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## Recycling: A cornerstone of long-term sustainability

**Arpita Grover, Saroj Yadav, Neelam M Rose, Shalini Rukhaya and Diksha Bisht**

### Abstract

Textiles, sometimes known as clothes, are most fundamental human need. Human nowadays not only meet this basic need, but they are also increasingly keen to dress in stylish attire. The fashion industry has a huge environmental and social impact: it has a long and complicated supply chain, is one of the most polluting sectors. Various approaches and attempts have been undertaken to alleviate the impact. This study examines textile wastes (pre-consumer and post-consumer), current textile recycling types and techniques, advantages and their efficacy in reducing waste generated by the clothing industry also several initiatives to support sustainability through recycling. Recycling and reusing of fibres, fabrics, and waste materials is an efficient way to promote sustainability in the garment business. This will assist researchers to build a new path for research and the resolution of the waste management challenge.

**Keywords:** textile and apparel industry, fast fashion, textiles waste, textile recycling, sustainability

### 1. Introduction

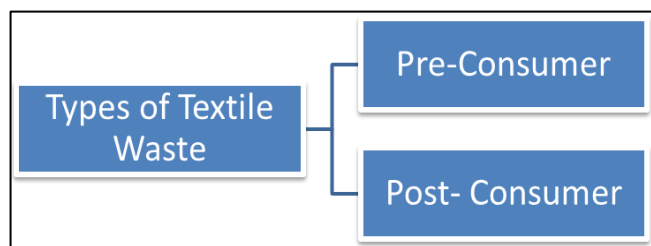
Textiles or clothing, is one of the most basic human necessities. Nowadays, humans not only satisfy this fundamental requirement, but they are also more eager to wear fashionable clothing. To keep up with the times, they always prefer new and more trendy goods. As a result, the RMG (Ready Made Garment) industry is exploding with a wide range of fashions<sup>[17]</sup>. The fashion world has a significant environmental and social impact: it has an exceptionally lengthy and convoluted supply chain, is considered as one of the most polluting industries and consumes the most water, and is frequently linked to labour abuses<sup>[9]</sup>.

The migration of manufacturing to emerging or developing nations with cheap labour costs, as well as the rise of the so-called "fast fashion" phenomena, which is the desire for "disposable" clothes at low prices, have worsened this impact in recent decades<sup>[9]</sup> Low-cost clothing lines that replicate current premium fashion trends are referred to as "fast fashion". Even if it is unsustainable, quick fashion serves to satisfy deeply held desires for luxury items among young buyers in the industrialized world. Trends move at breakneck speed, with today's newest fashions quickly displacing yesterday's, which have already been discarded<sup>[11]</sup>.

Not only has the textile industry doubled its output in the previous two decades, but global annual textile consumption has also doubled from 7 to 13 kg per person, reaching the milestone of 100 million tonnes of textile consumption. At the end of their life, more than two-thirds of textiles wind up in landfills, with only around 15 percent being recycled<sup>[16]</sup>. Textile market growth is influenced not just by population increase, but also by economic and fashion cycles. The textile industry's quick fashion cycle has resulted in a high degree of consumption and waste creation<sup>[13]</sup>.

### 2. Textile Waste

Textile waste, like other trash, comes from a variety of sources in the community, including fibres, textile or garment manufacturing businesses, consumers, commercial and service industries. As a result, textile waste may be described as material that becomes unusable or worthless once a textile products manufacturing process is completed<sup>[14]</sup>. The textile waste is further classified in two categories are



## 2.1 Pre-Consumer Waste

This textile waste is generated by several textile manufacturing sectors, including spinning, weaving, dyeing, finishing, and garment production. This waste is generally clean waste <sup>[15]</sup>.

**2.1.1 Spinning waste:** The blow room waste percentage is 3 percent and blow room waste is referred to as lap waste. The waste rate in the carding process is around 10 percent. Dropping-1, dropping-2 and sliver waste are the wastes of the carding section. In the draw frame segment, roughly 0.5 percent of the material is wasted. Sliver waste is the term for this section's trash. The wastage rate in the comber section is around 14-15 percent, and the wastes are known as noils, lap and vacuum waste. In the simplex portion, there is around 0.5 percent waste, which is referred to as roving and sliver wastage. The ring frame waste percentage is 2-2.5 percent, and the wastes are known as pneumafil, hard waste, vacuum waste, and so on.

