions which is sorted by many experienced workers.

”

Secondary Aggregator/Trader

Name: Pappu
Gender: Male,
Age: 34
Occupation: Aggregator and sorter
Location: Tirupur
Number of employees: ~80

Pappu has a large waste aggregation set up and stocks waste from different cities and sells it to the recyclers when demand arises



Illustration 19: Personas collecting, sorting and aggregating pre-consumer textile waste in India

Waste disposal by the manufacturers is done through a cost bidding process. This price is decided post visual inspection and is usually negotiable. In case of fibre waste, such requests are floated by manufacturers to the agents at the beginning of each month. On the other hand, for the disposal of cutting waste and fabric deadstock, orders are usually placed once the storage space in the factories is full. Both large scale spinning and apparel manufacturing units dispose off their waste every 15-20 days by truckloads. However, the quantity of such truckloads varies based on the size of collector and the availability of collection vehicles. For cutting waste, the average quantity for one shipment varies from 1000 to 10,000kgs.



We go see the waste, check its quality and only then quote a price. It can't happen virtually as we have to touch the material and see for ourselves.



Fibre waste dealer in Coimbatore

Specifically for fabric deadstock and overproduced apparel, high economic incentives and a strong network of collectors and traders have ensured minimal leakage.

By following brand policies to unbrand such products, by removing size labels, logos, wash care instructions and so on, this value chain ensures incentives for all stakeholders at every point. The frequency of selling deadstock and apparel overproduction is low at the manufacturers' end. They are usually sold once or twice a year, only after an average period of six months between original production and sales. This is to ensure that the actual value of fresh stock is realised and design imitations by market players are minimal. Depending on the specifications provided by the brands, branding components such as size labels, logos, wash care instructions and so on, are removed before selling. Fabric deadstock is mostly sold on a per kg basis (instead of a per metre basis) and is considered a low value realisation of the material at the manufacturer's level. Apparel overproduction, on the other hand, is sold at 10% of the product's original Maximum Retail Price (MRP), ensuring better value realisation from their perspective.

Depending on the type of waste, there could be additional processes or stakeholders involved in certain types of pre-consumer waste, before it is sent for end processing.

Fibre waste is collected and stored in a segregated manner at the factory level. On the other hand, cutting waste is not sorted by composition, size or colour at factory level and is usually sold as 'mixed waste'. Few manufacturers, however, separate out white cuttings and bigger cut panels as they recognise the high demand for these materials and therefore are able to garner a better price. White coloured cutting waste is sold at INR 50-60 per kg (USD 0.64-0.77 per kg), while the mixed waste can be sold at a cost between INR 6-INR 35 per kg (USD 0.07-0.45 per kg) depending on the quality and market trends. However, the extent of these segregation efforts across all manufacturers in India is not effective, according to the collectors, as most of the waste is still mixed with a contamination rate up to 20%. The contaminated materials include paper, plastics, needles, tea cups, sachets, and so on.

While sorting and contamination is not a concern for fibre waste, there are additional processes involved post the collection of waste. During the transaction of fibre waste, an additional layer of brokers/agents exist to ease the interaction between the manufacturer and trader by transferring supply and demand

information. Post collection, willower (for blow room waste) and garneter (for yarn waste) procure the waste directly from traders/collectors. The bigger spinning establishments with their own open-end spinning mills, directly interact with willower and garneter, and buy back the processed material.

On the other hand, since cutting waste is usually not processed within the manufacturing setup, apart from sorting, there are no additional processes involved in it. Unlike fibre waste, cutting waste is known to travel long distances to reach key recycling and downcycling locations from source areas. Agents/middlemen exist in the trade to ease out transportation and transactions.

Every stakeholder in the pre-consumer waste value chain is providing a level of aggregation and sorting for the next stakeholder, while maintaining cost efficiencies.

In the pre-consumer waste stream, the requirement for sorting is highest for cutting waste and comparatively lower for fibre waste, as it is procured in a segregated manner. Sorting of cutting waste is undertaken based on the needs and specifications of the next stakeholder in the value chain. It has been observed that the first-level sorter in the value chain sorts the material only based on one parameter. At the level of the aggregator, sorting takes place on multiple parameters and as the material moves closer to the recycler/downcycler or for reuse, it reaches the desired quality. However, if the collector is a recycler as well or is interacting with the recycler directly (which has been observed in some cases), then sorting is undertaken by first-level collectors/sorters based on all possible parameters and specifications. Most small-scale collectors only sort materials based on size or in some cases colour or material, depending on the quality of waste received. These sorting parameters include material composition, colour, size, fabric construction, contamination, etc.

Any traces of contamination (such as paper, needles, and so on) are mostly eliminated by the first collector/sorter in the value chain. Such contaminated materials find their way into non-textile value chains if usable. However, most of the heavily soiled textiles are sent to landfills, forming almost 1% of pre-consumer waste. Fabric deadstock, on the other hand, is sorted by size (quantity) and thickness (quality) of the fabric. This sorting is mostly undertaken to determine and assign prices for these rolls.

MuddleArt: Step towards organising the pre-consumer waste collection

MuddleArt has created a systematic one stop solution and acts as a link between manufacturers and recyclers/other organisations by collecting all kinds of pre-consumer textile waste from brands and manufacturers and then sorting it based on the specifications of the end users/recyclers. Lastly, MuddleArt ensures that the material reaches its final destination without any contamination. MuddleArt understands the requirements of types of waste that its stakeholders need and then channelise it accordingly. Furthermore, the supply chain they have created factors in accountability, traceability and a concentrated effort to bring about positive change in the livelihoods of waste workers/sorters. Through their customised solutions for pre-consumer textile waste management, they help brands/manufacturers/producers transition to a circular economy. They are currently working with brands like H&M and manufacturers like Shahi Exports and Cotton World.

Besides sorting, large aggregators also support the value chain by storing the waste till adequate demand arises.

Waste aggregation collects pre-consumer waste from both domestic and imported sources. The aggregators are in contact with the exporters in Bangladesh and Vietnam, or have their own partners in other countries who facilitate the procurement process. In this way, aggregators serve as a bridge between collectors and recyclers in India.

For both cutting and fibre waste, recyclers require an adequate amount of waste of consistent quality to carry out the process. This service of providing quality and quantity of waste is offered by the aggregators who maintain waste inventory for a significant period of time for stakeholders who lack storage facilities such as recyclers and boutique owners. Aggregators often store up to 30% of the pre-consumer waste due to lack of adequate use cases of certain materials such as polyester, this waste is at risk of being landfilled or incinerated.

Impact of the COVID-19 pandemic:

In the pre-consumer waste stream, the closure of manufacturing units during the lockdown and the closure of local weekly markets for a long time affected both supply and demand of waste. To date, many of the traders in the waste markets do not have enough customers given low demand, due to low disposable incomes post the lockdowns. This has also led to delay in wages to the workers and layoffs.

Factors Determining The End Use Of Pre-Consumer Waste

The final level of waste sorting takes into account all the waste characteristics that determine its end use. Colour, material composition, contamination and fabric construction determine the recyclability of cutting waste. The characteristics of virgin yarn production process such as the manufacturing machine quality, strength and staple length of virgin fibre, etc., highly influence the recyclability of cotton fibre waste.

Category	Parameters	Pre-consumer waste stream				
		Fibre waste	Cutting waste		Fabric Deadstock	Apparel Overproduction
Waste Characteristics	 Size	Not relevant	Smaller pieces with no reuse value move to recycle and downcycle	Bigger pieces have wider use case and hence higher valued	Longer rolls of fabric have a higher utility	Not relevant
	 Colour and prints	Depends on the quality of raw fibre and is visually inspected while buying. In polyester, dope dyed fibres produce lower quality waste than whites.	Prints reduce the recyclability of materials. In colours as well, plain white and pastels are high valued	Solid colours and prints based on fashion trends have high reusability	Determined by the trends and market requirements	Determined by the trends and market requirements
	 Contamination rates*	Trash % is visually inspected and is dependent on the raw fibre and machinery	Higher contamination levels (soiled/stained) are not suitable for recycling and get downcycled	Higher contamination levels (soiled/stained) are not suitable for reuse	Deadstock with stains might not be accepted	Apparel overproduction with stains is usually not easily acceptable.
	 Material composition	Not relevant	Cotton material has high recyclability into yarn and other industries as well	Not relevant	Not relevant	Not relevant
	 Fabric construction	Not relevant	Knits are easier to recycle. Garnetting of woven damages the fibre more, leading to low quality yarn	Not relevant	Not relevant	Not relevant
	 Condition of Clothing	Not relevant	Not relevant	Not relevant	If there are defects, the material is less acceptable	If there are defects, the material is less acceptable

Category	Parameters	Pre-consumer waste stream				
		Fibre waste	Cutting waste	Fabric Dead-stock	Apparel Overproduction	
Characteristics of the virgin production process	 Quality of machine	Newer and better quality machines have less damaged fibres as waste	Not relevant	Not relevant	Not relevant	Not relevant
	 Strength and staple length of the fibre	Checked manually by stretching the fibres	Not relevant	Not relevant	Not relevant	Not relevant
	 Stage of generation	Combing stage waste is considered best quality as the fibre is refined till that stage	Overlock waste generated at sewing stage is low value as it is mixed with thread	Not relevant	Not relevant	Not relevant
	 Quality of the virgin yarn being produced	60s and 80s Ne count yarn usually give the best by-product/ waste	Not relevant	Not relevant	Not relevant	Not relevant
	 Quality of fabric	Not relevant	Fineness of the original fabric determines the quality of recycled fabric	Not relevant	Not relevant	Not relevant
	External factors	 Fashion trends	Not relevant	Not relevant	Not relevant	Determine the acceptability for reuse

Illustration 20: Factors determining end use of pre-consumer waste

Key takeaways from the pre-consumer waste value chain:

1. The value chain for pre-consumer waste stream is unorganised and informal, consisting of brokers, agents and other middlemen, who facilitate information flow between supply and demand players.
2. Though informal, pre-consumer waste stream is decentralised in nature and stakeholders in the value chain prevent leakages to ensure that the waste from manufacturers is utilised within or outside the textile industry, in order to maximise returns.
3. All the fibre and yarn waste generated during spinning and mill processes travel through the fibre waste value chain facilitated by brokers, traders, willowers and garnetters. On the other hand, the waste generated during mill and apparel production travels through the cutting waste value chain, facilitated by a large and wide network of collectors, sorters and aggregators between manufacturers and recyclers.
4. Every stakeholder in the pre-consumer waste value chain is providing a level of aggregation and sorting for the next stakeholder, while maintaining cost efficiencies. Further, large aggregators play the role of storing the waste till adequate demand arises for end use.
5. Manual sorting of cutting waste is undertaken based on the needs and specifications of the next stakeholder in the value chain. These specifications are more particular for cutting waste and comparatively lower for fibre waste, as it is already procured in a segregated manner.
6. Any traces of contamination (such as paper, needles, and so on) are eliminated by the first sorter in the value chain, which could be harmful to them in some instances. Such contaminated materials also find their way into non-textile value chains if usable.
7. Up to 12 quality parameters play a role in determining the end use of waste types. Most of the sub-types of spinning waste are recycled and most categories of mill waste are downcycled. RMG waste has all three applications of reuse, recycle and downcycle. Overproduction and deadstock are mostly reused.

Deep-dive into domestic post-consumer textile waste value chain

Overview Of The Value Chain

While domestic post-consumer waste stream has many interaction points at the collection stage, there's a lack of formal sorting and waste processing systems, making it difficult to track to prevent it from being incinerated/ landfilled.

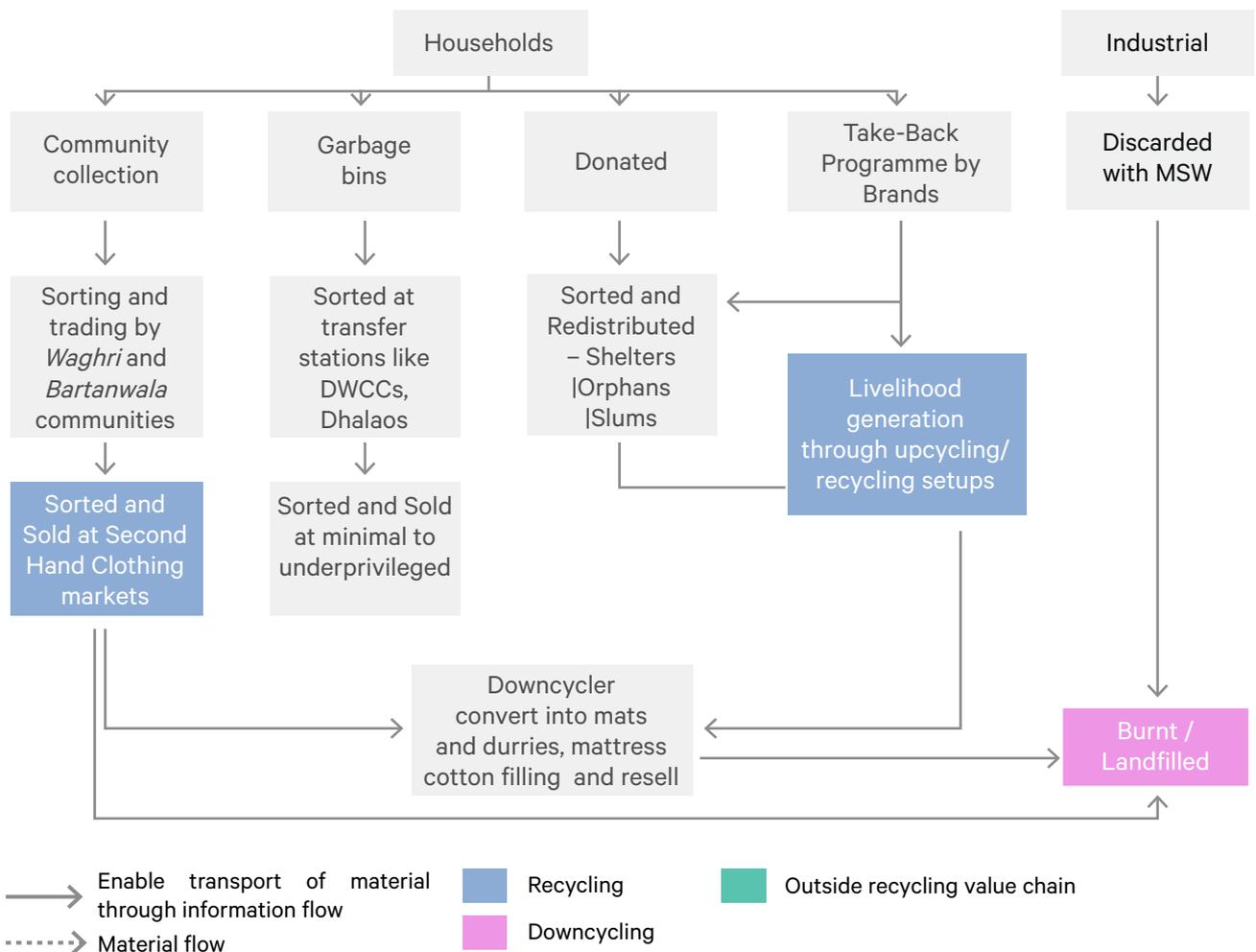


Illustration 21: Value chain for domestic post-consumer waste

Collection, Aggregation And Sorting Processes

“ I collect used clothes from households and then segregate it. Then, I sell it in markets for very low prices. Sometimes the clothes are soiled and have to be sent to cement factories, landfills or incineration ”

Collector

Name: Manda
Gender: Female
Age: 68
Occupation: *Bartanwali*
Location: Bangalore
Number of employees: 0

Manda conducts door-to-door collection of waste from residents in Bangalore and sells them.



“ Around 20-23 MT of second hand waste from across Delhi, Gurgaon, Swaroop nagar, Seemapuri and Jahangir puri is collected by me in a month. I then sell it to Raghubir nagar sellers or small factories in Panipat, Ghaziabad for shredding or burning for energy purposes. If there are any torn clothes, we cut it into smaller pieces for cleaning or repair them and sell them ”

Aggregator

Name: MD Mukim
Gender: Male
Age: 29
Occupation: Aggregator
Location: Swaroop nagar, Delhi
Number of employees: 0

Mukim collects SHC from PCD collectors, segregates, and then sells them to sellers in Raghubir Nagar and Panipat.



“ We get second hand clothes from Bartanwala, waste workers, collection centres, traders, aggregators. We then wash and iron the clothes if needed. We then sell it to the resellers every week. 6-10 clothes are sold per day costing - Rs 50 to 150. Most of the the clothes are brought by labourers, daily workers working in the field and mechanics. ”

Secondary Aggregator

Name: Pappu
Gender: Male,
Age: 34
Occupation: Aggregator and sorter
Location: Tirupur
Number of employees: ~80

Pappu has a large waste aggregation set up and stocks waste from different cities and sells it to the recyclers when demand arises



Illustration 22: Personas of collection, sorting and aggregation stakeholders in domestic post-consumer waste stream

1. NGOs and collection organisations:

NGOs and charitable organisations like Goonj and Clothes collection box organise community collection drives to collect wearable clothing from households. Such collections are performed door-to-door, or using drop-off boxes in local community spaces or institutions. They facilitate the transfer of clothes to those in need.

NGOs and charities mostly inspect and pick up clean clothes, which are wearable or in mendable condition. These are sorted into approximately 35 categories based on utility, repairs needed, age, gender, and size. Clothing that cannot be worn is reused to make other products like cloth pads, patchworks, etc. or are disposed of to landfills.

Kiabza: Digital Thrift Store for Pre-owned Fashion

Kiabza aims to bridge the gap between second-hand buyers and sellers through their online platform, while also reducing the carbon footprint of the consumers. Through their website www.kiabza.com, Kiabza allows consumers to buy and sell branded pre-owned fashion including apparel, bags and fashion accessories. While sellers earn money by selling their products and making sure these are not disposed of in an unsafe manner, buyers are able to buy these products, which are 100% curated by Kiabza, at a small fraction of the original price.

The product is collected from the seller free of cost and inspected for hygiene and quality at their warehouse. The items are then categorised based on their profile and condition and approved by the team, before being sold to consumers on the website. The ones that are not approved are sent to not-for-profit organisations working with children and youth belonging to weaker sections of our society.

To date, Kiabza has 15,000 consumers, out of which 48% are repeat customers. They collect approximately 2000 clothes per month in 6-8 metro cities, of which 60% of them are sold in tier 2 and 3 cities such as Dimapur, Indore, Imphal, Kohima, Ludhiana, Patiala, Surat, Siliguri, etc.

Kiabza acts as an accessible e-commerce thrift shop platform for Indian consumers and accepts clothing of 3000 domestic and international high street brands including Zara, Mango, Vero Moda, M&S etc. and premium brands like Armani, Burberry, Versace, Hugo Boss and many more.

Kiabza, however, faces challenges with both supply and demand. On the supply, they find it challenging to reach potential sellers of branded, pre-owned products easily as collection mechanisms in India are lacking and expensive. Regarding demand, they must underscore the quality control of items to overcome apprehensions on the quality and hygiene of pre-owned products.

