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Recycling of Waste Cloths for Greener Future

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Abstract

The exponential development of fashion and textile industries around the world largely increase, the production of waste cloth has grown by a steep rate, presenting serious environmental issues in terms of landfill garbage, greenhouse gas emissions and waste depletion. Millions of tons of textiles are disposed of every year, and the recycling of waste cloth has become one of the critical solutions to a circular economy in the process of eliminating environmental degradation. This paper examines the recycling of waste fabrics as an efficient way of reducing waste textiles besides promoting sustainable development. The main aim of the given research is to compare the possibility of recycling of different types of textiles using mechanical, chemical depolymerization, and imaginative upcycling techniques, in terms of their feasibility, efficiency, and environmental advantages. The research is a mixed approach where literature review, experimental analysis, and case study of textile recycling industries have been used. The data is processed to determine material recovery, energy use, and carbon footprint impacts of each approach. The most critical results show that mechanical recycling can be used to recycle natural fibers, including cotton and wool, but chemical recycling can be used to recycle synthetic fibers, including polyester, and recover almost virgin quality fibers. Despite being small-scale, upcycling practices have a great impact on the local economies and social sustainability through job creation and promotion of eco- friendly consumer behavior. In general, the study shows that the effective waste cloth recycling can significantly decrease the landfills, save the natural resources, and decrease the emission of CO_2*. Textile recycling can be a transformative element in attaining a green, more sustainable future through the addition of recycling technologies, public awareness and policy support. This paper explains why the implementation of the circular textile systems should become the foundation of worldwide environmental sustainability and conscious consumption.*

Keywords: Cloth waste reduction, green technology, resource conservation, sustainable fashion, upcycling

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INTRODUCTION

Waste and Environmental Impact Background

The global textile and fashion industry has been growing rapidly, which has led to a great surge in the production and consumption of textile, thus causing a resulting increase in the production of textile waste. Millions of tons of used garments and fabric scraps are discarded every year and much of this is in landfills or burns. The textile industry is among the most resource-intensive industries as it uses tremendous volumes of water, energy, and raw material and discharges toxic chemicals and dyes into the environment. Non-biodegradable polyester and nylon synthetic fibers pollute in the long term as they remain in landfills for decades long, releasing microplastics into the soil and the water bodies. Further, 20% of the industrial water pollution worldwide is attributed to dyeing and finishing of textiles. The fast fashion culture, which encourages short product life cycles and overconsumption, also contributes to the burden of the environment. As a result, textile waste does not only drain the natural resources but also leads to a great contribution to greenhouse gas emissions and deterioration of the ecosystem (Figure 1). The need to reduce environmental impact and achieve a circular economy in the textile industry has consequently led to the necessity of addressing this specific issue through the implementation of sustainable waste management and recycling practices. Textile waste is any waste cloth, fabric scrap, or fibrous material that are not in use anymore or that have been rejected in the production, use of the product or disposal of the product. It contains both pre-consumer waste (waste produced in the manufacturing and processing stage), and post-consumer waste (discarded clothes by households and retailers). As the worldwide population increases together with the shift in lifestyle pattern, textile waste has been on an alarming rate. An average of millions of tons of garments are discarded annually, most of which are discarded in landfills or burned. The practices introduce toxic chemicals, dyes, and microfibers to the soil, water, and air, which result in severe pollution and the degradation of the ecological condition in the long run. Artificial fiber like polyester and nylon require hundreds of years to decay emitting greenhouse gases like methane during decomposition. The total environmental cost of textile waste is thus enormous, as it has a substantial contribution to climate change, water pollution and loss of biodiversity.

The Contribution of the Fast Fashion Industry to the Generation of Waste

Within recent decades, the fast fashion industry has turned out to be one of the main causes of textile waste (Figure 2). Fast fashion brands manufacture fashionable low priced products at high rate to suit the shifting consumer needs. Although this model makes fashion to be affordable and reachable to many, it is also fostering an overconsumption and disposing culture. Customers are urged to purchase more clothes, use them with lesser frequency and change them with new designs frequently. Consequently, an enormous quantity of clothes is thrown away much earlier than the date of their

Figure 1. Textile waste and its impact on environment.