**2.1.2 Weaving waste:** Wastages are leftover yarns from the warping process that are left on the cones. It is impossible to unload all of the cones in the warping creel area, thus there will always be some yarn on the cones. Another type of waste in a weaving plant is sizing waste. The knotting wastage follows the sizing wastage. Knotting ensures that all of the warp ends of two beams are available for joining. Another type of weaving waste is beam residual wastage. A tiny bit of warp yarn remains unused on the weavers beam after a weaver beam is done and it is not feasible to finish it yet. Weaving wastage of auxiliary selvages is also prevalent. Auxiliary selvage is a false selvage used to keep the weft yarn in place while the loom is being banged up.

**2.1.3 Knitting waste:** There will be knitting waste if there is a flaw in the knitting process or in the raw materials. When a new order is placed, the merchandiser first creates a sample. Trials are conducted in the knitting machine to create a sample which can lead to knitting waste as a result of the testing. Yarn wastage on the floor might happen when knitting. Wastage can occur if either the cone or the yarn is defective. Knitted fabric flaws include barriness, spirality, thick and thin spots, holes, slubs, sinker marks, stains, stripes, and more which results in knitting waste. Knitting waste also occurs as a result of the incorrect knitting programme.

**2.1.4 Dyeing waste:** Textile dyeing industries are the most prevalent sources of waste water, posing a serious environmental hazard. Many machine manufacturers are attempting to implement innovative technology in order to decrease waste water. Some are attempting to create dyeing techniques that do not require the use of water. Aside from it, there are a variety of dyeing flaws. Wastes are produced as a result of several sorts of dyeing errors. Uneven dyeing, batch to batch shade variation, crease markings, selvage to selvage

shade variation for denim, metamerism, and other dyeing flaws are the most frequent which leads to waste creation.

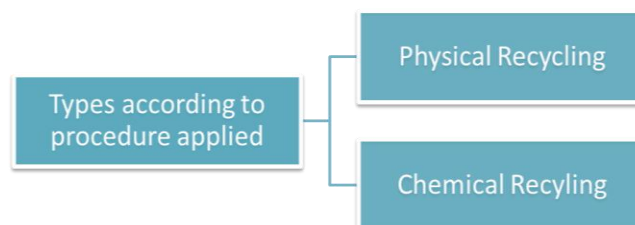
**2.1.5 Clothing waste:** There are several sectors in the garment business, including as cutting, bundling, sewing, printing, embroidery and finishing. There are wastes in every area. In a garment industry, the cutting department is the major source of waste. The cutting area produces a large quantity of waste due to many functions and marker usage. As a result, some defective parts may end up as waste in this area. The loaders then distribute these bundled parts in the sewing area. If a worker detects a defective item in the sewing department, he rejects it. As a result, there is waste in the stitching area. If any print in the printing portion does not fit the standard, the garment item will be discarded. If the embroidery is not done properly in the embroidery portion, the garment will be considered waste. There will be wastage in the finishing process if there are measuring errors, cuts, or press errors.

## 2.2 Post-Consumer Waste

Post-consumer textile waste is primarily derived from domestic sources and comprises of clothes or textiles that the owner no longer need in their original state. Due to quick fashion cycles and increased buying power of Indian customers in metropolitan areas, garment products have short lifecycles, resulting in substantial volumes of postconsumer textile waste in the form of used or even second-hand clothes <sup>[3]</sup>. In the fashion business, waste is frequently seen as a problem that must be addressed, whether by reduced consumption, improved manufacturing methods, or recycling and up cycling techniques <sup>[5]</sup>. Waste valorization is described as a process activity that focuses on reusing, recycling, or composting waste to create value-added commodities while embracing long-term sustainability.

## 3. Recycling

Recycling has the ability to give old garments a second life, which has a direct positive influence on the environment and the economy. Recycling, as defined by Directive 2008/98/EC, is any process through which waste materials are recycled into goods, materials or substances, whether for the original or additional uses. It includes organic material reprocessing, but excludes energy recovery and reprocessing into materials that will be utilized as fuels or for backfilling processes. After preventing and reusing, the recycling approach is employed. The use of procedures to manage textile waste is one approach to identify recycling kinds <sup>[14]</sup>.