2. Informal waste collectors:

This includes collectors from Waghri, Kathiawad and other collecting communities, commonly known as *Bartanwalas* or *Bhandivale* in India. They form an important link bartering old clothes in exchange for utensils or money from households, and selling to aggregators or in local second hand clothing markets directly. Raghubir Nagar market in Delhi is one of the biggest second hand clothing markets in India, with an overall estimated population of 25,000-30,000 Waghri community members. Each bartanwala collects

50-100 clothes daily from Delhi and the neighbouring cities.

The informal waste collectors segregate, wash and iron clothes to sell to bulk buyers or retail shops. For wearables, this segregation is performed primarily on the basis of wear and tear and quality of the garment. Dhoti and sari, on the other hand, are used in non-textile industries, as wipes and are segregated based on material composition.

3. Municipal waste collectors:

Textile waste is also disposed through the usual household waste dustbins. This municipal solid waste collected from households is aggregated at designated centres like the Dhalaos/ transfer stations in Delhi and DWCCs (Dry Waste Collection Centres) in Bengaluru. The rag pickers in these locations collect recyclable and reusable textiles from these transfer stations. The remaining non-recyclable materials are loaded and sent to landfills or incineration for energy recovery.

The waste collected by municipal bodies in both Bangalore and Delhi, undergoes one level of manual sorting at DWCCs and Dhalaos respectively. Sorting is done on the basis of the size of the cloth and the usable materials are taken out. Out of 30 DWCCs visited in Bangalore, 23 used a manual method for sorting of garments and very few had conveyor belts. The collected waste is then sorted into wearables, which are reused or sold, and non-wearables which are compacted and sent to landfills.

4. Take back programmes by brands:

Although at a nascent stage in the country, take back programmes are brand initiatives where consumers can return old clothes back to the brand for recovering and reprocessing.

Nepra Resource Management Private Limited is a leading Dry Waste Management company specialising in collection, segregation, processing and recycling of dry waste. It strives in creating a value chain for different waste streams. NEPRA is actively working in finding solutions for textile waste. Apart from other solid waste, they also collect textile waste in a segregated manner from different stakeholders, both pre-and post consumer waste generators. It is working towards formalising the unorganised waste sector.

Hasiru Dala Innovations Private Limited is a social impact organisation that focuses on securing justice for waste pickers through interventions co-created with waste pickers, in the areas of identity rights, access to family education, healthcare, housing and pension, skill development, market and employment access, and multi-tier policy advocacy. They have initiated a pilot to test a micro-entrepreneurs led approach for local collection and sorting of domestic post-consumer textile waste. This approach leverages the existing Dry Waste Collection Centres, existing in Bangalore at a ward level, and their close interactions with residents; this pilot aims to establish a traceable textile waste stream from households and minimising the quantum of textiles that make it to end-of-life processes.



We collect everything- all types of clothes, even if it's soiled or torn. If it's made out of cotton (suti) it gets sold fast, but clothes made out of polyester (tericot) do not. We give the clothes that we are not able to sell to someone who wants to use it for incineration or we just pack it in bags and throw it in a naala (drainage)



Aggregator, Nayandahalli, Bangalore

Factors Determining End Use Of Materials

Second hand clothing is expected to be in a good condition, aligned with fashion trends and size requirements for being reused. For downcycling, fewer parameters are relevant and almost all kinds of materials are used.

		Domestic Post Consumer Waste		
		Reuse	Recycle	Downcycle
Waste Characteristics	<p>Size</p>	Adult clothings are preferred over kids SHC	Not relevant	Long length materials like dhoti and saree are preferred for wipes
	<p>Colour and prints</p>	Determined by the trends and market requirements	Printed materials have low recyclability	Not relevant
	<p>Contamination rates</p>	SHC with high contamination rates are not accepted easily for reusing or recycling	SHC with high contamination rates are not accepted easily for reusing or recycling	Heavily contaminated materials are downcycled or incinerated and landfilled
	<p>Material composition</p>	Cotton has a higher acceptability for reuse	Cotton has high acceptability for recycling	Not relevant
	<p>Fabric construction</p>	Not relevant	Not known	Not relevant
	<p>Condition of Clothing</p>	Condition of the clothing determines how the clothing can be used further	Only tailor cutting waste is known to be recycled in PCD	Not relevant
External factors	<p>Fashion trends</p>	Determine the acceptability for reuse	Not relevant	Not relevant

Illustration 23: Factors determining end use of domestic post-consumer waste

Key takeaways for domestic post-consumer waste value chain:

1. Collection for domestic post-consumer waste is done through four key channels- NGOs, municipal bodies, informal waste collectors and brand take back programmes.
2. Sorting of domestic post-consumer waste is dependent on the stakeholder handling the waste. The priority for each stakeholder is to identify reusable clothing for donations or resale.
3. 43% of domestic post-consumer waste moving to downcycling, incineration and landfills highlight the lack of efficiency in managing this waste.
4. Alignment with fashion trends, size requirements and wearable condition gives a higher return for second hand clothing being resold.

Deep-dive into imported waste value chain

Overview Of The Value Chain

India is one of the largest importers of second hand clothing and mutilated rags, most of which is exported with or without processing. Aggregators and middlemen/women exist at every node of interaction in the value chain to smoothen out importing, sorting and re-exporting processes.

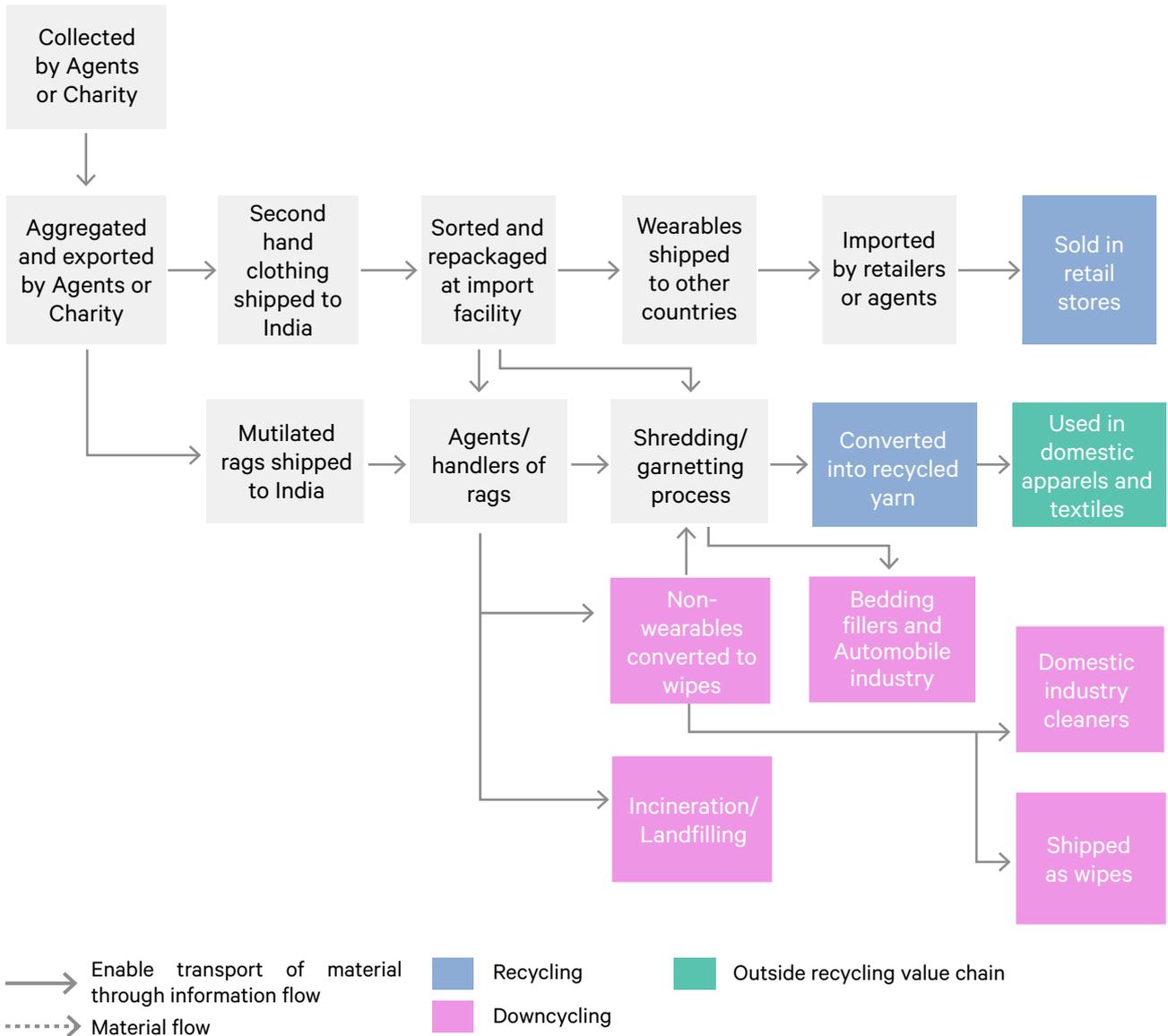


Illustration 24: Value chain for imported waste stream

Collection, Aggregation And Sorting Processes

“ Containers with second hand clothes from other countries come to the KASEZ, which are sorted and repacked for exports here. Whatever can't be re-exported as wearables, is sold to different agents around the country for recycling and downcycling ”

Collector

Name: Samir
Gender: Male
Age: 48
Occupation: Importer
Location: Kandla
Number of employees: 25

Samir runs a large import house in Kandla Special Economic Zone



“ We get a lot of material from different collectors so we sort out whatever recyclers want, which is easy to understand from our experience. The rest of the waste is sent to traders in different cities in the city to be sold in markets. ”

Aggregator

Name: Manish
Gender: Male
Age: 39
Occupation: Aggregator
Location: Panipat
Number of employees: 4

Manish is a mid-size aggregator collecting and sorting waste in Panipat.



“ I collect different second hand garments from different traders across India and aggregate it here. I have a big space where this is done. After getting it from different cities, I send it shredders within Amroha for shredding. ”

Secondary Aggregator

Name: Deepak,
Gender: Male,
Age: 30
Occupation: Second-hand clothes aggregator
Location: Amroha
Number of employees: 2

Deepak is a second hand clothing aggregator in Amroha.



Illustration 25: Personas of collection, sorting and aggregation stakeholders in imported waste stream

Trade practices for imported waste varies per port and the size of the importer

In the countries exporting second hand clothing, charities collect clothing either by a door-to-door collection exercise or through community drop-off bins in different locations. These clothes are then sorted, with a small amount going to local reuse and thrift shops, the remaining is exported to India and other countries directly or via agents. In case of cutting waste/mutilated rags, the process of collection is similar to that of pre-consumer waste in India. At the importer's end in India, orders are placed either via indentors or directly to the exporters, depending on the relationship between the importer and the exporter. On average, shipments take up to 50 days to reach India, depending on the export location. Indian ports importing textile waste have different practices as outlined below:

1. Importing of second hand clothing (under code 6309) is only allowed at the Mundra port and is directly transferred to the Kandla SEZ (Special Economic Zone). Clearing agents at Mundra port are not active in this process, the customs check happens directly in the KASEZ region. Only scanning of shipment/container codes is done at the Mundra port to verify if the right containers are moving into the country.
2. Customs checks for imports at Nhava Sheva port, Tughlakabad and Patli ICD (Inland Container Depots) are performed in the Tughlakabad and Patli ICD. This mandates the need for a clearing agent or an official from the importing organisation to manage the process end to end.
3. Textile waste coming from Bangladesh, crosses borders via land and the customs clearance occurs at the Petrapole, 80 km from Kolkata.⁵⁴

Once the material passes through the customs check, it is sent to the relevant importer for sorting, re-export and recycling processes. As per the SEZ policy (2003, 2009, 2013) issued by the Department of Commerce, Ministry of Commerce & Industry, items imported under HS Code 6309 second hand clothing fall under the restricted category, implying that they can only be imported at the Kandla port.⁵⁵ The regulations require all importing units to re-export at least 50% of their total imports in terms of value, in order to maintain a positive net foreign exchange. The mutilated clothing that is not exported as wipes or raw material for recycling, can be sold domestically.

A sizable share of the total imported waste, while not permitted, is known to be leaked into the domestic market for repair and resale in local markets. This quantity is difficult to estimate as there are multiple points of leakages across the value chain. Additionally, due to the highly informal nature of this value chain, the study could not access stakeholders dealing with this waste and estimate its quantity.

Imported second hand clothing is sorted into 400 categories at the KASEZ, mostly for re-export purposes. The material moving into the domestic tariff area (DTA) for further processing, goes through 2-3 stakeholders before the end processor.

The first level of sorting at the second hand clothing importers' level is undertaken according to various clothing categories such as pants, shirts, dresses, kidswear among others. While some importers use conveyor belts in the process, others use a simple trolley and bin system. Once the clothes are divided into product categories, they are further sorted into wearables and non-wearables (mutilated or stained) as well as other categories based on export requirements such as fashion trends, brands, sizes, vintage style. Garments from the USA are more in demand in African countries, as there are similarities in sizes and fashion trends. Garments from the EU mostly consist of winter clothes and pastel colours which have less relevance in these countries.

The non-wearable category is further segregated for the wipes and recycling industry. This classification is done on the basis of material composition (wipes that require cotton-rich materials) and size of the clothes. Around 35 categories of wipes have been curated by the KASEZ importers and aggregators in Gandhidham. The best quality wipes are exported for industrial cleaning purposes. The seam waste, leftover after cutting the wipes in desired size, and other non-wearable waste are sent to Amroha for downcycling into fibres used for filling purposes in bedding, quilts, car seats, soft toys, etc. Sorting of material for recycling purposes is done only in Panipat, where most of this recyclable waste ends up and here as well, the first level of sorting is into wearables and non-wearables. Like the pre-consumer cutting waste, non-wearables are then sorted based on recycler's requirements of material, colour, fabric construction, and so on.

BANK & VOGUE

Operating within the KASEZ, BVH works to maximise the value of used clothing and textiles across multiple key areas at scale. Through circular design, textile-to-textile recycling, component remanufacturing and re-commerce, they offer a "circular ecosystem" with which they work to adapt to their clients' unique needs and assure a better future for people and the planet.

Flax Apparels Pvt Ltd

Flax Apparels is one of the leaders in imports and re-exports of used clothing in India. The organisation has two sorting units in the Kandla Special Economic Zones, with about 600 workers. They are into re-exports of used clothing, making and exports of wipes and selling of recyclable materials to the Indian domestic market. They also make fibres from solid cotton and sell them to recycling units for yarn making. Other similar units also exist in KASEZ like Canam Clothing, US Clothing, and Texpoly Impex.

Impact of the COVID-19 pandemic

COVID-19 pandemic has doubled the cost of importing waste, leading to closure of some import facilities in KASEZ. The onset of the pandemic significantly reduced the charity collection in exporting countries. The cost of shipping also increased along with the raw material, making procurement costly, leading to losses during importing exercises. Importers have reported shutting down operations as the imported waste value chain suffered a severe blow during the pandemic.

Factors Determining The End Use Of Imported Textile Waste

End of use is determined by waste characteristics such as material composition, printed fabrics, and contamination. Once these are assessed textiles are either reused, recycled and downcycled. Reuse of second hand clothing is determined by the condition of clothing (wear and tear), country it is imported from and fashion trends.

	Imported Waste			
	Reuse	Recycle	Downcycle	
Waste Characteristics	 Size	Size of the clothing should be suitable for the country importing the material from India	Not relevant	Only fabrics greater than 1 ft (0.3m) can go for wipes
	 Colour and prints	For reuse, acceptability determined by the trends and market requirements.	Printed materials are not preferred	Printed materials go as low quality wipes or downcycled for fillers
	 Contamination rates	Clothing with contamination is not wearable	High contamination not accepted	Heavily contaminated material is downcycled to fillers
	 Material composition	For reuse, cotton and polyester have a higher utility. For wipes and recycling, cotton is preferred	Cotton rich materials preferred	Cotton rich materials for wipes and all compositions for downcycling into fillers
	 Fabric construction	Not relevant	Knitted materials have a higher acceptability for recycling.	Wovens go for second grade wipes only
	 Condition of Clothing	Low wear and tear is accepted for reuse	Not relevant	Not relevant
External factors	 Exporting Country	Determines the quality of clothing in terms of wear and tear, fashion trend. Western coast of US is known to have the best quality	Not relevant	Not relevant
	 Fashion trends	Determine the acceptability for reuse	Not relevant	Not relevant

Illustration 26: Factors determining end use of imported waste

Key takeaways for imported waste value chain:

1. Imported waste enters India through Kandla, Nhava Sheva, Petrapole and Patli ports. Each of the ports deal with different materials and have different trade practices. Similarly, trade practices also vary by the size of the importer and their capacities.
2. Imported second hand clothing is sorted into 400 categories at the KASEZ, mostly for re-export purposes. These categories are developed based on the requirements from the importing countries and usually vary by fashion trends, size requirements and preferred material compositions.
3. Non-wearable second hand clothing and mutilated rags move into India for further processing and travel through two to three stakeholders before the end processor. Wipes and recycled yarn are two most common end processes for the imported waste being processed in India.
4. Parameters defining the recyclability of the material are similar to pre-consumer waste stream but for reuse, additional parameters of the exporting country becomes important.

Use Cases for Textile Waste: Reuse, recycle and downcycle

Textile waste is finding economic value by moving into textile and non-textile industries for reuse, recycling and downcycling. But there is some debate that it is not being used in the best way possible and to its fullest potential, even in the textile industry

Reuse Of Textile Waste

For decades, reuse of textile waste has been a practice among domestic consumers, from hand-me-downs to purchasing it from local second hand clothing markets. A niche segment of consumers in India are also increasingly preferring second hand clothing.

Further, this segment of domestic consumers is consciously switching to more sustainable products, due to increased awareness of the impact of fashion on the environment and an increase in ongoing global conversations about circularity of textiles.⁵⁶ The increase in demand for pre-owned clothes has led to the creation of innovative startups meeting the demand.



Why are we using the terminology waste? In reality, it is prime raw material for somebody who's manufacturing something.



Leading collector and aggregator of pre-consumer and imported waste streams

Although reuse of garments has recently been brought to the forefront, it's had an established value chain in India for decades. Few players in the market who deal with garments or fabrics that can be reused have successfully created a large customer base over the years. However, these reuse materials were then positioned as cheaper alternatives rather than sustainable clothing.

Pre - Consumer Waste:

Following are the ways in which various materials are being reused for making new products:

1. Bigger cut panels: Bigger cut panels are usually produced due to excessive or inaccurate fabric cutting. Referred to as 'marbet/thapki' locally, they are used to make new products that are sold in the local markets at low prices. Kidswear and undergarments are the most commonly manufactured products as they require less fabric. In parallel, 'patti' or the long cuttings are reused into 'chindi durries' and other home decor products produced on handlooms.

2. Fabric rejects and deadstock: Sustainability conscious manufacturers try to limit the generation of excess fabrics, however when excess fabric is generated, they sell it either once or twice a year. Sorting of the material is done based on composition, length and quality of the fabric rolls and is sold to local tailors, reuse players or to traders for direct sales in local markets. Stakeholders who procure these fabrics make garments that are sold in local second hand clothing markets. Instances of excess fabric or rejects travelling from Bangalore to Tirupur and Erode have been found for reuse. The clothes made from these rejects and deadstock find their place in local roadside markets that are frequented by urban, semi-rural and rural populations alike. Materials like poplin for tops, rayon, twill and drill for pants and voile for lining are preferred.