Figure 2. the role of fast fashion industry to the generation of waste

utilization. In addition, the fast fashion industries tend to be based on inexpensive synthetic fabrics and high production speeds that use tremendous amounts of water, power, and chemicals. The low-quality fabrics, the short products lifecycles, and low recycling efforts have contributed to the huge piles of waste in the landfills. It is one of the greatest environmental challenges of this time since it does not only damage the environment, but also abuses labor and wastes natural resources.

Significance of Textile Waste Recycling to be Sustainable

Recycling textile waste is very crucial in creating a sustainable and environmentalist future. It manages to decrease the amount of pressure on landfills, save resources, and decrease contamination of textile production. Reprocessing former discarded cloths and fabrics into new materials or products will go a long way to lessen the demand of virgin resources like cotton, water, and oil which are used to produce synthetic fibers. Recycling further reduces carbon emissions and the use of energy in comparison to production of new textiles through production. Besides, it helps the idea of a circular economy wherein products undergo reuse, repair, and reuse instead of disposal. Sustainable textile recycling is beneficial to the environment as well as it creates job opportunities in the collection, sorting, and processing industry. Prompting the consumer to recycle, donate, or upcycle old clothes helps to create a more responsible and conscious attitude to fashion. Therefore, textile recycling is critical towards the realization of a balance between economic development, environmental conservation and social wellbeing.

The Purpose and Intention of the Study to Promote a Greener Future by Recycling Clothes

It is hoped that the proposed research will help find new and viable ways of recycling waste clothes to establish a more green and sustainable future. The paper will examine different methods of recycling, using mechanical, chemical methods and creative upcycling and compare them on the basis of environmental and economic advantages. It also seeks to know the prevailing issue in the waste management of textiles and come up with effective measures to improve it. The breadth of this study will be beyond the identification of sources of textile waste to the possible recycling of fabrics in the fashion and industrial industry. It focuses on the awareness of the masses, policy formulation, and the use of technology in converting garbage to useful products. Finally, the study envisions making an impact on the issue of efficient recycling through adopting sustainable approaches to recycling to decrease pollution, save natural resources, and create a new fashion system that is eco-conscious and based on circularity to meet the global environmental objectives.

Problem Statement

The amount of discarded clothes has now become a very big issue in the global environment, and discarded textile wastes are now in millions of tons yearly, being deposited in landfills. With the increase in the production and use of clothes, the number of non-biodegradable synthetic fabrics that are hundreds of years to decompose is filling up these landfills. This continuous piling up of waste in the textile industry does not only take up productive land space, but also introduces the soil, air, and water channels to dangerous chemicals, dyes, and microfibers. Synthetic materials are also releasing greenhouse gases like methane when they decompose and harm the ground water as well as cause an imbalance in the ecosystem due to the release of toxic substances. Moreover, the manufacturing of new fabrics also uses enormous portions of the natural resources, especially water, energy, and raw materials like cotton and petroleum-based fibers, thus, exacerbating the issue of resource depletion and environmental deterioration. Despite the urgency of the problem, the level of awareness towards textile recycling among the population is very low, as well as the absence of proper waste management systems in most of the areas. Lack of good collection, sorting, and recycling facilities results to the endless process of wastes production and disposal. Consequently, the world is becoming increasingly ecologically stressed, which is why it is highly necessary to start working on the sustainable recycling of textile products and encourage people to be more concerned about the future and their role in promoting a more sustainable environment.

Objectives of the Study

- To study various methods of recycling waste clothes.
- To analyze the environmental and economic benefits of recycling.
- To promote sustainable fashion practices.
- To explore innovative technologies for textile reuse.