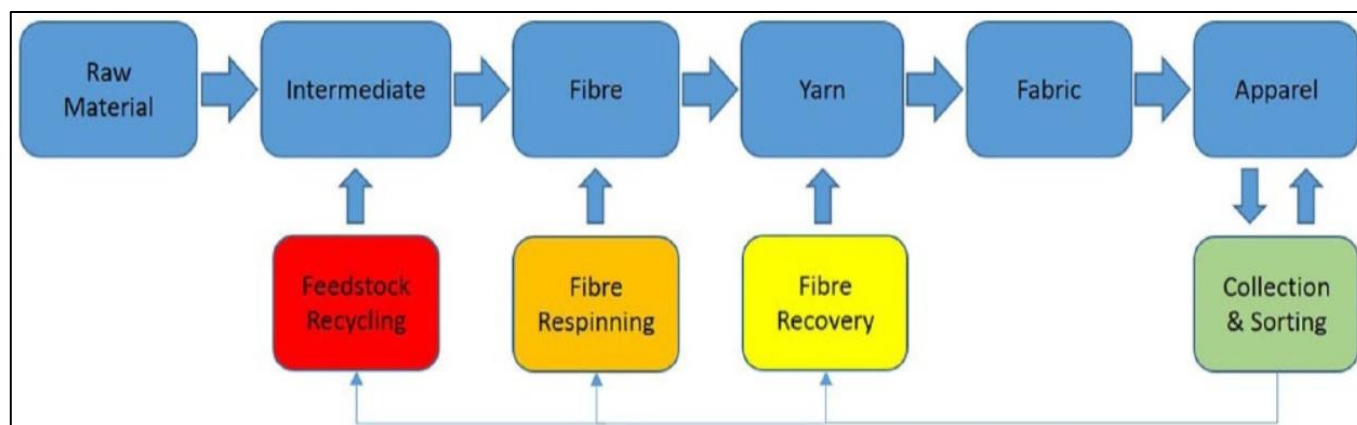


**3.1 Physical Recycling:** In terms of physical recycling, reclamation or commingled plastics waste processing are used to reprocess manufacturing waste and post-consumer items into new products. Physical recycling is preferable to chemical recycling since it is a simpler, less expensive, and more environmentally beneficial method.

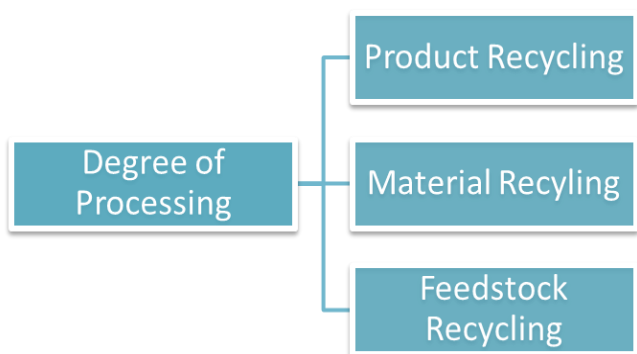
**3.2 Chemical Recycling:** The conversion of high molecular weight polymers into low molecular weight compounds is known as chemical recycling. The compounds produced can be utilized as reactants in the manufacture of other chemicals

and polymers.

At several phases of the textile processing chain, the recycling process interacts differently as shown below-



But the degree of processing that happens throughout the recycling process may be used to classify the processes further [4] as-



- **Product Recycling:** When the chemical and physical makeup of the waste products is not altered during the process.
- **Material Recycling:** When the physical but not the chemical content of waste material is changed.
- **Feedstock Recycling:** Where the chemical and physical properties of the waste material are altered.

**4. Advantages of Textile Recycling to Build a Cornerstone**  
 Recycling and reusing fabrics, fibres, and waste materials is an efficient way to promote sustainability in the garment business. According to a U.S. Environmental Protection Agency, textiles constitute a significant source of greenhouse gas emissions. Efforts are being undertaken to promote textile recycling in order to minimize greenhouse gas emissions. Textile recycling is the only way to slow the rise of textile waste.