Apparel overproduction generated in the factory is also sold in the domestic markets and is not regarded as waste by manufacturers.

Annual apparel overproduction amounts to about 152.5 k tons. Assuming a single t-shirt weighs around 0.4kg, there could potentially be 380 million t-shirts forming this segment.⁵⁷ Taking into account the international standards of a consumer buying 13 garments every year, these garments can serve 15 million individuals in the country.⁵⁸ Apparel overproduction and rejects are usually sold at significantly lower price points after removing labels, tags and logos to retain the goodwill of the company. Often overlooked, this part of the textile industry caters to a huge section of domestic consumers.

Domestic post-consumer waste:

Domestic second hand clothing also serves a large domestic need. Evidence of imported second hand clothing can also be witnessed in some of the local marketplaces.

Although a large part of the second hand clothing is handed down to younger generations and domestic help within India, some of these also make their way to local markets and thrift stores. Markets like Raghbir Nagar in Delhi and K.R Market in Bengaluru are huge second hand clothing markets that sell around 81,064 and 51,575 pieces a day respectively.⁵⁹ With several godowns (warehouse) of retailers, these local markets sell all kinds of products including pants, shirts, jeans, t-shirts and tops, but the demand for sarees, dhotis and denim is higher. Since dhotis are made of 100% cotton, they are aggregated separately and sold. The collection of seasonal clothes like sweaters and blankets are primarily collected in Delhi, with smaller quantities in Bangalore. According to aggregators in Delhi, collection is at its highest during festivals like Diwali, Holi and other local festivals and lowest during winters.

Both secondary and primary sources suggest that imported second hand clothing is also sold in certain parts of Delhi, Bangalore and Mumbai. However, this was not a focus for the study and has not been studied in depth.

Doodlage: Reusing pre-consumer waste to make new garments

Although fast fashion had made clothing cheap and affordable, it left consumers unaware of the harmful impact to the environment. Textile waste is limited not only to clothing that is thrown away after several uses by consumers, but also by manufacturers that produce waste in a variety of processes.

Doodlage reuses pre-consumer waste and recycled post consumer waste to make new garments. Their own waste is also converted into accessories and packaging. With ethical production units, they are also finding ways to support the people associated with this industry. The waste comes in different shapes and sizes, but the artisans are skilled at putting these pieces together. Once the material is collected, it is checked for defects and collections are designed around various fabric issues and sizes of the panel sourced. Apparel for men and women might be the brands forte but one can find a variety of products from home furnishing to kids clothing made in similar material available on their website.

Using waste comes with its own set of challenges. Waste from factories is dumped by weight; estimating defects before buying the material is not an option, working with an unorganised supply chain is difficult and once the fabric is over so is the collection hence optimisation of each fabric is key. We work with common colours and prints that are available in quantity and use multiple fabrics to create an outfit to

make each collection last longer. Recycled fabrics made from post consumer waste are blended with virgin material, it has taken years to come up with a blend and quality of fabric that is suitable for making clothing for India where most of Doodlage customers are based in cities with warm climates. While their expertise lies in creating garments, they work closely with weavers to improve the quality of their recycled fabrics.

There is a demand for consciously made products as consumers become aware about the impact of fashion as long as the product is sold at a justified cost. More regulations, subsidies and loans for innovations in fashion can go a long way as a lot of the Indian population depend on the fashion industry from the farmer who grows cotton to the big production houses serving a global consumer. As climate change becomes more severe each year it is crucial to support alternate fashion businesses from reselling, renting, recycling, upcycling to organisations working with alternate materials.

Recycling Of Textile Waste

India is one of the leaders in mechanical recycling (recycling 1900 ktons of textile waste), with high efficiency in recycling cotton and cotton blends. Influenced by industry trends, chemical and high-grade mechanical recycling technologies are also emerging in the country.

The recycled yarn produced in India is often used to make new apparels and home furnishing products for the domestic market. Open-ended recycled yarns of 0s-30s Ne count are common in the industry, with very few recyclers working with ring-spun yarns. Since the recycled yarns cut down the price of the final product by 50%, a large share, 60-90% of recycled yarn is used within the country to make products like towels, bedsheets, apparel, for the domestic market. While the remaining 10-40% are exported, they are mostly positioned as a cheaper alternative rather than a sustainable one.

“

There is a high demand for cotton waste among recyclers, therefore, I buy and sell more cotton waste.

”

Waste trader selling RMG cutting waste in Amroha

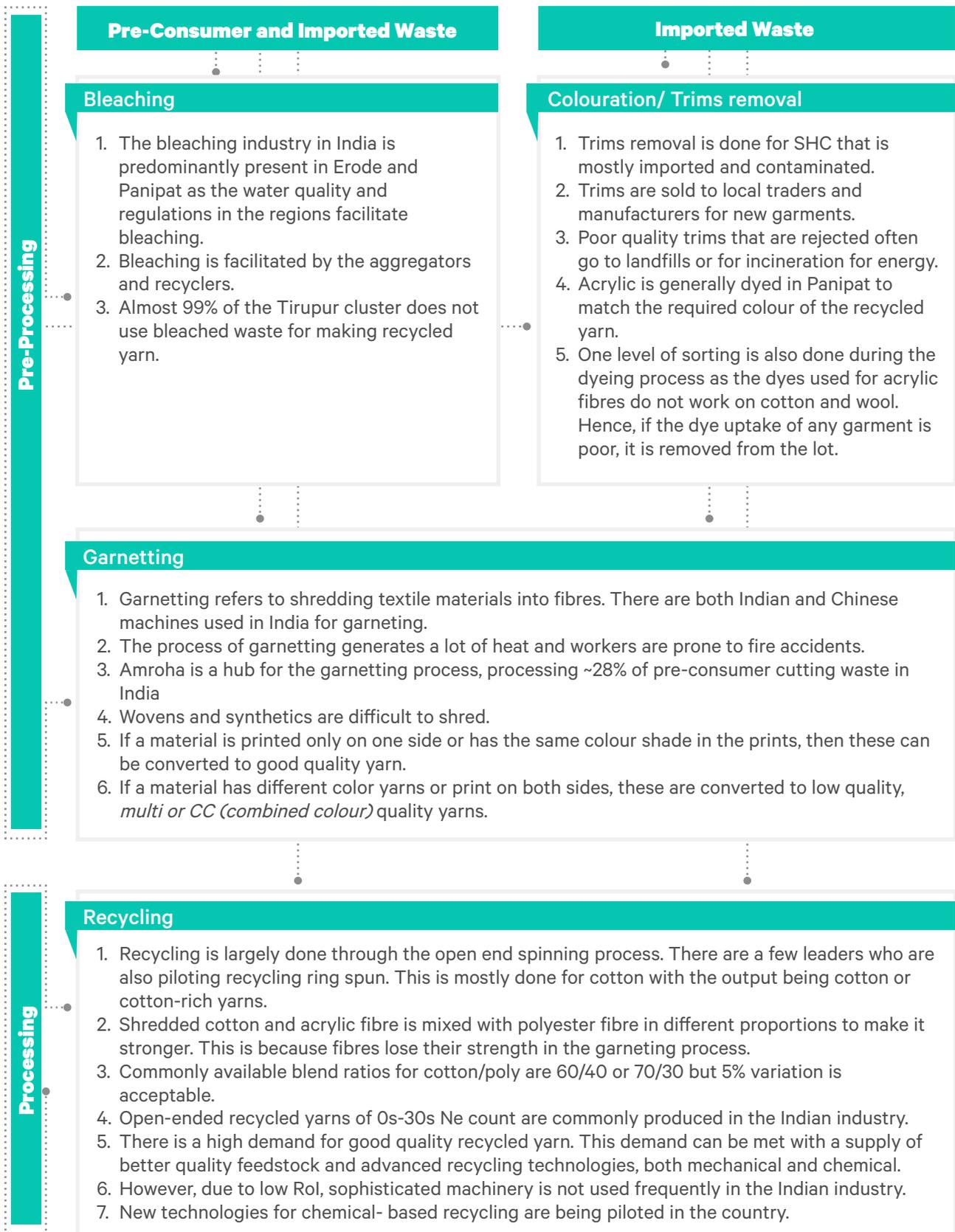


Illustration 27: Processes involved in recycling in India

Birla Cellulose: Building a chemical recycling technology

Mechanical recycling is a popularly sought after technique for recycling textile waste in India but it has its own limitations in terms of quality and further recyclability of the material.

Birla Cellulose has developed a chemical recycling technology for production of viscose fibre 'Liva Reviva' using pre-consumer cotton waste. Liva Reviva is a Recycled Claimed Standard (RCS) certified product that comprises up to 30% pre-consumer waste and the remaining wood pulp from sustainable forests. Products from Liva Reviva have been sold to more than 20 brands like H&M, adidas, Levi Strauss & Co, Walmart, Ikea and Inditex. They are piloting their technology with other materials and have signed a Letter of Intent with Sweden-based Renewcell for a long-term commercial collaboration for man-made cellulosic fibre production. The shared target is to use 30 ktons of Circulose® per year. However, Birla Cellulose is limited to using only white and pastel coloured pure cotton material for recycling. Furthermore, they are only accepting pre-consumer cotton waste as of now. In order to scale, they either need access to larger quantities of white coloured cotton waste or need to expand to accept more types of waste to ensure consistent feedstock.

Downcycling Of Textile Waste

Almost 19% of waste constituting synthetics and printed materials does not return back to the textile industry, but moves to other industries such as automobile, paper and pulp, steel, and pharmaceuticals.

“

Other low quality materials left (not fit for spinning) are sold at INR 10-15 (USD \$ 0.13-0.19) per kg for bedding purposes.

”

Small to medium scale recycler in Tirupur

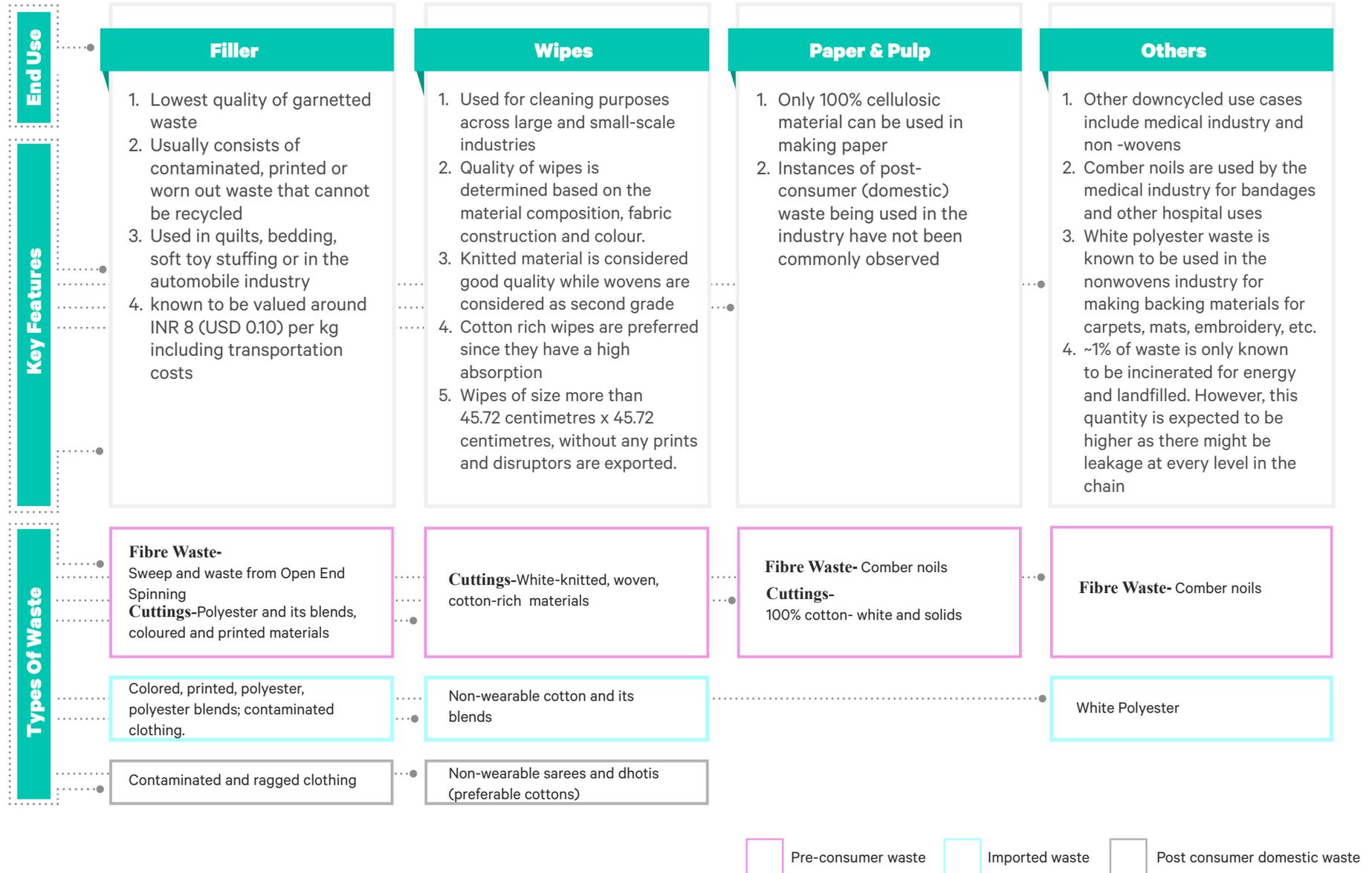


Illustration 28: Downcycling use cases of textile waste in non-textile industries in India

Key takeaways for end use of textile waste in India:

1. End-use of textile waste can be studied on a waste value framework to understand the waste realisation
2. India has an existing demand of pre-owned clothes and recycled products both in the niche, conscious citizens and the mass population who consider them a cheaper alternative to virgin materials.
3. India is one of the leaders in mechanical recycling, with high efficiency in recycling cotton and cotton blends. Influenced by industry trends, newer closed-loop technologies are also emerging in the country.
4. Despite the existing infrastructure, 50% of total waste is not being utilised to its best potential.
5. Blended and printed textile waste needs the highest focus as the current infrastructure and technologies are limited in their capabilities to process them.

PART 4

PERCEIVED HIERARCHY OF TEXTILE WASTE IN INDIA

Presents the first of its kind
waste value hierarchy for
Indian ecosystem

Perceived hierarchy of textile waste based on types, size, colour, material composition and condition

Using the EU waste hierarchy framework, this study has developed a first-of-its-kind textile waste value hierarchy for India that provides a consolidated view of how the ecosystem currently perceives the value of the different waste types

The hierarchy presents the current value of waste and identifies waste types to further valorise. However, the value of waste is dependent on its type, purity of feedstock, technologies that can revalorise it and demand for its recycled form. This hierarchy, though not exhaustive, acts as a toolkit for the ecosystem to understand waste types that require interventions to realise their full value potential.

The study has contextualised the European Environmental Agency's⁶⁰ end-use hierarchy framework to understand the valorisation and flow of textile waste in India.

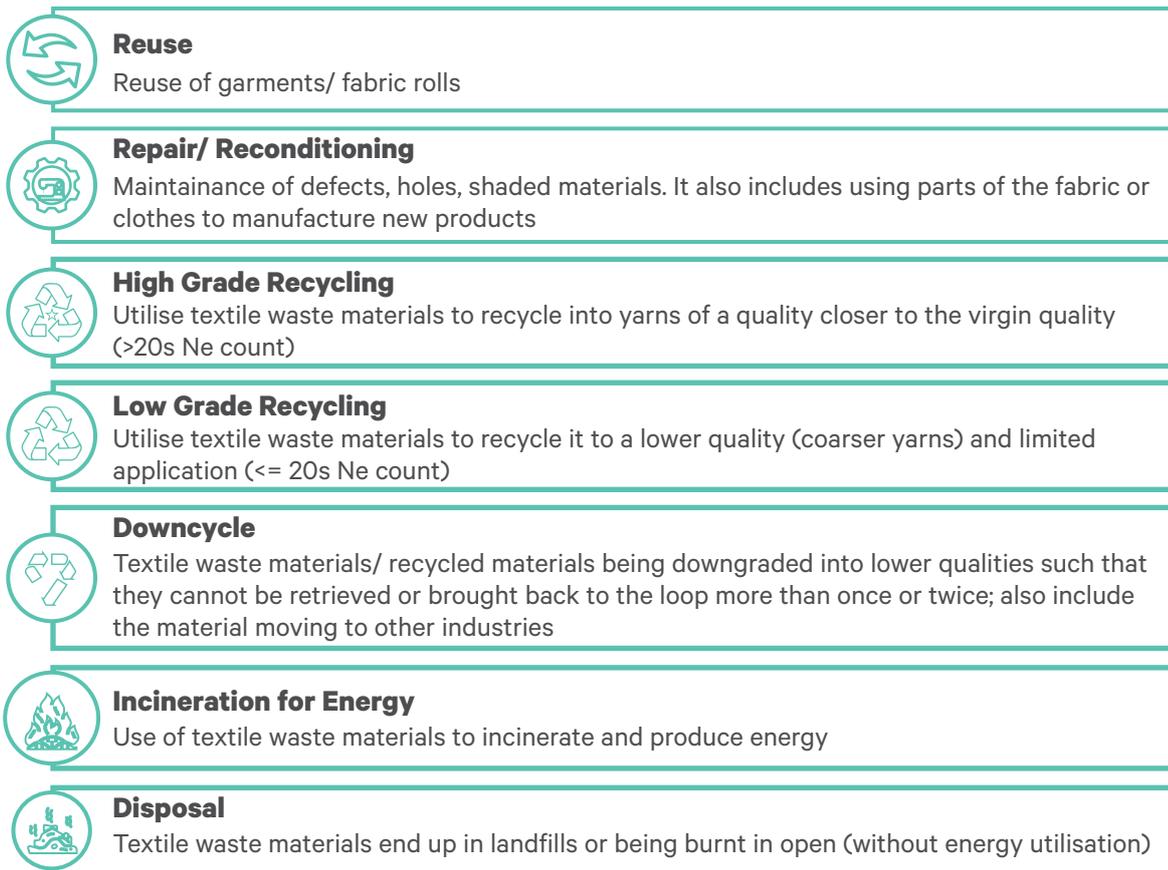


Illustration 29: Factors determining end use of imported waste

Developing the textile waste hierarchy framework:

One waste type can have multiple use cases and therefore the developed framework takes into account various parameters such as contamination, fabric construction, colours and prints, to define the accurate position of the waste type. Despite this, not all use cases of a waste type have been captured in this simplified version and our understanding of the ecosystem suggests that every material in the hierarchy can be used for a lower level application depending on market demand and conditions. Additionally, the cost of waste has not been used as a parameter to determine the value of waste since it was found to be varying in different locations and levels of the value chain. Moreover, the cost of textile waste was found to be significantly dependent on the prices of virgin material and hence, subject to high market volatility.