LITERATURE REVIEW

The rapid increase in the consumption of textiles and the control of fast-fashion has greatly contributed to the rise in the production of waste in textile sectors which has necessitated the necessity of recycling and reuse of textile waste to attain the objectives of sustainability and the circular economy. Recycling of textile waste helps decrease the landfill load, as well as, saving resources, energy, and raw materials and also encourages green industry. The literature review presented below is a compilation of key works in the reversed chronological order to reflect the current developments and directions that can be taken in researching how waste cloth can be recycled to a greener future. Biyada and Urbonavičius (2025) [1] examined the issues of circularity in managing textile waste and identified obstacles of complex materials, inefficiencies in collection processes, and recycling. Their analysis suggested technological innovation, alignment of policy and better value-chain cooperation to be avenues of sustainable textile circularity. In a similar manner, Shamsuzzaman et al. (2025) [2] have given a systematic review of textile waste management under the context of the circular economy. The paper highlighted recovery methods like reuse, recycling, remanufacturing, and eco-design and highlighted policy, stakeholder cooperation and consumer involvement as major implementation methods in large scale. In [3], Tripathi et al. reviewed the latest technologies that transform textile waste into value-added products, including composite materials, insulation, and bio-based chemicals. Their efforts prove that instead of being taken as waste, the textile material may be utilized to produce more sophisticated materials. Dissanayake and Weerasinghe (2021) [4] carried out a systematic review devoted to organizational issues, techniques, and problems of fabric waste recycling. They discovered mechanical, chemical, and thermal recycling methodologies although they highlighted the sorting and fiber blending problems as the significant constraints. Bengtsson et al. (2022) [5] investigated the chemical recycling of polyester-viscose mixtures using alkaline hydrolysis and elucidated the reaction mechanisms of recovering polyester, to increase the effectiveness with which the blended textiles can be recovered. Yesodharan et al. (2021) [6] investigated neutral hydrolysis to depolymerize polyester and nylon 6 in the co-processing systems, and the study showed that mixed synthetic fabrics could be recycled. According to Wang (2010) [7], the previous study has examined the fiber and textile waste in terms of usage paths, including recycling, reuse, and energy recovery as the main sustainable ways to valorize the textile waste. The use of chemical recycling of cotton fibers was studied by Schuch (2016) [8], with the outcomes demonstrating that it was possible to produce regenerated cellulose of acceptable quality, which proved the prospects of cotton recycling. Lyocell-type recycling processes became economically and environmentally efficient because Elsayed et al. (2020) [9] proved that ionic liquid solvents recycled in the process of regenerated cellulose production are economically viable and do not harm the environment. The study by Moriam et al. (2021) [10] took a repair step in developing regenerated cellulose fiber with better toughness, which improves textile performance on recycled cellulose. Ma et al. (2020) [11] exhibited wet-spinning regenerated fibers through different waste cellulose sources and it was demonstrated that textile waste cellulose can generate new fibers with competitive properties. The article by Michud et al. (2016) [12] has proposed a technology called Ioncell-F, which is a technology that produces fibers based on ionic liquids as an alternative to the viscose processes in a sustainable manner. A literature review of thermochemical recycling of post consumer textiles into fuels and biocarbon [13] by Athanasopoulos and Zabaniotou offers the opportunity of using pyrolysis and gasification in energy recovery systems. Miranda et al. (2007) [14] conducted a research on textile waste pyrolysis and established that it can be used to produce