Furthermore, textile recycling has several environmental advantages. It reduces the requirement for landfill space while accounting for the greenhouse gases emitted by the discarded textiles. Furthermore, the region surrounding the dump endangers groundwater. When it rains, the water absorbs all of the chemicals and hazardous elements from whatever is deposited in the landfill, such as textile chemicals, dyes, and bleaches. This water is gathered at the landfill's bottom and can be 200 times more hazardous than sewage water.

Also, recycling clothing and textiles decreases the need for virgin materials and facilitates the creation of new markets

since recycled content is typically less expensive, making its usage appealing and desired to producers. It has been calculated that if every individual in the United Kingdom purchased one recycled woolen clothing each year, it would save roughly 371 gallons of water and 480 tonnes of chemical dyes. Many fashion manufacturers are now embracing the usage of recycled fibres and textiles in their clothing collections.

**5. Various Recycling Initiatives**

- Making textile sorting simple will be a significant step in increasing the efficiency of textile recycling. The T4T (Textiles for Textiles) machine was created to enhance and speed up the textile sorting process. Textiles may be sorted using the machine depending on their fibre composition, colour, chemical combination, and other factors. The system can identify and classify the individual characteristics of the clothing swiftly and efficiently. It can scan around one garment each second.
- Various sustainability solutions for the effective usage of textile waste are being explored. Manufacturers must take a proactive approach to textile recycling. The textile recycling business is expected to expand further. As a result, in order to achieve sustainability, the garment sector must focus on reusing and reprocessing clothes, fibres, and trash in the most effective way possible.
- **Recycling Hub:** Panipat is Asia's largest textile recycling hub. This town's uniqueness is that most of the world's discarded clothes wind up here for recycling. It's interesting that many of these clothing were likely produced in India for US or European fashion names before making their way across the world and back to India. According to one research, the city of Panipat became recognized as a recycling hotspot after the owners of Panipat mills acquired second-hand machinery from Prato, Italy, and began recycling wool and producing terrible yarn. Panipat is regarded as the "cast off capital" and each year it helps to the recycling of \$182 million in old clothes imported into India [12].
- **Curbside Recycling Policy:** A research of curbside textile recycling in southern Nevada found that frequent waste-recycling practices, political affiliation, family size, minority status, house ownership, and income all had a substantial effect on the probability of support for a

curbside textile-recycling programme. The binary logit regression analysis results show that (a) present waste-recycling behavior is a good predictor of support for a curbside textile-recycling policy, and (b) the relevance of recycling practices is demonstrated by its influence on the effect of political affiliation on policy support [6]. Another study looked at the impact of convenience on recycling frequency, and the findings showed that having access to curbside recycling had a substantial impact on the volume and diversity of goods recycled. The authors came to the conclusion that high-recycling-activity homes might be identified and targeted for curbside recycling programs that included textiles. Curbside recycling programs must be expanded to accept a wider range of postconsumer waste goods, such as textiles and clothing, in order to continue to minimize the quantity of solid waste sent to landfills [8].

- **Educating Public about Recycling:** Currently, only 15 percent of old clothes and textiles are recycled. The remaining 85 percent is disposed of in landfills, and the majority of people are unaware that leftover textiles may be recycled to help decrease negative environmental effect. The Secondary Materials and Recycled Textiles Association (SMART) is dedicated to assisting federal, state, and municipal governments in reducing the quantity of textiles that end up in landfills.
- School initiatives might help children think about textile recycling from an early age.
- All existing public relations and promotion activities promoting recycling programmes should incorporate textile recycling information.
- Clothing that is clean and dry can be given and recycled.
- All worn clothes may be reused and repurposed, even if it has stains or missing buttons.
- Donations of hats, gloves, socks, undergarments, belts, ties, purses, and handbags of any style, age, or condition are welcome in addition to the regular shirts, pants, and suits.
- 95 percent of consumer textiles may be recycled and re-worn or reused. Charities either sell or distribute wearable things.
- Unwearable things are made into cleaning cloths and rags or crushed into fibre for stuffing, insulation, and carpet underlayment.
- Curtains, drapes, comforters, sheets, pillow covers, towels, tablecloths, and linens are all recyclable.

## 6. Conclusion

The primary goal is to increase public awareness of the socioeconomic repercussions of excessive consumption and waste. We must consider alternatives to ecologically sustainable disposal. This review will assist researchers in identifying past study results and will help to build a new path for research and the resolution of the waste management challenge.

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