While textile and non-textile industries in India have been able to find use cases for most waste types, over 50% of total waste is not being realised to the highest value. In addition, the industry also values the same fabric composition from different waste streams differently. For example, a 100% white cotton fabric from a pre-consumer waste stream is considered more valuable than the same material from imported and domestic post-consumer waste streams. This difference emerges due to the different levels of contaminations across waste streams, pre-processing requirements and availability. The hierarchy is split between material types within each waste stream with high and low value realisation. The study further explored the opportunities and interventions that can help move low value materials to high value.

High Value Realisation

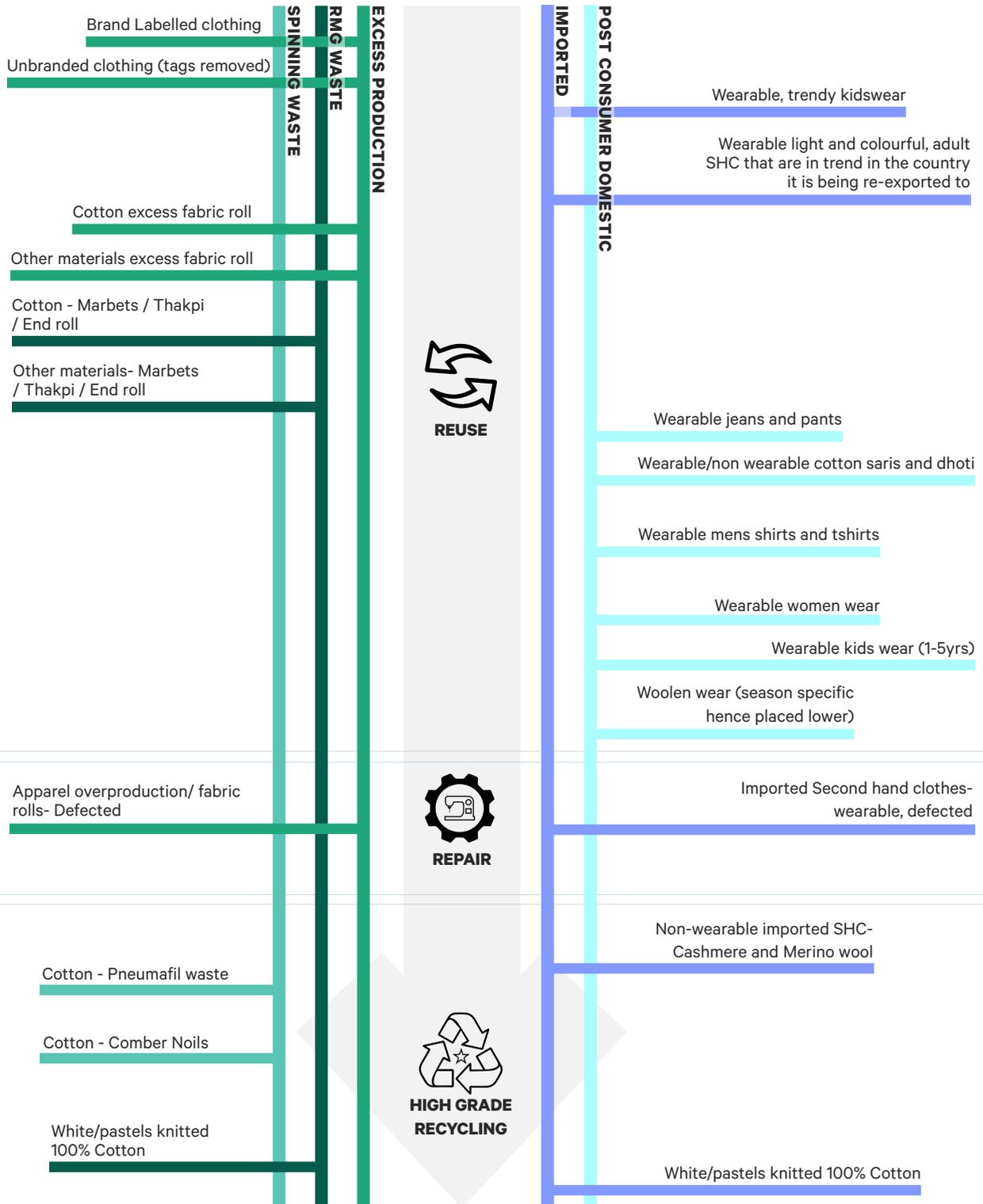


Illustration 30: Waste types which have a high value realisation

Less than 50% of the textile waste in India is being reused, repaired or undergoing high grade recycling. These materials include fabric deadstock, re-wearable clothing, apparel overproduction and white-knitted 100% cotton waste.

Adequate technologies and focus exists to realise the potential of these materials. However, the unorganised nature of the industry and limited traceability makes access to these waste types difficult. Moreover, new age recycling technologies and standards around segregation could further improve the potential of value realisation here.

Bank & Vogue: Giving new life to old clothes

Although consumers might be aware of the consequences of fast fashion, little is done to solve for this. While thrift shops have been existing for a long time, a systematic second-hand goods market has never been established at a global level.

Bank & Vogue works across multiple key areas of the second-hand clothing industry to make fashion circular. Their retail arm Beyond Retro, where customers can find hand-picked, one-of-a-kind second-hand items from all over the world, is the largest vintage retailer in the UK and Sweden. With 15 stores and an e-commerce site, the BV group of companies sells almost 30 million garments a month in 27 countries.

Bank & Vogue's innovation hub, BVH Services sorts millions of garments a month and gives them a second life through circular design, textile-to-textile recycling, component remanufacturing, and re-commerce. Bank & Vogue has evolved into a one-of-a-kind player in the global second-hand goods market, combining incredible knowledge and experience in wholesale, retail, design, and manufacturing segments. They also provide creative ideas and solutions to help deal with the overwhelming amount of "stuff" that we all consume.

Low Value Realisation With Significant Volumes

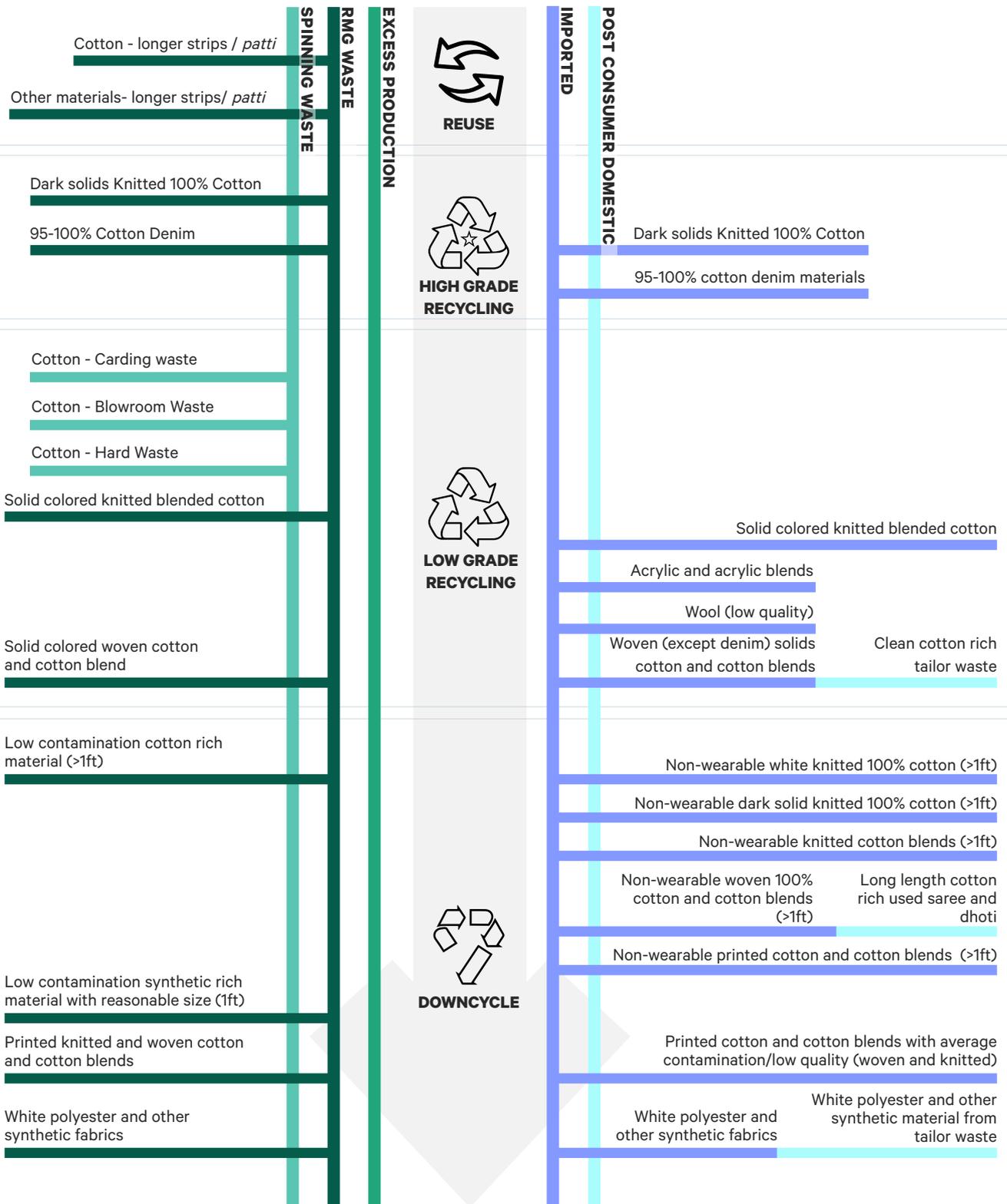


Illustration 31: Waste types which have a low value realisation and are present in significant volumes

Solid coloured cotton, MMCF blends and printed textiles form a significant volume of total waste generated in India and require a high industry focus to prevent value loss as the current recycling technologies are limited in their capabilities to process them.

The downcycled use cases for these materials renders it unfit for bringing it back into the textile industry. These waste types require extensive innovations and infrastructure development for segregation and recycling. Furthermore, it requires awareness building and incentivisation in the waste value chain to realise the need of sorting these materials efficiently and improving their recyclability. Even though there are advanced recycling technologies available for cotton and cotton blends, they are currently not scaled. Hence, most of these materials go through a low grade recycling or downcycling in India, which limits the reusability or recyclability of the material in the next cycle.

Jindal Woollen: Recycling imported acrylic waste

Jindal Woollens is one of the few recyclers in the country, recycling imported acrylic second hand clothing. They import second hand clothing acrylics and knits via Nhava Sheva and Tughlakabad/Patli port. They primarily work with acrylic materials only and hence the exporters do one level of sorting before shipping to ensure that the shipment contains around 85% of acrylic clothing.

Post receiving the shipment, the organisation sorts the waste into three different levels. The first level of sorting is on the basis of material and colours of the same family, the second level is only done for acrylic of the same colour, and the third level is based on the client's requirements. On an average, the workers here sort around 25,000 to 30,000 pieces of garments a day. The material may also go through a dyeing process to reach the exact colour required to the client. Post the dyeing process, the second hand clothing is cut into pieces while also removing the trims and seams.

After the sorting and trim removal stage, the acrylic waste goes for shredding, carding and is then spun into yarn. The recycled acrylic yarn is produced by blending acrylic wastes with same colour polyester fibres to achieve the finer quality and strength in many different shades. A yarn of 1.5-1.8Nm is produced through this recycling process and most of it is exported. There are only a few known players in the industry working with acrylic yarns. Geetanjali woollens and Texwool work with it through a similar mechanical recycling process while some parts of this waste also go for making acrylic based paints and adhesives.

Low Value Realisation With Low Volumes

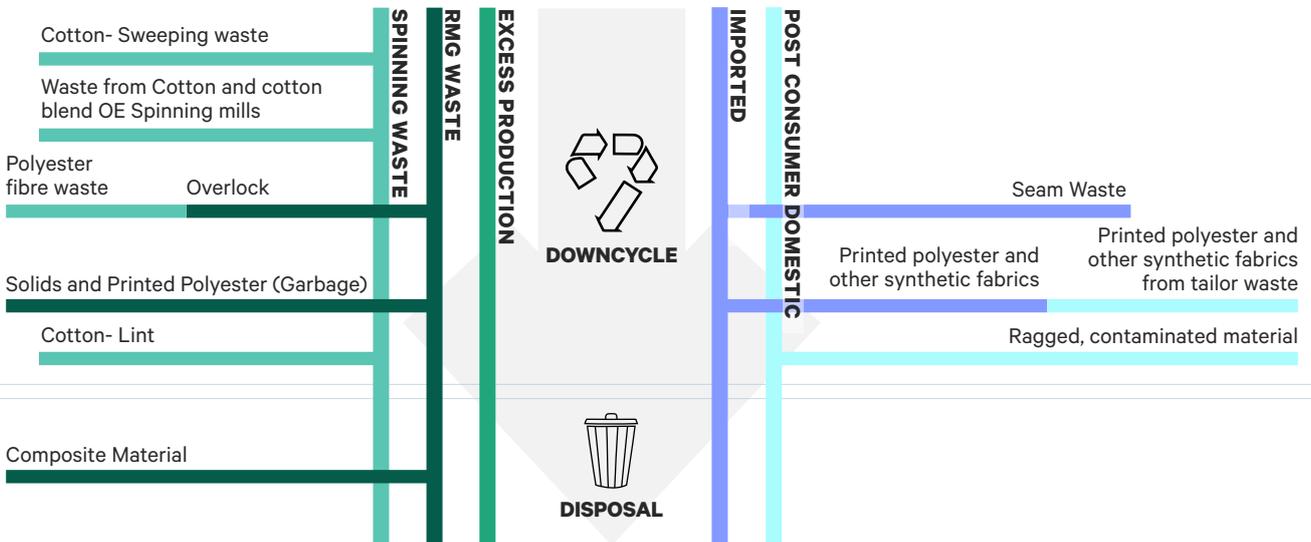
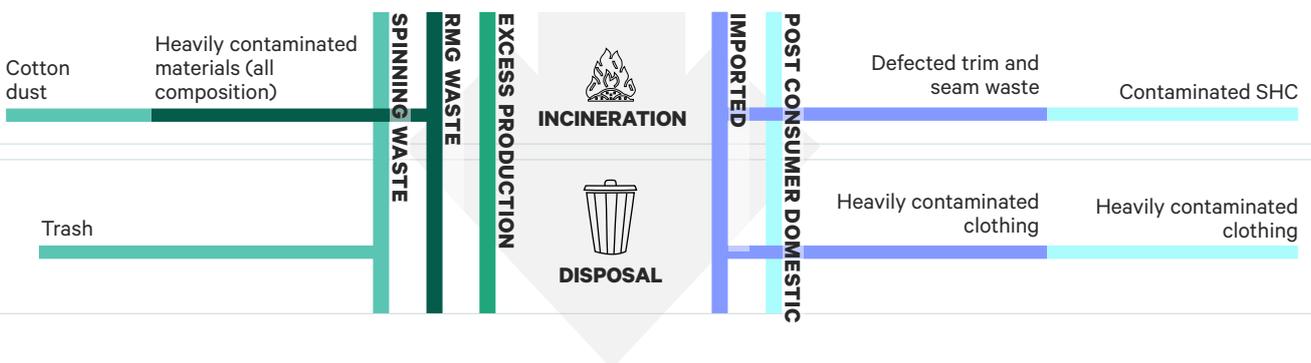


Illustration 32: Waste types which have a low value realisation and are present in small volumes

Certain spinning waste types and materials like printed synthetics have very little value being retrieved from their usage, however they hold a high potential.

Sweeping waste from the cotton spinning process and polyester fibre waste still retain the virgin quality of the material and can be brought back to the textile industry. Similarly, printed polyester materials are resource intensive during the manufacturing process, and quality of polyester varies extensively. A lot of these low quality synthetics have no solutions yet. Polyester waste types can be supported by de-colouration and chemical recycling technologies focused on synthetics, but only once these technologies scale.

Low Value Potential



Heavily contaminated and ragged materials which have reached the end of their life are difficult to retrieve as they end up being incinerated/ landfilled.

Even from a circularity perspective, one can work to reduce generation of waste at consumers’ end and manufacturer’s end to reduce waste going to landfills, or identify use cases to retrieve them back into textile value chains.

Moving waste up the hierarchy - anticipating the upcoming demand of recycling technologies

Why is it important to bring waste up to high realisation?

- 1. Industry Momentum and building pressure:** With the global textile industry moving towards decarbonisation, there is momentum in the industry to reach net-zero within the next three decades. To reach net-zero, however, the industry needs to reduce the use of virgin materials and avoid any waste leakages. The waste types that have potential in the textile industry must be circulated through reuse and later recycled. With the pressure on industry emissions building in western governments, coupled with brands making commitments to long term sustainability, India, as a primary sourcing region, is starting to feel the global momentum through the sourcing brands.
- 2. Advanced Recycling Technologies at the cusp of implementation need higher quality feedstock:** Most chemical recycling technologies that are able to recycle cotton or polyester or separate blends are in the nascent stage of development. As they develop large scale capacity, they will require large volumes and very high quality textile waste as feedstock. According to a recent report by Mckinsey, fibre-to-fibre recycling in Europe alone can increase to 26 million tons by 2030.⁶¹ This exponential growth in the global recycling industry would put pressure on the various production markets for textile waste feedstock as well as markets with high post-consumer waste. Mechanical recycling, on the other hand, has also seen an uptake in demand due to technology upgradation, increasing the need for traceable high quality feedstock. India already has large volumes of cotton, cotton rich (~4700 ktons) and polyester waste (~1400 ktons) that can be fed into the recycling technologies.
- 3. Demand for traceability as an enabler to scale:** Industry's momentum to reach net-zero requires visibility of the supply chain and traceability of materials and their composition. Moreover, the exponential growth of recycling technology will require uncontaminated waste and a system to acquire traceable waste. Building resilience in these systems, coupled with transparency will be required for a smoother transition.

How can we move waste up the hierarchy?

- 1. Generating less or better quality waste:** There's a need to anticipate potential waste at the design stage and design accordingly to minimise or make it reusable. This could be done by revamping the production process to reduce waste, but also perceive waste as a resource at production. In the case of domestic post-consumer, there's a need to recover waste directly from consumers rather than recover soiled waste from landfills
- 2. Investments into sorting and segregation technologies:** Efficient sorting and segregation can make low-value waste into high-value feedstock for recycling technologies by removing contamination and disruptors while validating the material composition.
- 3. Systems, infrastructure and regulations for waste:** Organising the unorganised market, incentivising visibility and access to waste will help retail high-value waste for high-value recycling. This will also help in retaining the fibre integrity, which may result in better materials that can be rotated in the supply chain.
- 4. Upgrade mechanical recycling facilities and enable chemical recycling:** A large segment of mechanical recyclers currently reduce the fibre length, strength and quality. Upgrading mechanical recycling can lead to higher quality fibres from waste. Additionally, investment in chemical recycling could open doors to large-scale processing of virgin grade materials.

5. Engaging business models, so that price is not a barrier for materials to circulate in a continuous loop: The price of textile waste is a significant barrier, and with additional services of sorting and segregation, the price can be unsustainable for building sustainable business models.