oils, gases, and char that can be used as fuels. Ruiz et al. (2023) [15] also compared the two methods of pyrolysis, conventional, and flash, in textile biomass waste, and found that yield of products was higher, and energy prospects promising. Ozsin and Putun (2022) [16] investigated the kinetics of pyrolysis and gas evolution during the decomposition of textile wastes, which were used to optimize the design of a reactor. The study by Rittfors (2020) [17] employed pyrolysis and gasification of cotton and polyester wastes to substantiate that thermochemical recycling is a real option of waste management. Balcik-Canbolat et al. (2016) [18] investigated mixed-textile fibers pyrolysis, examining both gaseous and solid products as a source of energy. Yosef et al. (2021) [19] suggested functionalization of pyrolysis-derived char to be used as cement composite fillers, not only as fuels. As evidence of enhanced environmental performance of synthetic textile waste conversion, Kwon et al. (2021) [20] have demonstrated catalytic pyrolysis based on the use of CO_2 as a raw material. The study conducted by Yosef et al. (2021) [21] on the nature of pyrolysis lint microfibers in dryers found new uses of secondary textile wastes in recycling. Enzyme-based treatments were reviewed by Piribauer et al. (2021) [22] as promising solutions to fiber separation using enzymes as the environmentally friendly one. In a study by Ribul et al. (2021) [23], the researchers suggested the use of mechanical, chemical, and biological recycling paths to reach closed-loop bio-based textile recycling systems. Muratov and Kim (2002) [24] also investigated the enzymatic hydrolysis in the supercritical CO_2 environment revealing enhanced performance of fibers in terms of hydrolysis. Gritsch et al. (2023) [25] showed the enzymatic recovery of high-purity glucose and polyester on blended textiles and, therefore, opened a pair of closed-loop fabric recycling. This socioeconomic benefits of textile recycling were reviewed by Leal Filho et al. (2019) [26], where employment, environmental benefits, and resource savings were identified. During the process of textile industries, the industrial membrane filtration technologies [27] become more and more popular in the wastewater treatment and recycling processes, enhancing the efficiency of water reuse. In a study by Aluigi et al. (2009) [28], the authors used wool waste as the basis of their keratin-based nanofibers and utilized the nanofibers in the filtration process, which is an added value to the textile by-products. A review of nanofiltration membranes in dye wastewater treatment by Lau and Ismail (2009) [29] endorses sustainable textile recycling by purifying water used to recycle the textiles. Nguyen et al. (2021) [30] have indicated the use of textile waste in the production of ropes that can be used in soil erosion control, which provides civil engineering reuse possibilities. In pursuing the possibility of environmental application of recycled textile materials, Hyvonen (2022) [31] examined cotton-polyester waste as a soil application, which offered potential prospects on the application of the material in various environmental settings. Broda et al. (2016) [32] created geotextiles using recycled fibers to be used in the reinforcement of highways. Zornberg (2017) [33] summarized the use of geosynthetic in the construction of roadways, where recycled textiles can be used in reinforcement and drainage systems. Lastly, Ghosh et al. (2014) [34] showed that woven jute can be used as geotextile in geotechnical and this is a sign that natural fiber can be recycled in construction sectors. It is evident in the literature that textile waste recycling technologies are now extended to mechanical recycling, chemical depolymerization, enzymatic treatment, thermochemical conversion, fiber regeneration, filtration material, civil engineering. Nevertheless, the fiber separation, blended material recycling, process economics, and scalable infrastructure are still considered to be major challenges. To achieve a green textile future, future studies should incorporate the model of the circular economy, new separation technologies, and development of value-added products.