The next section, Part 5 of the report details out the key levers that will help move the waste up the hierarchy and resolve the anticipated challenges in the textile waste ecosystem.



The textile industry in India, a major contributor to the economy and around 5-6% of the GDP, has been dealing with large quantities of waste, of which 50% has been downscaled, put in landfills, or incinerated. The report visualises possibilities for circularity in textile waste along with opportunities for new jobs. Birla cellulose prioritises circularity and has set targets which can be achieved through regulation of large quantities of textile waste. This report provides a comprehensive overview on textile waste and the underlying opportunities for a circular economy.



Surya Valluri, Chief Sustainability Officer - Birla Cellulose

PART 5

BECOMING A CIRCULAR SOURCING REGION - KEY LEVERS

Summarises the challenges and opportunities to actualise the circularity potential of Indian textile waste

Valorising waste to full potential: bringing waste back into the textile supply chains

For a holistic transition from linear to circular economy, the industry needs to transform all stages of production to reduce waste generation and consumption of virgin materials, while valorising waste to its fullest potential. This transition should account for the well-being of all stakeholders across the value chain and their interests. Below we highlight the key circularity principles for the textile industry:

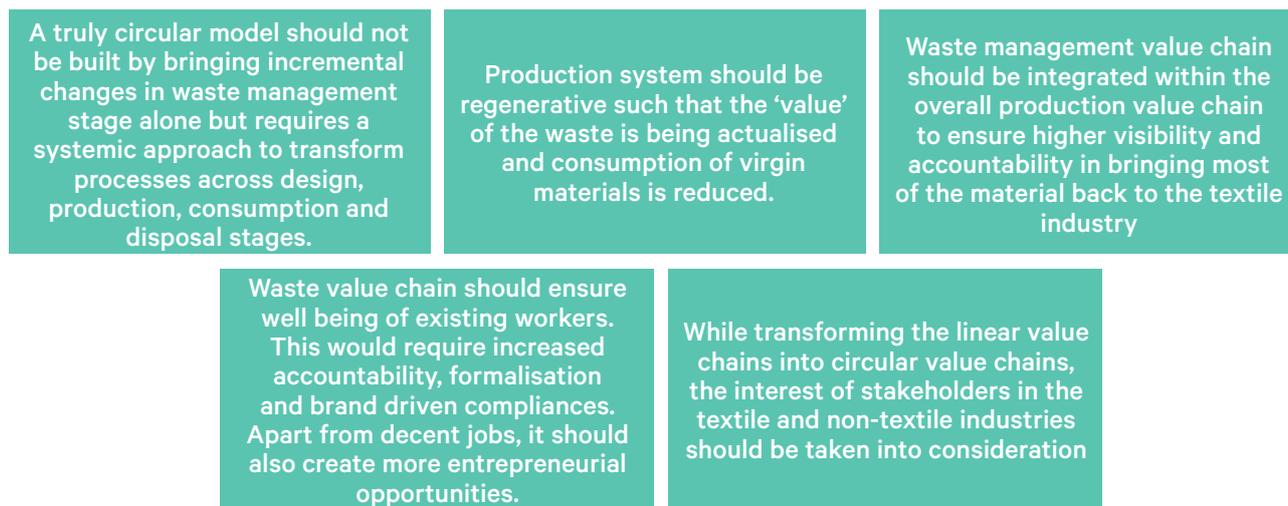


Illustration 33: Key principles for circularity in Textile Industry

India's history of cotton production and the culture of reusing, remaking and redesigning garments has enabled the trade routes for textile waste and the infrastructure to process it. As compared to other countries with similar textile consumption and production patterns, the existing infrastructure and expertise makes the country strategically positioned to become a circular sourcing region. This requires minimising low value use cases and valorising waste to its highest potential. Bringing the waste back into the textile supply chains will enable use in production processes and reduce dependency on virgin materials. This study highlights tremendous opportunity in India, as value chains and processing technologies already exist.

As discussed in the previous chapters, India is the best positioned to become circular as:

1. Huge quantities of waste (~7793 ktons) are generated through textile and apparel manufacturing and consumption and also imports waste, giving it unique edge over other regions
2. The textile waste processing value chain is well established for reuse, high to low grade recycling and downcycling
3. An informal but effective and well-integrated textile waste value chain, that also employs a large workforce
4. Recycling industry in India caters to primarily natural fibres (~60% of the waste), but also has huge uptick on synthetics and covers mostly all fibres in the market
5. New age technologies have an advantage to enter the market with proximity to the waste, spinning and manufacturing ecosystem
6. Its a cost effective market even with the increase in the cost of living

However, to realise the potential of textile waste in India, few bottlenecks need to be overcome. The study identifies four bottlenecks that the industry is currently facing and three pathways that could help it achieve circularity.

Bottlenecks To A Circular Indian Textile Industry

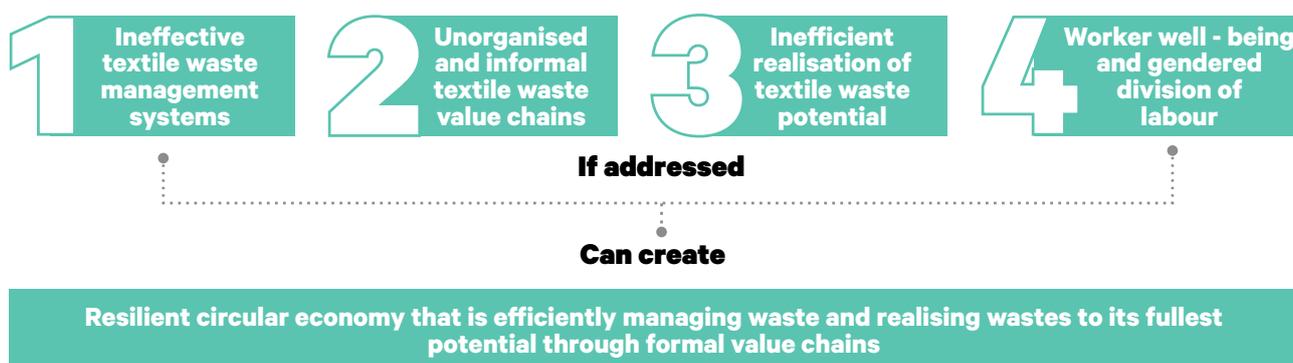


Illustration 34: Bottlenecks to a circular Indian textile industry

1 Ineffective textile waste management

Lack of standardisation and policies in terms of waste sorting and handling at every level of the value chain has led to ineffective waste management.

- 1. Lack of data reliability and visibility of the waste value chain:** Absence of segregation at source has built inconsistency and lack of visibility on waste flow. Most of the apparel manufacturers sell their cutting (RMG) waste as 'mixed waste' without sorting and the recycling industry depends on the collectors and sorters to sort this waste. Challenges with sorting 'mixed waste' exist at both manufacturers and collectors' end. While manufacturers do not have adequate space and resources to sort this waste, accuracy of sorting as per exact fabric compositions and/or colour becomes a challenge for sorters. A similar challenge is also faced in domestic post-consumer waste streams as most of the garments received either don't have a sorting material composition tag or the information mentioned is not accurate. In such cases, it is only the expertise of the sorters that can be used for sorting this waste. This manual process not only creates quality concerns in the recycling process but hinders the traceability of the waste. The recyclers buying the waste struggle with contamination in the waste and brands buying recycled yarns do not have reliable data and visibility on the raw material that went into recycling, which in some cases also lead to compliance issues.
- 2. High contamination rates of manually sorted materials:** The contamination rate of waste sold by manufacturers (pre-consumer waste stream) is 20%, which includes materials like needles, tea cups, sachets, harmful dyes etc, making it difficult, unsafe, and unhygienic for the sorters to handle. All these factors hinder the ability of ensuring textile waste reaches its next best use case and/or type of recycling.
- 3. Low economic realisation of fabric deadstock, in spite of high value potential:** Fabric deadstock is a highly valued waste type in the industry and is usually reused. However, full economic realisation

of this waste has not materialised in the Indian ecosystem. Unlike new fabric rolls, these discarded fabric rolls are usually sold by weight rather than by length, hence not providing adequate economic returns to the manufacturers.

4. Lack of standards to identify and sort waste across waste streams: While the textile waste materials travel long distances for sorting and processing to India, there are no standard processes for waste sorting. The unorganised sorting value chain mainly consists of temporary workers who have built their expertise in sorting manually through on-the-job training. Notwithstanding, chances of leakage and lack of accuracy with sorting occurs due to manual sorting processes and frequent change in workers.

5. Lack of regulations for domestic post-consumer waste: In India, textile waste forms the third-largest share of total municipal dry waste collected followed by plastic and paper waste.⁶² Despite this large quantity, there is a lack of specialised policies for domestic post-consumer textile waste and is currently governed by policies designed for dry waste. Contrary to the other components of dry waste, the value of textile waste depends on the contamination rate. The lack of segregated collection from consumer results in mixing and contamination of wearable clothing, rendering it unfit for both reuse and recycling purposes. This leads to loss of economic value, while amplifying consumer apathy due to lack of understanding of this waste. According to studies, up to 86% of the domestic post-consumer waste collected by municipal bodies can be reused or reconditioned if waste management policies and logistics are strengthened.

6. Rural areas are excluded from most of the waste management programmes of domestic post-consumer waste that are specifically designed for urban areas: Second hand clothing from domestic post-consumer waste streams is known to travel from urban areas to peri-urban and rural areas after they are not sold in urban areas. Online marketplace and programmes run by various government and non government organisations for recycling, reusing and waste management are mostly limited to urban areas. This, however, does not resolve the problem of domestic post-consumer waste management as a large amount of waste is generated in rural India as well.

Unorganised textile waste value chain

Unorganised and informal nature of the textile waste value chain limits the availability of waste data, leads to inefficiencies, leakage of waste, shadow supply chains and worker well-being concerns.

1. Presence of unorganised value chain for all waste streams is leading to leakages of waste in the system: As per the official data on imported waste in India, 400 ktons of mutilated rags was imported in 2020 out of which, 129ktons came from Bangladesh. Since the material imported from Bangladesh is usually cotton rich, its recyclability is expected to be high. However, the study estimates that only 150 ktons of this waste was dealt within India for recycling. This clearly indicates leakage of imported mutilated rags towards low quality uses/downcycling. This could be expected for waste generated in other waste streams as well. Due to lack of data, transparency and adequate training for the traders in the value chain, leakages are occurring. The downcycling end use of this waste, not only violates the principles of circularity, but also results in economic losses for stakeholders. This leakage is

mostly expected due to the unorganised nature of the value chain and lack of regulations/checks on processing of this waste.

2. Procurement challenges faced by recyclers which impact the potential to valorise textile waste suitably:

Presence of numerous middle men in the value chains add to the price point at every step of the supply chain, eventually making sourcing desired feedstock very expensive. This in-turn, leads to an increase in the price of high quality recycled yarns, making them expensive for the brands. Lack of background information attached to procured textile waste materials makes recycling expensive. Without background information attached to their feedstock, recyclers are at times forced to test every batch of textile waste for unwanted and banned chemicals after it is sourced. These expenses yet again add to the final price of the recycled output and make it challenging to be re-introduced into the stage of manufacturing finished garments.

3. Existence of major communication gaps between industry players in all waste streams:

Due to the geographical expanse of the country and largely unorganised nature of the industry, there is a communication gap between collectors, sorter/aggregators and recyclers of waste. A lot of the waste that can be used for high quality products (recycled yarns, reused for new products, etc) either lies unused or is sent for low quality use cases because the ideal use and demand of it is unknown to these traders/aggregators. This results in economic loss for the stakeholders as well as value loss of the material.

4. High transport costs and non-availability of transporters:

High transport charges or non-availability of transporters poses a challenge for collectors and aggregators to ensure smooth flow of waste.

5. Presence of shadow supply chains that are potentially leaking imported second-hand clothing into the Indian markets:

Secondary sources have indicated that a sizable share of the total imported waste is also known to be diverted illegally into the domestic market for repair and resale as second hand clothing in local markets. This quantity was difficult to estimate due to the multiple points of leakages across the value chain.



Inefficient realisation of textile waste potential

Limitations of the current recycling technologies and the changing material compositions of the textiles have led to inefficient realisation of waste value and therefore, economic losses to the recyclers.

1. Low quality of recycled yarn and mismatch in expectations between supply and demand:

Most recycling units in India are not able to produce high-quality recycled yarn to the technological limitations and hence receive low prices for their products and are mostly utilised in domestic market or home textiles. While there are advanced mechanical and chemical recycling technologies available globally, large investments required to build the infrastructure are not expected to lead to desirable returns in the short-term. Aside from this business case for chemical recycling technologies are yet to be established as they are still nascent and under development. A large risk appetite is required for India to take lead in adopting these.

Further, since quality is not a sole differentiator, the recycling industry is highly cost competitive which further dis-incentivises the recyclers from taking any risks as it may impact their cash flows. While a select few recyclers have found a way out of this situation, they maintain their approaches as trade secrets/patented technologies which prevents them from being scaled within the industry at-large. This situation was observed in all the three recycling hubs (Panipat, Tirupur and Amroha) of the country.

2. Increase in polyester and blends is rendering a lot of material unsuitable for recycling: With ever-changing fashion trends, there has been an increase in the consumption of polyester and blended materials and consequently an increase in the waste volumes of these compositions. Within pre-consumer waste, a visible amount of polyester waste is observed to be lying unused at aggregator's end or being incinerated in small soap units or brick kilns. Absence of fibre to fibre technologies for polyester and blended materials is resulting in economic losses for the importers, traders and aggregators, as there is no demand for this material.

3. Domestic post-consumer waste has low recyclability due to significant wear and tear: Though a high percentage of domestic post-consumer waste is getting reused in India, about 43% of it is being incinerated and landfilled due to lack of efficient management systems and utilisation mechanisms. Recyclers interviewed across the country mentioned that they do not prefer recycling domestic post-consumer waste since the quality of waste is not suited for mechanical recycling technologies. This is because the garments in domestic post-consumer waste streams are soiled, display significant wear and tear or made with fibres that may have lost their natural strength through multiple wear and wash cycles. If this material is put through a mechanical recycling process, there may not be enough fibre strength to spin the yarn. However, the incineration and landfilling of this material is leading to a negative environmental impact.



Worker well-being and gendered division of labour

Worker well-being concerns exist across the three waste streams, particularly on the aspects of gendered division of labour and waste processing infrastructure, low wages and lack of social security in jobs, lack of safe and secure working conditions.

1. Gendered Division Of Labour And Waste Processing Infrastructure: Most of the recycling and sorting set ups are owned and operated by men, while non-technical tasks are performed by women. The process of sorting textile waste during collection and recycling stages is where women and elderly are most employed. The recycling industry prefers hiring men as they require technical skills for operating the tearing, carding and spinning machines. In Ramachandrapuram/ Srirampuram market (Bangalore), men aged 18-65 own and run most of the shops selling fabric deadstock and export surplus garments. While very few women were observed running the shop, male members in their family were found to be the proprietor of the shops.

In Delhi, reselling of second hand clothing occurs in markets through community based collectors and sorters. Primary resellers at these markets are mostly women. In other locations such as Amroha, Tirupur, Ludhiana, and Ahmedabad, men are observed to own collection and sorting facilities and act

as traders between the sellers and buyers of textile waste while women are workers who sort waste. In DWCCs in Bangalore, out of five facilities surveyed, only two had more men than women whereas three had the same number of men and women.

2. Low wages and lack of social security in jobs: Due to the informal nature of the industry, most of the workers are hired temporarily, do not get fair, consistent wages and lack social security. COVID-19 and associated lockdowns have further exacerbated the living conditions of workers as it impacted the operations of sorting and recycling set-ups. The unorganised nature of this industry stifled with competition leads to low revenues and profits of business owners, which translates to lower wages for the workers. Most of these workers are hired on a contractual basis and do not have any social security coverage. None of the workers interviewed had access to health benefits, retirement benefits, and so on.

Further, some of them did not have formal savings accounts, while others were not aware of the government schemes intended to protect their welfare. Since this industry mostly employs women, the negative impact of lack of social security is much more prominent on them. The concern is even higher for certain communities involved in managing domestic post-consumer waste, for whom their occupation is also not well identified.

However, a contrary situation was observed in the Kandla SEZ, where workers are considered indispensable assets due to their knowledge and skills. Despite the losses that the importers faced during COVID-19, they were found ensuring that the workers are being adequately paid.

3. Lack of safe and secure working conditions: Most of the workers in the textile waste industry lack protective gear such as gloves or masks, making them prone to injuries and risk exposure to hazardous waste. During primary research, it was observed that workers in collection, sorting and recycling set-ups were not given protective gears such as gloves or masks. Further, in Amroha, sorting was performed within the recycling units without proper ventilation or lighting. The men and the women in the recycling unit were given the same number of breaks during their shift and employment, however, none of these units had sanitation facilities for women and men.

The mechanical recycling process adopted in India involves ginning and carding of the textile waste to convert it into the spinnable fibre. The fibrous dust coming out from the process is known to cause respiratory disorders such as asthma, difficulty in breathing and in some cases can lead to fatal lung diseases among the workers. The workers, however, do not have access to any protective gear and can be seen covering their noses and mouths using a cloth mask.

On the other hand, in Delhi, sorting facilities in slums and encroached areas lack basic provisions such as clean washrooms, drinking water, shelter to protect workers from rain and extreme heat, etc and are also prone to fire hazards. It is important to note that the women, especially widows, seldom engage in these activities in bad working conditions due to lack of alternate livelihoods. They suffer injuries due to broken needles, glass and other harmful materials mixed in with the waste. Similar conditions can also be seen in the waste picker colonies.

So what does India need to do to bring its textile waste back to the supply chain?

Building on the existing systems and infrastructure, three key levers are required to enable India to bring this waste back.

Enabling visibility and access to waste

- 1. Generating less or better quality waste:** Circular design principles need to be built in the product design stage itself. Manufacturers should think of waste as a resource at the stage of design and production and build innovative ways of reducing and reusing them internally. In the case of post-consumer, recovering waste directly from consumers might lead to an increase in reuse and reduce the waste moving to landfills.
- 2. Sorting and segregation of pre-consumer waste at factory floor:** Contamination of textile waste with non-textile materials needs to be avoided. This could in turn not only provide hygienic and safe waste for sorters to work with, but also avoid any deterioration in waste quality due to staining and soiling. A collaborative effort between manufacturers, recyclers and collectors/sorters, to build an efficient system with minimal disruptions is the way forward. There's a need for specifications by brands or manufacturers to provide non-textile waste bins at factory floors, and educate the factory workers on improved waste handling and textile sorting processes.
- 3. Sorting and segregation on post-consumer waste:** Post-consumer waste is challenging due to the disrupters and while they still need manual segregation, sorting technologies can make this process transparent and traceable. Sorting technologies seem to be the way forward to provide the accuracy on material composition required for high-end recycling. While the technologies for sorting are in the nascent stages and the accuracy and business models are still being established, industry testing is the way forward to improve these metrics. They have a potential to increase accuracy and reduce time put in by the workers, however, benefits of this additional cost still need to be validated. In the near-term, pilots of globally available technologies can be done and at scale implementation can be attempted if the results are positive.
- 4. Real time waste mapping and supply chain transparency:** Real-time digital platforms can improve communication between supply and demand stakeholders, while enabling maximum and right utilisation of waste. Though the challenge of lack of communication is most evident for pre-consumer waste streams, a customised digital platform that provides a detailed view of waste quality and its market demand can serve all the waste streams. Technology can also support importers in predicting the flow of imports/waste generation in exporting countries, and forecast demand from the recycling industry. Technologies such as Textile Genesis, Apparel Magic, ChainPoint⁶³ and others may help in mapping the waste throughout the value chain and track waste leaking out of the system, ensuring higher circularity in the industry. Alongside, it could help in mapping the stakeholders dealing with waste and provide adequate micro-level visibility to waste management on ground. Success of this technology is dependent on its adoption by all stakeholders in the industry making this a long-term solution as a significant amount of investments and capacity building towards it would be required.

Reverse Resources- Mapping, steering and tracing textile waste flows

Many new recycling technologies are emerging in the textile recycling market, which are increasing the capability of recycling and valorising complex fabric composition blends. These technologies are envisioned to be able to recycle at least 80% of textile waste within the next 10 years. However, recyclers face the challenge of securing access to the type of waste that precisely matches their technical specifications. The biggest obstacle in facilitating this need is the absence of transparent and predictable supply chains.

Established over eight years ago, Reverse Resources has been focusing on investigating market barriers and identifying best use cases of textile waste streams. In an effort to address the need of predictable and traceable supply chains, Reverse Resources has developed a Software-as-a-Service platform that offers digital tools to enable mapping, steering and tracing the movement of textile waste flows along the textile supply chain. Below is a snapshot of the data flow on the RR platform and how it facilitates multi stakeholder engagement and efficient supply chain management.

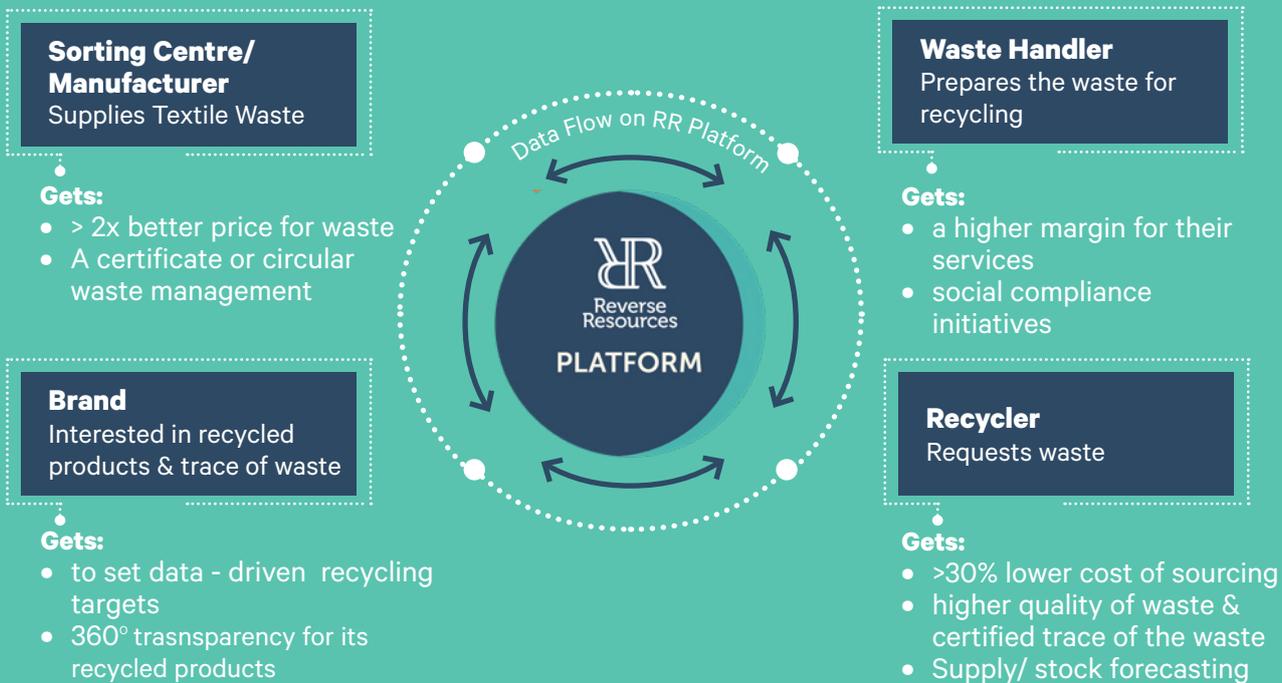


Illustration 35: Stakeholders Reverse Resources engaging with

The RR platform is expediting brands' (and their respective supply chains') transition to circularity. Fashion corporations like the H&M Group, the Kmart Group, Next and many more have invited their garment suppliers and domestic post-consumer waste collectors to segregate waste by its exact composition and make it available for direct sourcing by recyclers. The real time data and market insights offered by the RR platform facilitates textile-to-textile recycling and brings its latent globally scalable business opportunity to the foreground.

RR traction to date:



20
Waste data mapped from 20 countries



7
Global brands monitoring their waste flows



122
Factories sharing waste in real time



1300
Tonnes/ month of waste visible regularly



50,000
Tons/ month of waste in demand from recyclers

Harnessing recycling potential of India

- 1. Upgradation of existing mechanical recycling facilities:** Advanced mechanical recycling technologies exist globally and can yield higher quality of recycled yarns. Investments and brand buy-in are required to pilot and implement these technologies in India. Once these technologies are established and adequate return on investment is achieved, new recycling/waste processing hubs can be developed which would significantly lower the cost of transportation, resulting in economic benefits for all stakeholders. Government can play an active role in boosting these new economic zones.
- 2. Investments in innovative chemical and mechanical recycling technologies:** Dedicated technologies for other material compositions beyond cotton, such as polyester, spandex, acrylic and high quality wool needs the focus of the ecosystem in the mid-term while technologies that can accept newer variety of materials (bamboo, hemp, modal etc.) and blends of different proportions at different quality levels can be built over the long-term. These technologies can be either mechanical, chemical or a mix of both but cost efficiency and environment friendliness need to be ensured as key principles. Alongside, R&D on building further chemical recycling for materials that cannot be mechanically recycled should be the focus of the industry in the long-term. R&D, piloting and investments towards these technologies can be collaboratively supported by brands, innovation platforms, philanthropists and government bodies.
- 3. Re-evaluate and standardise minimum prices offered by brands and manufacturers for recycled yarns.** Along with the efforts involved in collecting, sorting, transporting and processing this waste, the textile waste market in India is also subject to volatile import and raw cotton prices. These efforts and volatilities need to be dynamically accounted for while fixing prices for the recycled yarn. Alongside, a share of unused waste also exists that is adding to the cost of the traders that needs to be accounted for. Incentivisation, setting a base minimum prices as well as long-term partnerships between the buyers of recycler yarns and recyclers, can result in economic uplift of recyclers, stabilised demand and supply.

Enviu – Partnering to collect, sort and rejuvenate textile waste in India

The interaction gap between domestic manufacturers and domestic recyclers leads to the loss of value of a high quantity of pre-consumer textile waste.

Enviu is running several programmes that look specifically at textile waste and address the gaps across the textile value chain. For pre-consumer waste through their sorting facility in India, textile waste from manufacturers is sourced and sorted. Various levels of sorting expertise are available starting from manual segregation to mechanised techniques to bring more value to waste. Enviu works with emerging and innovative technology partners and enables their entry into India to bring out the most optimal use of pre consumer textile waste.

One of the key success factors for Enviu has been their collaborative work. They form new partnerships with major industry players as they ideate, build, and validate market-driven, scalable solutions with partners, foundations, and investors.

Enviu's ventures in India under the Reweave Programme tackles different issues across the textile waste supply chain. The Reweave programme looks to bring value to 40 million kgs of waste and create upward of 200 jobs by 2024. They have also partnered with large domestic and international clothing brands, European and Indian apparel manufacturers, solution providers, the Indian and Dutch governments, and many others to bring value to waste.

Circular Fashion Partnership with GFA - Supporting circularity of textile waste in Bangladesh

The Circular Fashion Partnership is a cross-sectoral partnership to achieve a long-term, scalable transition to a circular fashion system. The project supports scaling domestic textile recycling in manufacturing countries by directing pre-consumer textile waste back into the production process in Bangladesh. Organised by Global Fashion Agenda, Reverse Resources and the Bangladesh Garment Manufacturers and Exporters Association (BGMEA), the project has many partners like Bestseller, Target, Usha Yarns, Primark, Fashion For Good, McKinsey, M&S and H&M Group.

For the cutting waste, manufacturers in Bangladesh work together with partner brands and Reverse Resources to sort waste cuttings within their facility and digitally trace it to recycling solutions. Manufacturers sell this contamination-free, high-value waste at a premium price through a streamlined handling process and recyclers benefit with consistent high-quality feedstock that results in improved recycled fibre outputs, which project participants circulate back into production. With work underway in Bangladesh since 2020, the Circular Fashion Partnership is currently working on project replication tailored to the local context in Vietnam and Cambodia and will be welcoming new participants.

Establishing systems, infrastructure and regulations for textile waste management

1. Formalise textile waste value chain, ensuring worker well-being and high value returns for all stakeholders

- Ensuring legal registrations (such as GST) for the waste collectors/sorters/ traders/aggregators and providing them incentives to be a part of the formal value chain.
- Providing adequate training support on sorting processes, safety measures, etc to the waste workers to build their capacities.
- Providing dedicated, hygienic infrastructure such as covered and ventilated sorting spaces, washrooms, drinking water, etc to the workers working in slum or encroached areas.
- Compliances with respect to fair wages, working conditions, social security measures such as pensions, insurance and standard working processes need to be built in.
- GRS certifications can be encouraged among the stakeholders as it ensures reliable information for recyclers and brands and also allows the waste traders to get premium prices for their waste.
- Building a centralised database with all waste collectors/sorters/traders/aggregators could also help in formalising the value chain.

Brands along with manufacturers and recyclers can support development of certain compliance and certifications for the waste traders. These compliances can be scaled by both manufacturers and recyclers by incentivising traders to adopt them. However, all such efforts need to keep the betterment of workers and waste management at the centre, by not levying additional costs for the small stakeholders in the value chain.

2. Material identification and sorting standards: In the long-term, the textile waste industry needs standards on identifying, sorting and handling textile waste, to comprehend their end-use easily, across the world. These could be similar to the standards set out for plastic waste that depict their level of recyclability. The standards can be developed taking into account the following principles: 1) Existing practices and knowledge of the collectors and sorters should be accounted for 2) Adequate capacity building of existing workers should be done to adapt them to new standards and ensure their presence in the value chain 3) Standards should be global in nature to ensure similar understanding among all domestic and global stakeholders 4) Standards will have to be inculcated in the manufacturing process as well

3. Extended Producer Responsibility (EPR) for textile waste: An Extended Producer Responsibility (EPR)⁶⁴ policy, similar to that of plastic packaging, could bring in economic incentives for all stakeholders in all waste streams as well as enable traceability and transparency. While the Indian informal ecosystem has been working towards maximising the utilisation of this waste, the changing consumption and disposal patterns require better tracking and accounting of this waste, while also ensuring the well-being of workers in the sector. France was the first country to adopt an EPR policy specifically for the textile industry in 2009.⁶⁵ The country has drafted and implemented a legal framework that requires producers to assume responsibility and cost of collection, treatment and recycling of their end-of-use products such as clothing, linen and shoes. The producers are mandated to do so either by 'financially contributing to an accredited Producer Responsibility Organisation (PRO), or by creating an individual take-back programme approved by French public authorities'.⁶⁶ If such a policy is implemented in India, it would lead to systematic collection of domestic post-consumer waste, prevent it from getting soiled through better segregation practices and increase the reusability and recyclability of the waste.

Consumer education on post-consumer waste collection: Consumers are an important part of the domestic post-consumer waste supply chain and hence building their awareness on the types of domestic post-consumer waste (wearable, non-wearable, discarded) and the appropriate channels for discarding each of them is needed. Additionally, upon design and implementation of policies on segregation, there is a need for large-scale awareness campaigns on the kind of bins and frequency of collection of this waste. Consumer Behaviour Change Campaigns (BCC) can also be undertaken to change consumption and disposal patterns such as swapping of clothes, thrift, rental, repair stores.

Saahas Zero Waste : Creating value out of domestic post-consumer textile waste in Bangalore

Textile Waste post-consumed currently has no viable solutions which leads to its contamination and being dumped in the landfills or incinerated. The NGO’s, Pheriwala or bartanwala are some of the stakeholders in the supply chain who collect such garments but not all collected are utilised. Predominantly, the fast fashion garments in unused and good condition are dumped, unused, contaminated or burnt. An ideal solution to this is setting up collection and centralised sorting mechanisms for domestic post-consumer textile waste.

Saahas Zero Waste (SZW) is one such organisation working towards managing municipal solid waste in India for nearly a decade. Specifically for textile waste, SZW organises collection across Bangalore through RWAs, residential complexes, commercial spaces like tech parks. They collect an average of 5 MT in 10-15 days.

In terms of their processes:

Awareness and communications are done 10 days before the collection drive. A live form is sent across various channels which enables anyone to register and raise collection requests. The data from request forms are analysed and the collection is scheduled using predefined algorithms. The collected material is sent to the SZW facility and weighed before it is sent for further processing.

The collected textile waste is sorted in Grade 1 to 5 depending on defined parameters including quality, condition and end use. During the sorting process, the data mapped and recorded in the internal data management system for further analysis.

The sorting of such material is time and labour intensive, however the process can be optimised by deep study and profiling of the waste materials and technology intervention.



Illustration 37: Collection and Centralised Sorting Mechanism of SZW for domestic post-consumer in Bangalore

SZW has also been actively engaging on aspects of social welfare of workers. In 2019, SZW first set out a social inclusion project. Since then SZW has been working with different partners to facilitate the transition of Informal Waste Worker to a formal waste ecosystem.

SZW has recently initiated a pilot with Circular Apparel Innovation Factory (CAIF) to test a micro-entrepreneurship led approach for local collection and sorting of pre-consumer textile waste. This pilot aims to establish traceable textile waste through a self-sustaining entrepreneurship model focusing on creating green jobs for waste workers which ensures environmental and social compliance.

Taking Action - How To Future Proof Our Businesses

This study calls for collaborative and systemic interventions to close the loop on textile waste in India.

This means ensuring high value realisation for 59% of waste already being utilised in textile value chains, and bringing a significant portion of waste from the remaining 41% that is being utilised in non-textile industries. The textile waste value hierarchy presented in this report can act as a starting point for the industry to look at the various types of waste available and reassess their utility to enhance value realisation. Additionally, the levers and recommendations mentioned in the study are a call-to-action to build a resilient circular economy that is efficiently managing waste and realising wastes to its fullest potential through formal value chains.

Below we briefly describe immediate actions that can be take by key stakeholders:

- ➔ **Brands** can educate their suppliers on the value of traceable textile waste and create demand for recycled materials to facilitate closing the loop within their supply chain operations. This requires adopting and investing in new technologies for tracing, sorting and recycling waste. Additionally, brands can initiate collection of post-consumers waste and create partnerships with sorters, recyclers, and suppliers to extract high value materials from this waste. Brands can also prepare guidelines to create circular products at the design stage itself.
- ➔ **Manufacturers** can build systems to sort the factory waste at source to avoid any contamination. By leveraging waste as a resource, it can be sold through organised supply chain platforms to credible recycling partners and potentially create buy-back agreements. Long-term offtake agreements are also needed in partnership with brands and recyclers.
- ➔ **Recyclers** can source the high quality waste to create a higher quality recycled output. The existing mechanical recyclers in the region can upgrade their machineries and get access to higher quality waste feedstock with support from tools like Reverse Resources. Chemical recyclers can experiment and advance their innovations to process materials with higher percentages of blends. The chemical recyclers can open their operations and plants near to the source of waste feedstock such as in the manufacturing hubs within India.
- ➔ **Traders/Sorters/Aggregators** can train their staff to segregate the waste efficiently using automated sorting technologies and digitally keep a track on the inventory.
- ➔ **Policy makers** can incentivise stakeholders involved in textile waste management practices by providing tax benefits and simultaneously discourage incineration practices. Policy makers can also create policies for producers to responsibly treat their textile waste such as extended producer responsibility in textiles, similar to plastics. Additionally, to collaboratively implement the solutions at a larger scale, a multi-stakeholder working group to discuss the challenges and opportunities can be made.
- ➔ **Catalyst funders** can build appetite within their funds and increase their investments in innovations related to tracing, sorting and recycling.
- ➔ **Consumers** can educate themselves and their family/friends about their disposable practices of the garments purchased. They can dispose of their garments to the collection centres at the brand stores or to NGOs like Goonj. Consumers can also educate themselves and their family/friends on their purchasing pattern to buy less but also long lasting clothing items made from recycled materials. More importantly, consumers have to normalise buying a second hand garment product, participate in swapping initiatives and repeat clothes from their own wardrobe.