METHODOLOGY

By recycling textiles, the initial action is to ensure that waste cloths of all kinds are collected in a systematic manner and they include; household, garment factories, tailoring units, retail stores, and textile industries. Old curtains, beddings, and garments that are not currently used constitute post-consumer waste that is found in household collections. The industrial sources in their turn produce pre-consumer waste in terms of fabric trimmings, rejected materials, and unsold products. The waste samples are collected in urban and semi urban locations where the consumption of textiles is very high to enable representativeness. The experience can include the local recycling agencies, collections, and partnerships with the municipalities and clothing stores. Good records are kept of the quantity, type, and condition of the fabrics collected to make them easily analyzed. This step is very important because it forms the foundation on which the recycling methods can be considered and it is also possible to estimate the scale of the textile waste produced within a given area (Figure 3). Timely collection is not only a measure to guarantee a constant stream of recyclable waste but also to promote the involvement of the community or raise awareness about the necessity to separate the textile waste.

After that, the waste textiles are sorted to be divided into the type and quality of fabric and possibilities of reuse. Recycling is important since the various fibers (natural and synthetic) have different ways of recycling them. Examples of materials that can be biodegraded and recycled using mechanical or chemical methods to produce cellulose fibers are cotton, whereas polyester and nylon can be more effectively reused through depolymerization or thermochemical processes. Protein-based fibers like wool and silk require special treatment to preserve their structure. The sorting can also be done manually by trained personnel that visually determine fabrics by feel, color, and weave, but sophisticated facilities can employ automated methods to include near- infrared (NIR) scanning and

Figure 3. Working methodology.

spectral analysis to perform sorting faster and with increased accuracy. Sorting is also a process of purification of materials by eliminating contaminants like zipper, buttons, elastics, and labels. This action is critical in defining whether the recycling process is effective and good since mixed or low quality sorting of fabrics may result in the loss of fiber quality, high processing expenses and poor value of the final product.

The sorted fabrics are then recycled with different methods after the sorting process and this varies according to their composition and final application. Shredding is the mechanical recycling of textiles, in which the textiles are cut and torn into smaller strands which can be recycled into new yarn or as a stuffing, as insulation, or as an industrial cleaning agent. It suits best natural fibers like cotton and wool. Chemical recycling, however, is used to recycle the synthetic materials like polyester and nylon by hydrolyzing, glycolyzing or depolymerizing them into their monomeric components. The recovered monomers can then be purified and re-polymerized into new fibers thus saving the virgin raw materials. Upcycling is a creative and sustainable method, in which formerly worn clothes or fabric scraps are recycled into a more valuable product, in the form of fashion accessories, home decor, or artwork, instead of being torn down into bare fibers. The techniques have their own environmental and economic benefits that can be used to maximize the waste recovery and reduce the ecological footprint of textile production. The method taken is determined by the type of fabric, the availability of technology and the quality of the product required.

The last part of the methodology is the analysis of data which has been gathered on the recycling operations to evaluate their effect upon the environment and economy. The key performance indicators like energy saved, reduction of greenhouse gas emissions, and cost efficiency are measured and compared with the traditional methods of production of textiles. To give an example, recycling of cotton or polyester uses a lot less energy and water compared to the process of producing new fibers of raw materials. The analysis of the emission can be used to define the amount of carbon dioxide or methane prevented from entering the atmosphere because of less landfill disposal and less dependence on the necessity of extracting virgin material. Cost evaluation involves such factors as collection, processing, labor, and transportation, against possible profits in the recycled products. The qualitative observations usually support quantitative data, including the community involvement, consumer behaviour, and technological efficiency. The analysis presents scientific information on the viability and sustainability of textile recycling projects. It also shows loopholes and further improvements, and finally, paves the way to the notion that waste cloth recycling is not only clean but also profitable in the future of a more green and circular world.

TYPES OF CLOTH RECYCLING

Recycling: Recycling of Old Cloths to Make New Yarns

The recycling technique which is the most predominant and simplest in textile waste management is mechanical which makes use of physical processing of discarded fabric to extract fiber to be used again. Under this process, used clothes and scraps of cloth are sorted by first determining the type of fiber and color of the garments. The chosen fabrics are subsequently shredded and carded and re-spun in the new yarns without any complex chemicals being used. It is particularly appropriate to natural fibers like cotton, wool, and denim, and even some blends, which can undergo mechanical processing (Figure 4). A significant benefit of mechanical recycling is that it lowers the virgin fiber production which conserves water, energy as well as agricultural resources. Nevertheless, there are also disadvantages like recycled fibers tend to be shorter and weaker than original ones, and this may influence the quality and durability of the end product textile. To overcome this, recycled fibers are at times mixed with virgin fibers to enhance strength and texture. Nevertheless, mechanical recycling is also a significant element of the circular textile economy that allows the use of waste fabrics efficiently and contributes to decreasing the negative environmental impact of textile manufacturing significantly.

Recycling Chemicals: Recycling Synthetic Fibers into Usable Raw Material

Chemical recycling is that which employs high-technology chemical reactions to decompose synthetic fibers, like polyester, nylon, and acrylic into their starting monomer or some other reusable raw material (Figure 5). By using this technique, it is possible to recover pure components of chemicals that may be re-polymerized to form a new high-quality fibers without reducing the quality of the performance. Hydrolysis, glycolysis, methanolysis, and depolymerization are processes that are usually involved in separating polymer chains, dissolving dyes and impurities. Researchers have found that polyester blends are reusable, e.g., in studies by Bengtsson et al. (2022) and Yesodharan et al. (2021) that demonstrated the ability of chemical recycling to convert blends into reusable materials and provide a sustainable alternative to petroleum-based virgin fibers. The process is especially helpful since it is able to deal with complicated blended textiles that are hard to work with using mechanical processing. Despite the fact that chemical recycling demands high attention to solvents, energy, and emissions, nowadays modern inventions like enzyme-assisted depolymerization and closed-loop systems of solvents are turning it into a friendlier process to the environment and to business. This will not only reduce textile waste, but also will lead to the goal of achieving zero-waste production and the vision of the fashion industry being circular.

Figure 4. Mechanical recycling process of old cloths to make new yarns.

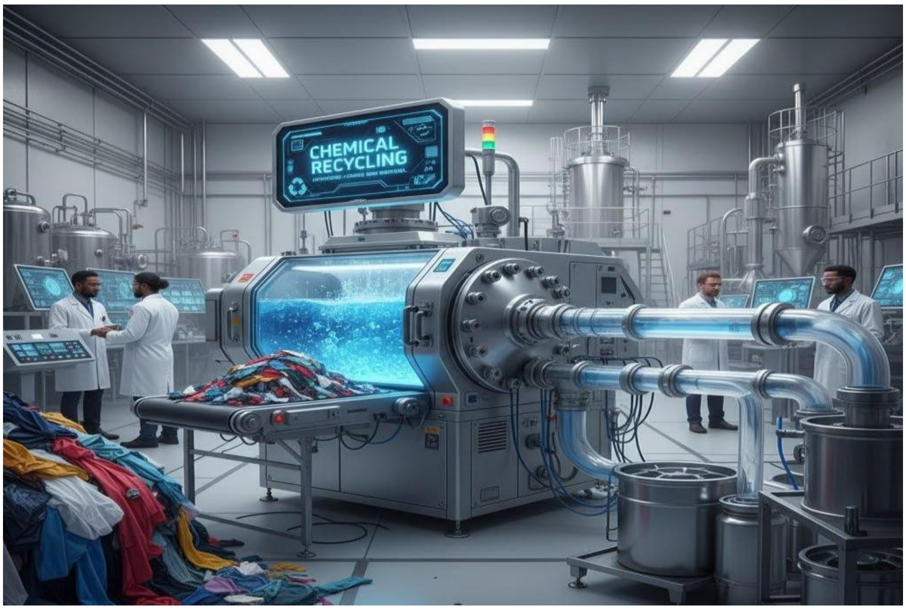

Figure 5. Recycling process of synthetic fibers into usable raw material.