ANNEXURE

Annexure 1: Glossary

Abbreviations

Abbreviations	Definitions
CI	Collective Impact
DWCC	Dry Waste Collection Centre
EPR	Extended Producer Responsibility
EU	European Union
FFG	Fashion For Good
GDP	Gross Domestic Product
GRS	Global Recycled Standard
HS Code	Harmonised Commodity Description and Coding System
ICD	Inland Container Depots
KASEZ	Kandla Special Economic Zone
MFA	Multi-Fibre Arrangement
MMCF	Man-Made Cellulosic Fibres
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
PPE	Personal Protective Equipment
PRO	Producer Responsibility Organisation
RCS	Recycled Claim Standard
RMG	Readymade Garments
RoI	Return on Investment
RR	Reverse Resources
SEZ	Special Economic Zone
SZW	Saahas Zero Waste
T&A	Textiles and Apparel
USA	The United States of America

Key Terms And Definitions

Term	Collective Impact
Blowroom Waste	Blowroom is an initial stage in the spinning process. The waste that comes out of this is called blowroom waste. ⁶⁷
Carding Waste	Waste that is generated in the carding stage of spinning is called carding waste.
Commercial all wool (CAW)	Comprises of woollen sweaters, scarves and knits clothing (second-hand or mutilated)
<i>Chindi/Katran</i>	A 'torn cloth' generated at the cutting table during the garmenting manufacturing process. 'Katran' also means scrap of cloth.
<i>Chindi Durries</i>	Rugs made by weaving 1ft long chindi on a handloom
Colour	The colour of an article is considered the solid or dominant colour. If it is not possible to define a singular dominant colour, the article is to be considered multicoloured. The dominant colour categories for the analysis will be predefined and added to the annex in this handbook.
Comber noils	Cotton Comber or Comber Noil is a by-product of the yarn spinning industry produced when cotton is combed to remove short fibres. ⁶⁸
Deadstock	Leftover, remnant, or scrap fabric which is either from the previous season or is a rejected roll of fabric [more than 10m]
Disruptors	A hard point that may be a disruptor to the recycling process present on an item of clothing (eg. fastener, button, zipper, etc.) which can be found in metal or plastic materials and can usually be the object of disassembling operations in preparation for recycling.
Downcycling	Reprocessing discarded textiles to create new consumer or industrial products, in a process that is usually mechanical (cutting, shredding, bonding). Discarded textiles are no longer in their original form, and new products do not re-enter the textile supply chain, resulting in a subsequent use that is of lower value than the original source of the material. ⁶⁹
Fancy	A bale with garments that have multiple colours, in addition to threads, checks, tweeds etc.
Fabric scrap/ cuttings	A 'torn cloth' generated at the cutting table during the garmenting manufacturing process. Fabric scrap/cuttings might be generated at sewing floor as well but in significantly low quantity as compared to cutting waste
Feedback Loop	A feedback loop is the part of a system in which some portion (or all) of the system's output is used as input for future operations. ⁷⁰
Fraction	Categories by which collected used textiles are sorted into for different reuse and recycling purposes, which are sold on different local and global markets. ⁷¹
Garbage	Refers to all garments that are of no use for a particular recycler. In general, polyester materials are referred to as 'garbage' in the industry.
Grade	Quality level by which collected used textiles are sorted, defined as grades, and sold both for reuse and recycling in different fractions (eg. Cream, A, B, C). ⁷²
High-Grade Recycling	Refers to the process where textile waste material are recycled into yarns of a closer quality to the virgin quality (> 20 Ne count)

Industrial Symbiosis	The use of one industry’s waste as another industry’s resource (very often via downcycling). It is important to note that it is different from textile-to-textile recycling and fibre-to-fibre recycling. A typical example is usage of textile waste in insulation panels manufacturing, automotive industry or cleaning textiles.
Low-Grade Recycling	Refers to the process where textile waste material are recycled into yarns of a lower quality (<= 20 Ne count)
Marbet	Bigger cut panels (usually a cutting of the neck piece of a t-shirt)
Mechanical fibre-to-fibre recycling	Mechanical recycling of cotton fibres to cotton fibres. In this process, typically textile cutting waste and yarns are torn and opened up into a fibre form ready to be re-spun again. Typically, this recycled fibre needs to be blended with a virgin fibre to achieve higher quality/strength
Mono-layer	Products that are made from one layer or type of textile ⁷³
Multi-layer	Products that are made from more than one distinct layer, each of which may be composed of different materials. There are two types of multi-material garments: <ul style="list-style-type: none"> • True multilayer = “Several main layers”. Refers to an article consisting of at least a second layer representing more than 1/3 of the surface of the article (eg. jacket lining) • Monolayer + others = “1 main layer and 1 or more auxiliary or minority layers”: article made up of a main layer with the presence of other minority layers representing less than 1/3 of the surface (eg. pocket bottom, badge, yoke, embroidery, lace)
Non-rewearable	Garments that cannot be reused in their original form and are made from one or multiple types or layers of textiles. This category is known as ‘material reuse’ among many textile collectors/sorters. ⁷⁴ This category is considered the ‘Black fraction’ in this study and includes: <ul style="list-style-type: none"> • Materials for recycling / garneting: Garment textile products which are meant to be shredded or garnetted (opening up the fabric into a fluffy, fibrous condition for reuse)⁷⁵, with a purpose of future use of these fibres for recycling into insulation, automotive, mattress filling, yarn or other. • Materials for wiping: Various rags (mainly cotton) used for cleaning machinery as well as for hand wiping.⁷⁶ • Fibres and materials destined to become refuse-derived fuel: Fibres and materials from garment textile products that are used to produce Refuse Derived Fuel (RDF) to ultimately produce energy and heat.⁷⁷ • Ultimate waste: Wet, damp, damaged garment textile products which are not fit to be sold in reuse or recycling markets.
Original Wool Rug (OWR)	Includes garments that have wool content and other fabrics. For example, coats, jackets and outerwear (second-hand or mutilated)
Original	A bale which contains both uni and fancy garments
<i>Patti</i>	Longer strips of fabric generated during the cutting stage of apparel manufacturing
Pre-consumer	Pre-consumer waste includes all post-industrial waste as well as any leftover/unsold materials or products such as fabric ends, unsold garments, etc.
Pneumafil	Pneumafil Cotton Waste is obtained during the process of yarn production. It consist of homogenous fibres, available in thickness ranging from 24-28mm ⁷⁸
Post-industrial	Any waste that gets generated as a by-product of industrial processes such as milling, spinning, printing and garmenting. This waste is a subset of the pre-consumer wast
Rags/Mutilated fabrics	Waste pieces of cloth which are either old, torn or in any other ragged condition. It can be interchangeably with mutilated clothes.
Regenerative blended recycling	Non-mechanical methods to convert blended fibres into separated outputs of cellulosic pulps, polyester fibres or pellets

Regenerative cellulosic recycling	Non-mechanical methods to convert cotton and cellulosic fibres into virgin-like cellulosic pulp
Regenerative synthetic recycling	Non-mechanical methods to convert used mono-synthetic like polyester and nylon fibres into virgin equivalent PET chips and fibre or nylon flakes
Rewearable	Garments that can be reused in their original form, for their original purpose. This category is known as 'product reuse' among many textile collectors/sorters. ⁷⁹ In this study, rewearables are represented by the 'White' and 'Grey' fractions
Shoddy/Mungo mills (England)	Shoddy is an inferior woollen yarn made by shredding scraps of woollen rags into fibres, grinding them and then mixing them with small amounts of new wool. Mills in Panipat working with wool waste are referred to as 'Shoddy Mills'.
Sweep Waste	It is a mixed waste generated in the cotton spinning process. It is ideally the waste that spills over during production and is later collected while cleaning.
Textile-to-textile recycling	In the context of this study, this encompasses all textile recycling processes where the output is used again in this specific sector, in similar applications for which it was first developed.
Thapki	Bigger cut panels and end rolls
Trims	A hard point that may be a disruptor to the recycling process present on an item of clothing (eg. fastener, button, zipper, etc.) which can be found in metal or plastic materials and are usually the object of disassembling operations in preparation for recycling. See list of relevant hardware in the annex of the Handbook for Sorters.
Uni	A bale that has single coloured garments
Yarn Waste	Residual yarns which are left on the cones after warping are considered wastages. ⁸⁰

Key Terms And Definitions

Units	Collective Impact
INR	Indian Rupee (1 INR= USD 0.000128)
Ktons	A unit of weight or capacity equal to 1,000 metric tons
mn	Million
Mtons	The Metric Ton is 1,000kg
Ne Count	The yarn count is a numerical expression which defines its fineness or coarseness
USD	US Dollar = INR 78.03 ⁸¹

Annexure 2: Table of roles and responsibilities carried out by stakeholders across all waste streams

Stakeholder	Roles and Responsibilities	Waste stream
Incinerator	Incinerators burn the soiled or unsorted waste for energy. This is usually when the textile waste has no commercial or industrial value. Incinerators could be the Waste to energy plants but in most cases in India, they are small-scale industries like brick kilns that burn textile waste for energy.	All waste streams
Shoddy mills	Usually found in Panipat, wool waste is usually dealt with by smaller recyclers or 'shoddy mills' as they are called in the industry.	All waste streams
Agents	Agents are middlemen that might exist between all nodes to ease the interaction. Presence of agents can specifically be found when the waste is moving to different cities. Critical role of agents is to ensure smooth information flow. They might not directly involve in material exchange but facilitate communications and transactions.	All waste streams
Aggregators	Aggregators serve as a bridge between collectors and recyclers. They can be the same or different from agents but their role is to ensure material aggregation and storage till the adequate demand of waste is found.	All waste streams
Bleacher	Bleachers discolour the textile waste so that they can be dyed into required colours. This activity could be facilitated by an aggregator in a few cases.	All waste streams
Reuser	Stakeholders who reuse generally procure fabrics locally and make garments that are sold back to the markets.	All waste streams
Downcyclers	Downcyclers usually take textile waste and convert them to wipes, rags, fillers or in the paper and pulp industry for further use.	All waste streams
Garnetter	Garneters shred the waste into fibres. They shred both yarn waste and fabric waste	All waste streams
Recycler	Recyclers convert textile waste into a yarn by mechanical or chemical process. In India, mostly mechanical recycling is observed, which is done through Open-end spinning process. Recyclers may or may not be engaged in garneting activities.	All waste streams
Manufacturers in India	Manufacturers in India generate textile waste in the different manufacturing stages. This includes spinning waste, fabric trimmings/cuttings, fabric deadstock and unsold garment inventory.	Pre-consumer
Waste collectors	Collectors collect textile waste directly from the manufacturers or factories. The small and medium sized collectors sort the waste according to one of the parameters (colour, size, material, etc) while the bigger ones sort it on all parameters depending on recycler needs. This activity could be facilitated by an aggregator in a few cases.	Pre-consumer
Willower	Willowers procure blow room waste from factories, traders or collectors and help separate the fibre and trash. This activity could be facilitated by an aggregator in a few cases.	Pre-consumer
Brokers	Brokers are middlemen who ease the transaction between the manufacturer and trader by transferring supply and demand information.	Pre-consumer

Stakeholder	Roles and Responsibilities	Waste stream
Importer	Importers import second hand clothing and mutilated rags from different countries. The importers working with second hand clothing have a sorting facility as well to sort wearables and non-wearables. For others, they might or might not have a sorting facility in house.	Imported
NGOs / Charities in other countries	Charities in other countries gather second-hand clothing either by door-to-door collection or through community bins in different locations. These clothes are then sorted, with a small amount going to the local reuse and thrift shops, whereas the remaining getting exported to India and other countries directly or via agents.	Imported
Manufacturers in other countries	Manufacturers from other countries generate textile waste in the different manufacturing stages and send this to India for recycling or downcycling.	Imported
Brands in other countries	Brands from other countries have take-back programmes where consumers can drop off old clothes for recovering and reprocessing.	Imported
Consumers in other countries	Consumers in other countries generate second hand clothing waste and donate it to charities there. This further gets transported to India for recycling.	Imported
Re-exporter	The re-exporter usually takes the second hand clothing, sorts it and sends it further to mostly third world countries. Re-exporters are the same as importers of second hand clothing. These second hand clothing are exported to agents or directly to retailers.	Imported
Indentors	Indentors are middlemen between the importers in India and exporters in other countries. Orders might be placed through indentors, depending upon the relationship shared by the importer and the exporter.	Imported
Exporters in other countries	Exporters can be agents or charities at the exporting country end. If they are an agent, they collect textile waste from charities or manufacturers in other countries and export it to countries like India.	Imported
Clearing agents	Clearing agents support the import process at Indian ports by ensuring that the right containers have been received and customs checks are carried out smoothly.	Imported
Informal waste collectors / <i>Bartanwalas/ Waghri Community</i>	This category includes the <i>Waghri, Kathiawad</i> and other similar collecting communities, commonly known as <i>Bartanwalas, Bhandivale</i> in local language. They serve as important links in bartering old clothes in exchange for utensils or money from households, and then selling the wearable clothes in local second hand markets.	Domestic post-consumer
Door-to-door waste collectors	Door-to-door waste collectors collect waste from households on behalf of municipal bodies. They collect all types of waste and textile waste is only a part of it. The collectors then aggregate the waste at designated centres like the Dhalaos/ transfer stations in Delhi and DWCCs (Dry Waste Collection Centres) in Bengaluru.	Domestic post-consumer
Waste workers / Rag pickers	The waste workers/rag pickers collect recyclable and reusable textiles from these transfer stations. The remaining non-recyclable materials are loaded and sent to landfills or incineration for energy recovery.	Domestic post-consumer

Part 5: Becoming A Circular Sourcing Region - Key Levers

NGOs / Charities in India	NGOs and charitable organisations like Goonj and Clothes Collection Box organise community collection drives to collect wearable clothing from households. These collections can be done door-to-door, in local community spaces or in institutions. They then facilitate the transfer of these clothes to the needy or affected in case of natural calamities.	Domestic post-consumer
Reseller	Resellers domestic second hand clothing from traders, aggregators or collectors and usually sell them in markets in the city or nearby suburbs and rural areas.	Domestic post-consumer
Traders	Traders are usually the middleman/woman between collectors and retailers of domestic second hand clothing. They usually sort, clean and mend the clothes for further selling.	Domestic post-consumer
Second Hand Clothing Retailers	These are the final stakeholder in the value chain for sale of domestic second hand clothing. The retailers sell the second hand clothing in flea markets such as <i>chor bazaar</i> (Mumbai) and Janpath, Cannaught place, Sarojani Nagar, Lajpat Nagar, Shankar Market (Jamunapaar) in Delhi.	Domestic post-consumer

Annexure 3: Detailed flow of domestic post-consumer waste across Delhi and Bangalore

Delhi:

DELHI VALUE CHAIN MAPPING

- Landfill
- Aggregator
- NGO | Collection center
- SHC Market
- Upcyclers/Brands
- Recyclers/Downcycler
- Waste worker | Informal collection center
- Waste collection all over NCR
- ↪ SHC to markets
- ↪ SHC to aggregators

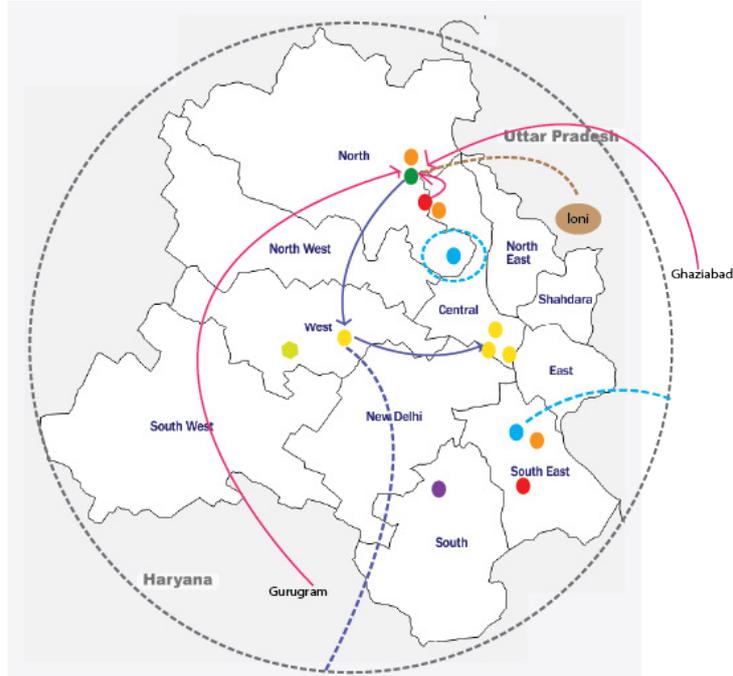


Illustration 38: Flow of domestic post-consumer waste in Delhi

Bangalore:

BANGALORE MAPPING

- Landfill
- Aggregators
- NGO | Collection center
- SHC Market
- Upcyclers/Brands
- Waste worker | Informal collection center
- Waste collection study
- ↪ SHC to markets
- ↪ SHC to aggregators
- | collection - PCD

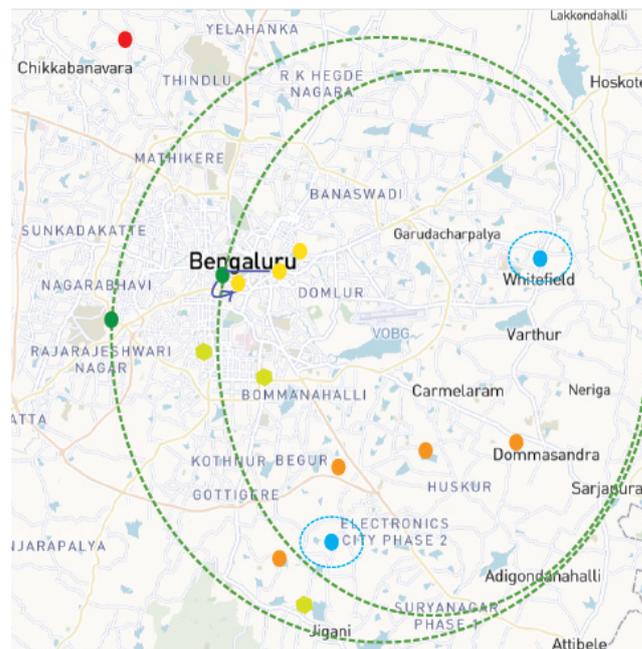


Illustration 39: Flow of domestic post-consumer waste in Bangalore

Annexure 4: Waste study done by Saahas Zero Waste team

Waste study done by SZW

Saahas Zero Waste (SZW), an environmental enterprise working in waste management, resource recovery and social impact, conducted an in-depth analysis of garments collected from Residential Welfare Associations at an SZW facility, and Banashankari ward in Bangalore. The collected garments were sorted by two female staff (employed by SZW) based on type, colour, style, condition and composition. 14% of the garments were collected from Banashankari ward and 86% were collected from RWAs were aggregated and sorted at SZW material recovery facility in Bangalore. To understand the composition of the garments, the field staff sorted the garments based on material tags attached to the garments.

The findings indicated that out of the 7999 total garments collected, the majority of the garments were wearable or fit for selling and donation purposes. Only a small percentage of 1% to 2% of the clothes were not wearable.

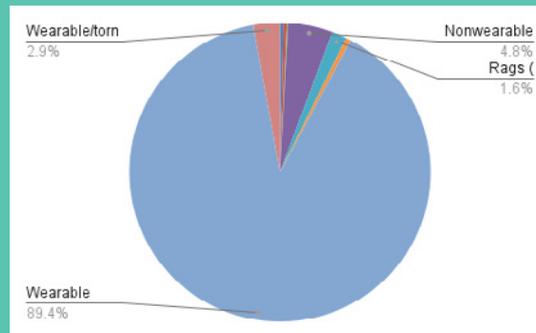


Illustration 40: Composition of post-consumer waste collected from households in Bangalore

The garments included t-shirts, pants, wollens such as sweaters, shawls, baby clothes, undergarments and even waterproof rainwear. Dhotis and home textiles such as curtains, bedsheets and towels were also a part of the sorted waste. The top three garments were T-shirts which constituted 22%, followed by full pants (17%) and Tops (16%).

60% of the garments were woven and 40% of the garments were knitted. A small number of garments were a mix of woven/knitted and non woven (felt/fused). 73% of the garments had disruptors. The majority of the garments had plastic buttons, beads, thread, elastic (28.6%) followed by garments having two disruptors (13.2%). 11% garments also had printed logos/brand names on them.