Creative Upcycling: New Clothes and Household Goods Made of Old Ones

Creative upcycling is a sustainable and artistic method of recycling textiles, where used clothing and scraps of fabric are reused and re-made into new and more valuable products without dismantling them into raw materials. In contrast to the conventional recycling, upcycling is more about design and making, as waste cloths are turned into stylish garments, handbags, ornaments, or interior decorations, or even art pieces (Figure 6). It is done through cutting, sewing, drying, and merging various types of fabrics to produce distinctive and beautiful products that possess an environmental and cultural cost. The upcycling of creative items contributes not only to the decrease of the number of garments sent to the landfills but also the recyclable fashion as the product life is prolonged. It allows designers and local craftsmen to work beyond the ordinary production and provoke consumer consciousness regarding slow fashion and conscious consumption. In addition, upcycling has economic and social advantages, like local businesses, entrepreneurs, and community-based recycling programs. Located on the border between environmental responsibility and the artistic expression, creative upcycling helps fill the gap between the needs of the environment and the needs of artists, so it can be viewed as one of the most effective instruments in the process of achieving a greener and more ethical fashion ecosystem.

Industrial Application: Transforming Waste Textiles into Insulators, Carpets, or Cleaning Rags

The other important use of recycled textile is that of industrial recycling where the waste fabrics are refurbished to form useful products like thermal and acoustic insulation, geotextiles, rugs, wipers, and pad materials. This form of recycling is aimed at reusing the waste of the textile that cannot be directly converted into the production of garments because it is mixed, contaminated, or its fibers have been destroyed. Recycling of industries is usually done using mechanical means like shredding, compressing, and felting, to transform the waste into the form of dense and durable resources. As an example, recycled cotton or polyester fibers are utilized in the form of insulation of buildings and cars, and the waste of wool and jute are used in the form of carpet underlays and soundproofing materials. Such a strategy not only eliminates huge amounts of waste in landfills, but also lowers the use of synthetic insulation among other non-renewable resources. Moreover, industrial reuse would help develop a low-cost, energy-efficient substitute in the production of secondary products, which would be in line with sustainability objectives. Using the textile waste as part of the industrial process, the recycling industry establishes the connection between the fashion, construction, and manufacturing sectors to create a more circular and highly resource-efficient economy.

Figure 6. Creative upcycling of new clothes and household goods made of old ones.

OBSERVATION AND DISCUSSION

Benefits of Cloth Recycling

- *Less garbage and pollution in landfills:* Saving waste clothes would reduce the increasing volume of textile waste in landfills that usually causes emission of harmful chemicals and greenhouse gases during decomposition. Through recycling and reusing fabrics and converting worn-out clothes, we minimize a significant amount of pollution of soil, air, and water, thereby establishing a cleaner and a healthier environment.
- *Water and energy conservation:* The textile sector uses enormous quantities of water and energy during the process of producing fibers and making their dye. Recycling of fabrics will decrease the production of virgin material hence it will save natural resources and also minimize industrial energy consumption as well as wastage of water.
- *Recycling and sustainable fashion development:* The process of cloth recycling provides new work places in fields like collection of waste, sorting, processing, and design of upcycling. The emergence of sustainable fashion companies and recycling centers helps in the local development of the economy and creation of green jobs.
- *Marketing of environmentally conscious consumerism:* Recycling of textiles promotes responsible consumption by making people donate, repair or recycle their old clothes. It creates awareness related to sustainable fashion options and suggests long-term, ecological-friendly life styles.

Challenges And Limitations

- *Inadequacy of recycling facilities:* Most of the areas have poor collection systems, recycling facilities, and advanced machines to process the textiles, which hinders massive recycling.
- *Hardly separable mixed types of fabrics:* Mixed fabrics of natural and synthetic fibers are hard to recycle because they require a sophisticated technology to segregate and work effectively.
- *Inadequate citizen interest and knowledge:* A large part of the population does not know what the recycling of textile can bring them or they do not have the means of proper disposal, which results in the further development of wastes.
- *There are high processing costs of some materials:* The use of synthetic fibers and chemically treated textiles may not be economical in terms of energy and involved treatment procedures could be costly to recycle.

Solutions and Recommendations

- *Innovation of new recycling technologies:* Recycling can be made more effective and less expensive with investment in new techniques like chemical depolymerization and automated fiber sorting.
- *Incentives provided by the government to recyclers of textile:* Industries could be encouraged to use the recycling and the use of the circular economy by giving subsidies, tax advantages, and policy aid.
- *Sensitization on the use of sustainable clothes:* Through educational campaigns, social media campaigns, and neighborhood efforts, the consumers can be persuaded to wear green and minimize wastage.
- *Partnerships between brands, non-governmental organizations and consumers:* The collaboration of fashion companies, environmental agencies, and customers can create an effective network that can promote the reuse of textiles and sustainable manufacturing.

The Table 1 shows integrated framework highlights how traditional recycling techniques (, e.g., reuse, upcycling, mechanical recycling) lay the foundation for sustainability, while emerging technologies (AI, biotechnology, blockchain, and circular processes) are driving the next generation of smart, efficient, and traceable textile recycling systems. The convergence of digital innovation and green material science marks the path toward a fully circular textile economy, reducing global textile waste and carbon footprint.

Table 1. Comparative overview of traditional and emerging cloth recycling methods

Type / method	Description / process	Significance / advantages	Limitations / challenges	Applications / future prospects
Reusing / donation	Direct reuse or redistribution of wearable garments through charities, thrift stores, and second-hand markets.	Extends garment lifespan; reduces waste; supports low-income communities.	Dependent on garment condition and fashion relevance; hygiene and sorting concerns.	Second-hand retail, relief programs, social welfare initiatives.
Upcycling / creative reuse	Converting old fabrics into higher-value items like bags, quilts, or accessories.	Promotes creativity, sustainability, and small-scale entrepreneurship.	Labor-intensive; not suitable for large-scale processing.	Eco-fashion products, household décor, artisan crafts.
Downcycling	Converting textiles into lower-grade materials such as rags or insulation.	Reduces landfill waste; simple and cost-effective.	Loss of fiber quality; limited lifecycle.	Cleaning rags, carpets, soundproofing, padding.
Mechanical recycling	Shredding fabrics to produce new fibers or nonwoven materials.	Saves energy and resources compared to virgin fiber production.	Degraded fiber quality; sorting and contamination issues.	Automotive interiors, industrial felt, nonwoven textiles.
Chemical recycling	Breaking down polymers into monomers for	Enables high-quality recovery and recycling of blended fabrics.	High setup cost; complex process	Production of regenerated polyester,

CONCLUSION AND FUTURE SCOPE

- To sum up, recycling waste cloths is very crucial in mitigating environmental pollution, resource conservation and sustainable development. The results highlight that the application of circular fashion, where the materials are reused and regenerated into circular forms, could help the ecological footprint of the textile sector to decrease significantly. Through recycling technologies, government assistance and consumer education, an individual and an industry can help in creating a greener and more sustainable future.
- Waste clothes' recycling is a crucial step in realizing a sustainable and greener future. By diverting textiles from landfills, conserving natural resources, and reducing greenhouse gas emissions, clothing recycling does not just minimize environmental harm but also encourages a circular economy. Reusing, processing, and redirecting post-usage textiles from homes into new attire, industrial products, and domestic products exemplify the beneficial aspects of current waste innovation. What is more, innovative community engagement, corporate responsibility, and governmental influence all play a key part in developing a strong textile recycling mechanism. Consequently, recycling waste clothes to use for alternative purposes encourages environmental stewardship, economic efficiency, and social responsiveness –, therefore, a critical element of contemporary sustainability efforts.
- The prospects are encouraging, with high prospects in waste cloth recycling. This is thanks to material evolution, artificial intelligence, and circular business models. Next-generation technologies including automated sorting using AI and micro biome sorting can improve efficiency and scalability. The development of environmentally friendly fibers and chemical recycling enables large-scale recovery from fabric mixes. Creating on-site depots and spurring designer-led recycling or immersing the use of blockchain can further revolutionize the field. Increased awareness and favorable policies could motivate industries and consumers towards environmental-friendly production and end-user practices hence, presenting a vast prospect for textile recycling research and development to move society closer to meeting its environmental aspirations and having a wholly sustainable green economy.

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