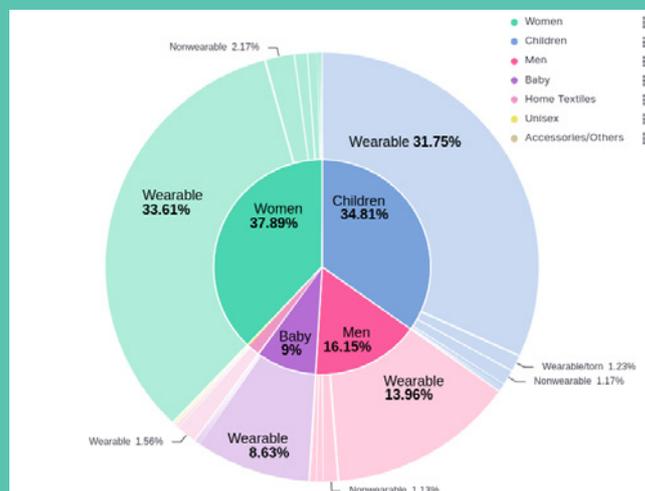


Illustration 41: Composition of post-consumer waste collected from households in Bangalore (by consumer category)

Annexure 5: Research Methodology

Research Aims And Objectives

This study is the first in-depth attempt to understand the current textile waste material flow in India. Moreover, the report aims to identify technologies that can assist in mapping and sorting of waste to address the challenges in India, and then pilot the solutions to prove the efficacy of the technologies identified. The objective of the study is to build a roadmap for the implementation of these solutions along with brands, manufacturers, recyclers and other stakeholders of the industry. The study was undertaken keeping the three waste streams - pre-consumer, imported and domestic post-consumer in mind.

Team and Roles



Project
Orchestrators



Study Co - Lead
(Pre - Consumer)



Study Lead
(Post -Consumer
Domestic)



Study Coordinators
Lead (Post -Consumer
Imported)
Co - Lead (Pre - Consumer)

The project was initiated by Fashion For Good, a global platform for innovation. FFG unites the entire fashion ecosystem, from brands, manufacturers and suppliers, to consumers, to collaborate and drive the change towards a circular industry. In this project, FFG served as an orchestrator and convener for all relevant stakeholders, while also producing communication output.

Sattva Consulting co-led the pre-consumer Waste Stream and led the imported waste streams. Sattva is an organisation driven by the mission to end poverty in our lifetime. Our work focuses on scalable solutions for sustainable social impact. They were responsible for the project coordination and consolidated analysis and reports from all workstreams and drafted the final report.

Saahas Zero Waste, a social enterprise, led the domestic post-consumer waste stream, capturing Bangalore and Delhi. They provide end-to-end waste management services and bring about environmental and social impact based on the principles of circular economy and global commitment to Sustainable Development Goals (SDG).

Reverse Resources co-led the pre-consumer, rolled out surveys and analysed data for the report. They are the innovators for the pre-consumer workstream of the project and will be working with FFG to conduct the pilot.

Research Methodologies



Sattva's team conducted both primary and secondary research to understand the quantum and categories of waste. For the pre-consumer and imported waste streams, in-depth interviews were conducted with 120+ stakeholders in the value chain including traders and recyclers. The data was collected from several cities in the country including Ahmedabad, Amroha, Amritsar, Bangalore, Coimbatore, Delhi/NCR, Gandhidham, Kandla SEZ, Ludhiana, Mumbai, Panipat, Surat, Trirupur. A total of 12 upcyclers, 46 recyclers, 62 collectors, sorters and handlers, 12 textile manufacturers, 11 waste importers and 2 brands across all cities were interviewed for the research. For expert consultations, 8 distinguished personalities from the sector were consulted.

In order to gather secondary data for imported waste streams, the UN Comtrade Database for the year 2020 was used to analyse the quantum of waste imported to the country from various parts of the world.

Saahas Zero Waste's survey team conducted desk based secondary research and reviewed existing secondary data available in the public domain such as research papers, government reports and studies, relevant laws, policies and guidelines applicable on a national and relevant state and city level, reports or scoping undertaken by credible agencies among others including data available with FFG relating to post consumer textile waste. They then identified the relevant stakeholders, conducted consumer disposal surveys and in-depth interviews along with site visits to understand the segregation levels, collection and transportation systems including primary collection from different waste generators and secondary transfer, processing and final disposal of textile waste, market linkages for end products for textile waste management systems. The data sets were reviewed and consolidated for the analysis phase.

In order to understand consumer disposal behaviour, a consumer survey of 570 consumers majorly from Delhi and Bangalore was done. Additionally, the Saahas Zero Waste team also conducted an in-depth analysis of 7999 garments collected from Residential Welfare Associations at a Saahas Zero Waste (SZW) facility, and Banashankari ward in Bangalore.

Reverse Resources used primary and secondary data to analyse the quantum and categories of pre-consumer textile waste in India. The quantitative data was collected from a sample of factories that received a link to the RR Platform from the Sattva team. The data was accumulated in the RR database and analysed accordingly. In addition to this the RR team used existing industry data and expertise to complete the data analysis and make sure it is within industry standards (as a means to compensate for the small sample size). Subsequently a data model was built covering main aspects of the Indian textile and garment industry (fibre composition usage, knit-woven industry split, waste/material ratios, et al.)

In order to understand the volume of textile material (fibre, yarn, fabric) being produced, imported, and transformed in the country RR used the UN Comtrade Database. From this database, the 2019 data was considered since it was the last full year of trading which was not affected by the Covid pandemic.

Waste/material ratios derived from the data model are then used with the secondary data to estimate the volumes of waste generated at each production process. All volumes and final estimates are represented on the Sankey diagram which displays yearly Ktons of material based on 2019 data.

Endnotes

1. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
2. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
3. www.fibre2fashion.com. (n.d.). Fibre2Fashion. Retrieved June 8, 2022, from <https://www.fibre2fashion.com/news/apparel-news>
4. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
5. Cotton Sector. Ministry of Textiles, Gol. Retrieved June 27, 2022, from <http://www.texmin.nic.in/sites/default/files/Cotton%20Sector.pdf>
6. * Industry level recycling certifications like Global Recycled Standards (GRS) and Recycled Claim Standards (RCS) don't consider spinning waste and other reusable materials as waste but for the purpose of this study, all the by-products of textile production and consumption have been called out as waste since its usability is also defined by the waste collection mechanism.
7. Primary analysis
8. Kaya Dory. Why fast fashion needs to slow down. UNEP. (27 JUN 2018). Retrieved July 19, 2022, from <https://www.unep.org/news-and-stories/blogpost/why-fast-fashion-needs-slow-down>
9. Refer to illustration 30 on page 53 for the waste hierarchy
10. The hierarchy has not been defined based on monetary value of the waste as significant variation in the same was observed in different locations and levels of the value chain.
11. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
12. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
13. ibid
14. Cotton Sector. Ministry of Textiles, Gol. Retrieved June 27, 2022, from <http://www.texmin.nic.in/sites/default/files/Cotton%20Sector.pdf>
15. R. GURUPRASAD and S. K. CHATTOPADHYAY. Indian Cotton and the Needs of Spinning Industry. Indian Society for Cotton Improvement (8 March 2014). Retrieved in June 2022, from https://www.cicr.org.in/isici/5-2/Paper_2.pd
16. Textile Industry & Market Growth in India. IBEF. Retrieved June, 2022 from <https://www.ibef.org/industry/textiles>
17. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
18. Textile Industry in India - Garment & Apparels Market in India. (n.d.). Retrieved June 8, 2022, from <https://www.investindia.gov.in/sector/textiles-apparel#:~:text=The%20domestic%20apparel%20%26%20textile%20industry.of%20the%20country%27s%20export%20earnings>
19. State of Fashion 2022: An uneven recovery and new frontiers. McKinsey & Company (December 1, 2021). Retrieved July 19, 2022, from <https://www.mckinsey.com/industries/retail/our-insights/state-of-fashion>
20. Shah, P. Circular fashion: Rethinking the way forward for India's fashion industry. WRI INDIA ((2019, December 5).. Retrieved July 19, 2022, from <https://wri-india.org/blog/circular-fashion-rethinking-way-forward-india%E2%80%99s-fashion-industry>
21. Nathalie Remy, Eveline Speelman, and Steven Swartz. Style that's sustainable: A new fast-fashion formula. McKinsey Sustainability (October 20, 2016). Retrieved June 8, 2022, from <https://www.mckinsey.com/business-functions/sustainability/our-insights/style-thats-sustainable-a-new-fast-fashion-formula>
22. N Bairagi. Recycling of textiles in India - open access journals. (n.d.). Journal of Textile Science & Engineering. Retrieved June 8, 2022, from <https://www.hilarispublisher.com/open-access/recycling-of-textiles-in-india-2165-8064.S2-003.pdf>
23. The story of Asia's biggest textile recycling hub. Dwij (Apr 8, 2021). Retrieved June 8, 2022, from <https://www.dwijproducts.com/post/the-story-of-asia-s-biggest-textile-recycling-hub>
24. Primary analysis
25. Primary analysis
26. Primary analysis
27. Primary analysis
28. The Indian Textile Engineering Industry. Textile News, Apparel News, Fashion News. Retrieved June 8, 2022, from <https://textilevaluechain.in/in-depth-analysis/articles/textile-articles/the-indian-textile-engineering-industry/>
29. The story of Asia's biggest textile recycling hub. Dwij (Apr 8, 2021). Retrieved June 8, 2022, from <https://www.dwijproducts.com/post/the-story-of-asia-s-biggest-textile-recycling-hub>
30. Reserve Bank of India - RBI Bulletin. (n.d.). Retrieved June 8, 2022, from https://rbi.org.in/scripts/BS_ViewBulletin.aspx/
31. EU strategy for sustainable and circular textiles. European Commission. Retrieved June 8, 2022, from https://ec.europa.eu/environment/strategy/textiles-strategy_en

Part 5: Becoming A Circular Sourcing Region - Key Levers

32. Textile EPR: Recycling laws for fashion e-commerce across Europe. Retrieved June 8, 2022, from <https://ecommercegermany.com/blog/textile-epr-recycling-laws-for-fashion-e-commerce-across-europe>
33. Primary analysis
34. How is a circular economy different from a linear economy? Retrieved June 8, 2022, from <https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/how-is-a-circular-economy-different-from-a-linear-economy/>
35. BBC. (n.d.). Why clothes are so hard to recycle. BBC Future. Retrieved June 8, 2022, from <https://www.bbc.com/future/article/20200710-why-clothes-are-so-hard-to-recycle>
36. ibid
37. Textile Exchange. (n.d.). Retrieved July 19, 2022, from https://textileexchange.org/wp-content/uploads/2020/06/Textile-Exchange_Preferred-Fiber-Material-Market-Report_2020.pdf
38. A New Textiles Economy: Redesigning fashion's future. Ellen McArthur Foundation. Retrieved July 19, 2022, from <https://ellenmacarthurfoundation.org/a-new-textiles-economy>
39. Pulse of the fashion industry 2017. Common Objective. (2018, April 5). Retrieved June 8, 2022, from <https://www.commonobjective.co/article/pulse-of-the-fashion-industry-2017>
40. A New Textiles Economy: Redesigning fashion's future. Ellen McArthur Foundation. Retrieved July 19, 2022, from <https://ellenmacarthurfoundation.org/a-new-textiles-economy>
41. Business Standard (February 8, 2016) Retrieved in June, 2022 from https://www.business-standard.com/article/pti-stories/open-end-yarn-mills-in-tirupur-coimbatore-stop-production-116020800478_1.html
42. Apparel Resources News Desk. Experts explain why India has all reasons to become a recycling hub. Apparel Resources (08-March-2022). Retrieved July 19, 2022, from <https://in.apparelresources.com/business-news/sustainability/experts-explain-india-reasons-become-recycling-hub/>
43. Textile Exchange Guide to Recycled Inputs. Textile Exchange (September 22, 2021). Retrieved July 19, 2022, from <https://textileexchange.org/documents/textile-exchange-guide-to-recycled-inputs/>
44. KASEZ-Working-Unit-List-2018-19.pdf - Kasez Working Unit List 2018-2019. Course Hero. (n.d.). Retrieved July 19, 2022, from <https://www.coursehero.com/file/89248524/KASEZ-Working-Unit-List-2018-19pdf/>
45. Indian textile industry - an overview - free industry articles. Fibre2Fashion. Retrieved June 14, 2022, from <https://www.fibre2fashion.com/industry-article/2363/indian-textile-industry-an-overview>
46. Synthetic textiles industry in India and opportunities ahead. Wazir. (16th November, 2018). Retrieved June 14, 2022, from <https://wazir.in/synthetic-textiles-industry-in-india-and-opportunities-ahead>
47. Polyester. CFDA. Retrieved June 10, 2022, from <https://cfda.com/resources/materials/detail/polyester>
48. Preferred Fiber & Materials - Market Report 2021. Textile Exchange. Retrieved in June, 2022 from https://textileexchange.org/wp-content/uploads/2021/08/Textile-Exchange_Preferred-Fiber-and-Materials-Market-Report_2021.pdf
49. James Pruden. Preference for polyester may make fast fashion brands vulnerable. The Robin Report (November 27, 2017). Retrieved June 8, 2022, from <https://www.the-robin-report.com/preference-for-polyester-may-make-fast-fashion-brands-vulnerable/>
50. Synthetic textiles industry in India and opportunities ahead. Wazir (2019, May 29). Retrieved June 14, 2022, from <https://wazir.in/synthetic-textiles-industry-in-india-and-opportunities-ahead>
51. Primary interviews
52. Ministry of Textiles Annual Report 2018-19. MINISTRY OF TEXTILES, GOVERNMENT OF INDIA. Retrieved June 14, 2022, from <http://www.texmin.nic.in/sites/default/files/Textiles-AnnualReport2018-2019%28English%29.pdf>
53. The story of Asia's biggest textile recycling hub. Dwij Products (Apr 8, 2021). Retrieved June 8, 2022, from <https://www.dwijproducts.com/post/the-story-of-asia-s-biggest-textile-recycling-hub>
54. Sattva primary research analysis
55. Trade and Transport Facilitation Monitoring Mechanism in Bangladesh: Baseline Study. ADB (June 2017). Retrieved June 14, 2022, from <https://www.adb.org/publications/ttfmm-baseline-study-bangladesh>
56. Special economic zones in India. Ministry of Commerce & Industry, Department of Commerce. Retrieved July 19, 2022, from <http://www.sezindia.nic.in/>
57. Anna Granskog, Libbi Lee, Karl-Hendrik Magnus, and Corinne Sawers. Survey: Consumer sentiment on Sustainability In Fashion. McKinsey (17 July, 2020). Retrieved June 14, 2022, from <https://www.mckinsey.com/industries/retail/our-insights/survey-consumer-sentiment-on-sustainability-in-fashion>
58. Primary Analysis
59. Volume and consumption: How much does the world buy?. Common Objective. (May 14, 2018). Retrieved June 14, 2022, from <https://www.commonobjective.co/article/volume-and-consumption-how-much-does-the-world-buy>
60. SZW primary research in these markets
61. Progressing towards waste prevention in Europe – the case of textile waste prevention. European Environment Agency. (2021, December 15). Retrieved June 15, 2022, from <https://www.eea.europa.eu/publications/progressing-towards-waste-prevention-in>
62. Scaling textile recycling in Europe--turning waste into value. McKinsey (July 15, 2022). Retrieved July 19, 2022, from <https://www.mckinsey.com/industries/retail/our-insights/scaling-textile-recycling-in-europe-turning-waste-into-value>
63. Textile Waste - an Environmental Crisis. OCS. Retrieved June 9, 2022, from <https://www.onlineclothingstudy.com/2021/03/textile-waste-environmental-crisis.html>
64. TextileGenesis Competitors' Key Highlights. Textile Genesis. Retrieved June, 2022 from <https://www.owler.com/company/textilegenesis/competitors>

Part 5: Becoming A Circular Sourcing Region - Key Levers

65. Annual Report 2020-21 - Ministry of Environment, Forest and Climate Change. Retrieved June 16, 2022, from <https://moef.gov.in/wp-content/uploads/2021/03/Environment-AR-English-2020-21.pdf>
66. Adrian Wilson. Learnings from France on textile waste and EPR. Innovation in Textiles - Technical Textiles & Smart Textiles. Retrieved June 16, 2022, from <https://www.innovationintextiles.com/learnings-from-france-on-textile-waste-and-epr/>
67. EPR Policy: France's National Programme for Textiles Recovery. Knowledge Hub. (2 September, 2021). Retrieved June 8, 2022, from <https://knowledge-hub.circle-lab.com/article/8959?n=EPR-Policy-France%27s-National-Programme-for-Textiles-Recovery>
68. Pranay Latkar. Waste management in spinning. Textile Sphere- Weaving Contemporary Ideologies. Retrieved June 15, 2022, from <https://www.textilesphere.com/2019/09/waste-management-in-spinning.html>
69. Cotton Comber Noil. GP Group India. Retrieved June 15, 2022, from <https://www.gpgroupindia.com/cotton-comber-noil.html>
70. Textile Exchange (n.d.). Glossary. Retrieved from <https://textileexchange.org/glossary-abbreviations/>
71. Laura Fitzgibbons. What is Feedback Loop? - definition from whatis.com. SearchITChannel. Retrieved June 15, 2022, from <https://www.techtarget.com/searchitchannel/definition/feedback-loop#:~:text=A%20feedback%20loop%20is%20the,input%20is%20captured%20and%20stored>
72. Hanna Ljungkvist, David Watson, Maria Elander. Developments in global markets for used textiles and implications for reuse and recycling. ISBN: : 978-91-88695-73-4. Retrieved June, 2022 from <http://mistrafuturefashion.com/wp-content/uploads/2018/09/Mistra-Future-Fashion-2018.04-M-Elander-D.3.3.4.1.pdf>
73. Hanna Ljungkvist, David Watson, Maria Elander. Developments in global markets for used textiles and implications for reuse and recycling. ISBN: : 978-91-88695-73-4. Retrieved June, 2022 from <http://mistrafuturefashion.com/wp-content/uploads/2018/09/Mistra-Future-Fashion-2018.04-M-Elander-D.3.3.4.1.pdf>
74. Manual sort of post-consumer textiles. Fibersort (2018). Retrieved June, 2022 from
75. https://www.nweurope.eu/media/3453/fibersort_manual-sort-pct_jan2018.pdf
76. Manual sort of post-consumer textiles. Fibersort (2018). Retrieved June, 2022 from
77. https://www.nweurope.eu/media/3453/fibersort_manual-sort-pct_jan2018.pdf
78. Textile Exchange (n.d.). Glossary. Retrieved from <https://textileexchange.org/glossary-abbreviations/>
79. WASTE TEXTILE TERMS AND DEFINITIONS. Henry Day. Retrieved June, 2022 from <https://www.henryday.co.uk/documents/Waste-Textile-Terms-and-Definitions.pdf>
80. Implementation and Enforcement of Environmental Law. Refuse-derived fuel (2017). Retrieved June, 2022 from <https://www.impel.eu/en>
81. Pneumafil Cotton Waste. Joy Cotton Exports. Retrieved June 15, 2022, from <https://www.joycottonexports.com/pneumafil-cotton-waste.php#:~:text=A%20pneumafil%20is%20a%20long,long%20lengths%20suitable%20for%20spinning.>
82. Manual sort of post-consumer textiles. Fibersort (2018). Retrieved June, 2022 from https://www.nweurope.eu/media/3453/fibersort_manual-sort-pct_jan2018.pdf
83. Md Abu Sayed. What is textile waste? definition, meaning and types. What is Textile waste? Definition, Meaning and Types. Textile Apex. Retrieved June 15, 2022, from <https://textileapex.blogspot.com/2018/12/what-is-textile-waste-definition.html>
84. Xe currency converter. Xe Currency Converter - Live Exchange Rates Today. (n.d.). Retrieved June 15, 2022, from <https://www.xe.com/currencyconverter>

For more details, refer to the technical appendix:

