

TEXTILE WASTE VALORIZATION IN THE CONTEXT OF CIRCULAR ECONOMY: OPPORTUNITIES FOR SUSTAINABLE BUSINESS DEVELOPMENT IN MOLDOVA

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Abstract: *The increasing generation of textile waste has become a significant environmental and economic challenge worldwide, driven by rapid consumption patterns and the expansion of the fashion industry. In the context of the transition toward a circular economy, textile waste valorization is gaining increasing attention as a strategic approach to reducing environmental impacts while creating new economic opportunities. This study explores the potential of textile waste valorization as a pathway for supporting sustainable business development, with a particular focus on emerging circular economy systems such as the Republic of Moldova. The research is based on a qualitative analytical approach, including the review and synthesis of scientific literature, policy documents, and existing industry practices. The paper identifies and systematizes the main sources of textile waste, distinguishing between pre-consumer and post-consumer streams, and analyzes key valorization pathways, including direct reuse, upcycling, material recycling, industrial applications, and energy recovery. The findings highlight the importance of adopting a hierarchical and integrated approach to textile waste management in order to maximize resource efficiency and value retention. Furthermore, the study proposes a conceptual framework for the integration of textile waste valorization into circular value chains and outlines key opportunities for sustainable business development in Moldova. The results emphasize the need for stronger collaboration between academia, industry, and policymakers, as well as the development of supportive infrastructure and regulatory mechanisms to facilitate the transition toward a circular and resilient economy.*

Keywords: *circular economy, textile waste; valorization, sustainable business, resource efficiency, recycling, innovation.*

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1. Introduction

In recent decades, the rapid expansion of the textile and fashion industry has led to a substantial increase in global textile waste generation. Driven by accelerated consumption patterns, short product life cycles, and the rise of fast fashion, textile waste has become a critical environmental and resource management challenge at the global scale.

Traditionally, textile waste has been managed within a linear “take-make-dispose” economic model, resulting in significant material losses and environmental pressure. In response, the transition toward a Circular Economy has gained momentum, emphasizing resource efficiency, waste minimization, and the reintegration of secondary materials into production systems.

Within this paradigm, textile waste valorization has emerged as a strategic approach, encompassing reuse, recycling, and the development of alternative applications for textile residues. These processes contribute to the formation of circular value chains and support the emergence of sustainable and resource-efficient business models.

In economies with developing circular economy frameworks, including the Republic of Moldova, the implementation of integrated textile waste management systems remains at an early stage. The absence of a centralized collection infrastructure and limited processing capacities significantly constrain effective textile waste management. Despite the economic relevance of the textile sector, the majority of textile waste is still directed to municipal landfills or handled without adequate material recovery. This structural gap underscores the necessity of improved analytical frameworks for textile waste flows and the identification of viable valorization pathways.

Against this background, the present study aims to analyse the potential of textile waste valorization as a mechanism for supporting circular economy development and fostering sustainable business opportunities, with a particular focus on the Republic of Moldova.

2. Literature Review

The growing environmental impact of textile production and consumption has attracted increasing attention from researchers and policymakers in recent years. The textile and fashion industry is considered one of the most resource-intensive sectors, characterized by high consumption of raw materials, water, and energy, as well as significant waste generation (Ellen MacArthur Foundation, 2017). As a result, textile waste management has emerged as a critical research frontier within the broader frameworks of waste management and the circular economy (European Environment Agency, 2024, May).

Traditional waste management systems were primarily focused on end-of-pipe disposal practices, such as landfilling and incineration. However, these approaches are increasingly viewed as unsustainable due to their negative environmental externalities and the inefficient loss of valuable resources (Ghisellini, P., Cialani, C., & Ulgiati, S., 2016). In response, researchers have emphasized the necessity of transitioning from “take-make-dispose” linear models toward circular economic systems that prioritize waste prevention, reuse, and resource recovery (Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J., 2017; Scipencio, A., & Pashkevich, K., 2020).

Within the circular economy framework, the concept of waste valorization has emerged as a pivotal strategy for transforming waste materials into high-value resources (Arshadi, M.,

et al., 2020). Valorization involves diverse processes that reintegrate waste into production cycles, thereby reducing the demand for virgin raw materials and mitigating environmental pressures. In the textile sector, these strategies encompass the reuse of garments, upcycling, material recycling, and the application of textile residues in cross-industrial processes (Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B., 2016).

While several studies highlight the potential of advanced recycling technologies and innovative fiber recovery, researchers argue that technological solutions alone are insufficient to address the systemic challenges of textile waste (Sandin, G., & Peters, G. M., 2018). Effective management requires a holistic shift involving supply chain restructuring, novel business models, and shifts in consumer behavior (Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A., 2020). Another vital research direction concerns the development of circular value chains, which aim to extend product lifecycles through repair, remanufacturing, and closed-loop recycling (Graur, I. V., Scripcenco, A., Avadanei, M., Florea-Burduja, E., Vatra, A. D., & Roşca, M. I., 2025; Stahel, W. R., 2016).

Despite the expanding body of literature, research remains heavily skewed toward the technical aspects of recycling. Less attention has been dedicated to the systematization of valorization pathways and their role in supporting sustainable business development, particularly in emerging economies (World Bank, 2022). Consequently, further research is required to analyze how diverse valorization strategies can catalyze circular models and create opportunities for sustainable entrepreneurship. Such analysis is especially pertinent for countries like Moldova, where the transition to a circular economy is in its nascent stages but offers significant potential for innovation through collaboration between academia, industry, and policymakers (Popovici, A., & Catan, P., 2021; Scripcenco, A., 2025, April).

This analysis is particularly urgent for the Republic of Moldova, where the textile sector represents a strategic branch of the national economy but faces an acute lack of infrastructure for managing post-industrial and post-consumer waste. The transition toward a circular economy in Moldova is supported by a regulatory framework currently being aligned with European Union directives, specifically through the implementation of Extended Producer Responsibility (EPR) (Ministerul Mediului al Republicii Moldova, 2023). However, practical implementation remains fragmented. Recent studies indicate that most local textile companies are limited to exporting waste or disposing of it through landfilling, thereby missing the economic potential of domestic valorization (World Bank, 2022). There is a significant gap between environmental policies and the technological capacity of SMEs to adopt upcycling or chemical recycling solutions. Therefore, developing an ecosystem based on collaboration between academia, the industrial sector, and policymakers is essential to transform textile waste from an environmental problem into a resource for industrial innovation, aligning the local industry with the standards of the European Green Deal (European Commission, 2020).

3. Methodology

This study applies a qualitative analytical approach aimed at examining the potential of textile waste valorization within the framework of the Circular Economy and its implications for sustainable business development. The research is based on the analysis and synthesis of scientific literature, policy reports, and existing practices related to textile waste management and resource recovery.

The methodological framework includes several complementary research methods. First, a **literature review** was conducted to identify key concepts and current research trends related to textile waste management, valorization strategies, and circular economic models. This step allowed the identification of the main approaches used in recent studies and the determination of existing research gaps.

Second, a **comparative analysis** of different textile waste valorization pathways was carried out in order to systematize the main strategies applied in the textile and fashion industries. Particular attention was given to approaches that enable the transformation of textile waste into valuable secondary resources, including reuse, upcycling, material recycling, and industrial applications.

Third, the study employs **conceptual modelling** to illustrate the integration of textile waste valorization processes into circular value chains. The proposed conceptual framework highlights the relationships between textile waste generation, valorization pathways, and potential opportunities for sustainable business development.

This methodological approach makes it possible to analyse textile waste valorization from a systemic perspective and to identify opportunities for improving resource efficiency and promoting circular economic practices, particularly in emerging contexts such as Moldova.

4. Results and Discussion

Sources and Types of Textile Waste

The analysis of textile waste streams reveals that the textile and fashion industry generates substantial volumes of waste at multiple stages of the product lifecycle. From a circular economy perspective, the identification and classification of these waste streams represent a critical prerequisite for designing effective valorization strategies and optimizing resource recovery processes.

Estimates of textile waste generation in the Republic of Moldova vary significantly depending on the methodology used. According to modeling approaches based on consumption patterns and European benchmarks, total textile waste generation is estimated at **50,000–55,000 tons annually** (European Environment Agency, 2024, May).

However, more conservative assessments, including data reported within national circular economy initiatives such as e-Circular (Centrul de instruire și consultanță e-Circular. (2026), indicate lower values of approximately **30,000 tons per year**, reflecting only the officially recorded or managed waste streams.

This discrepancy highlights a substantial data gap and suggests that a significant share of textile waste remains unaccounted for due to the lack of separate collection systems and incomplete monitoring. Consequently, actual textile waste generation in Moldova is likely underestimated in official statistics.

Textile waste can be broadly categorized into **pre-consumer** and **post-consumer waste**, each characterized by distinct properties and implications for valorization. According to data from the European Environment Agency, **post-consumer textile waste accounts for approximately 82% of the total textile waste stream**, while the remaining share corresponds to pre-consumer and industrial waste (European Environment Agency, 2024, May).

Pre-consumer textile waste originates within industrial production processes, including fiber processing, yarn manufacturing, fabric formation, and garment assembly. This category comprises fabric offcuts, defective materials, trimming waste, and unsold inventory. Due to its relatively homogeneous composition and predictable material characteristics, pre-consumer waste is particularly suitable for high-value recycling and reintegration into industrial production cycles. From a business perspective, this type of waste represents a readily accessible resource for implementing closed-loop production systems and improving material efficiency.

In contrast, post-consumer textile waste consists of textile products discarded after use, including clothing, household textiles, and other fabric-based items. This waste stream is significantly more heterogeneous, often containing mixed fibers, varying levels of wear, and contamination. As a result, it requires more complex processes such as sorting, classification, and cleaning prior to valorization. Despite these challenges, post-consumer waste represents a substantial untapped resource within circular economy systems, particularly in emerging markets where collection and processing infrastructures are still underdeveloped.

In addition, industrial textile waste generated from technical textiles and specialized applications introduces further complexity due to the presence of composite materials and nonwoven structures. These materials often require advanced processing technologies but also offer opportunities for cross-sectoral valorization in industries such as construction, automotive, and environmental engineering.

Table 1. Estimated textile waste flows in the Republic of Moldova

Waste category	Source	Estimated share (%)	Material composition	Current management practice	Valorization potential
Pre-consumer waste	Garment manufacturing	20–30	Cotton, polyester, blends	Partial reuse (internal), disposal	High (reuse, recycling)
Cutting scraps	Cutting processes	10–20 (of material)	Mostly homogeneous fabrics	Limited reuse	Very high (recycling, upcycling)
Production defects	Sewing/finishing	5–10	Mixed materials	Disposal or secondary use	Medium
Post-consumer waste	Households	50–60	Highly heterogeneous	Landfill	Medium (requires sorting)
Second-hand waste	Imported used clothing	20–30	Worn mixed textiles	Disposal	Low–medium
Commercial waste	Retail sector	5–10	Unsold garments	Discounting / disposal	High (reuse, donation)
Total textile waste	National level	~100	Mixed	>90% landfill	Underutilized

Source: Developed by the authors

The increasing volume and diversity of textile waste streams highlight the limitations of traditional linear waste management approaches. The continued reliance on landfilling and incineration leads to significant losses of material value and contributes to environmental

degradation. In contrast, the circular economy framework emphasizes the need to treat textile waste as a resource rather than a disposal problem.

In this context, the classification of textile waste is not merely a descriptive exercise but a strategic tool that enables the alignment of specific waste streams with appropriate valorization pathways. This alignment is essential for the development of efficient circular value chains and for maximizing both environmental and economic benefits.

During the study, an analysis of the structure of textile waste flows in the Republic of Moldova was carried out, including their sources, composition, and recycling potential, as presented in Table 1.

Pathways for Textile Waste Valorization

The systematization of textile waste valorization pathways provides a structured understanding of how waste materials can be transformed into valuable resources within circular economic systems. Based on the analysis of existing research and industry practices, several key pathways can be identified, differing in terms of technological complexity, value retention, and economic potential.

A hierarchical approach to valorization reveals that strategies such as **direct reuse and upcycling** generally preserve the highest level of product value, while **recycling and energy recovery** involve progressively greater material transformation and value loss. This hierarchy is consistent with the principles of the circular economy, which prioritize resource efficiency and lifecycle extension.

Direct reuse represents the most resource-efficient strategy, as it requires minimal processing and preserves the original function of textile products. The expansion of second-hand markets and clothing exchange systems can significantly reduce the demand for new production. In the context of Moldova, the development of organized reuse systems remains limited, indicating a clear opportunity for business innovation and infrastructure development.

Creative reuse and upcycling introduce additional value through design and innovation. This pathway is particularly relevant for small and medium-sized enterprises, designers, and social enterprises, as it combines environmental benefits with economic and cultural value creation. Upcycling practices can contribute to the development of niche markets and support the growth of sustainable fashion initiatives.

Material recycling enables the recovery of fibers and their reintegration into new production cycles. While this approach contributes significantly to resource efficiency, it is often constrained by technological limitations, especially in the case of blended materials. In Moldova, the lack of local recycling infrastructure represents a major barrier, resulting in the export or disposal of textile waste rather than its domestic valorization.

Industrial applications offer an alternative pathway for utilizing textile waste in non-fashion sectors. The transformation of textile residues into insulation materials, geotextiles, or composite components illustrates the potential for cross-industry integration. This diversification of applications enhances the resilience of circular systems and reduces dependence on single-sector solutions.

Finally, **energy recovery** represents the least preferred option within the circular hierarchy, as it involves the destruction of material value. However, it remains a relevant solution for waste

streams that cannot be effectively reused or recycled. From a sustainability perspective, energy recovery should be considered a complementary rather than primary strategy.

The comparative analysis of these pathways demonstrates that the effectiveness of textile waste valorization depends on the integration of multiple strategies within a coherent system. Isolated solutions are insufficient; instead, a systemic approach is required to optimize material flows and maximize value retention.

As a result of the study, the main ways of recycling textile waste were summarized and presented in Table 2.

Table 2. Main Pathways of Textile Waste Valorization

Valorization pathway	Description	Examples
Direct reuse	Reuse of textile products without significant processing	Second-hand clothing, donation, clothing exchange
Creative reuse (upcycling)	Transformation of textile waste into new products with higher value	Fashion design, accessories, decorative objects
Material recycling	Recovery of fibers for the production of new textile materials	Recycled yarns, recycled fabrics
Industrial applications	Use of textile residues in non-fashion industrial sectors	Insulation, filling materials, geotextiles
Energy recovery	Use of textile waste as a secondary energy resource	Thermal energy recovery

Source: Developed by the authors

The identification and classification of textile waste valorization pathways provide a conceptual basis for analysing how such strategies may contribute to the development of sustainable business initiatives and circular economic practices. These opportunities are particularly relevant for countries with emerging circular economy systems, such as Moldova.

Based on the conducted research and analysis of possible ways of processing textile waste in the Republic of Moldova, we have developed a conceptual model for the valorization of textile waste within the framework of a circular economy (Figure 1)

Opportunities for Sustainable Business Development in Moldova

The transition toward a circular economy creates significant opportunities for sustainable business development, particularly in emerging markets such as Moldova. The valorization of textile waste can serve as a catalyst for innovation, enabling the creation of new business models, value chains, and economic activities.

One of the most promising areas is the development of **reuse-based business models**, including second-hand retail, repair services, and clothing rental systems. These models extend product lifecycles while generating economic value from existing resources.

Another important opportunity lies in **upcycling and creative industries**, where textile waste is transformed into high-value products. This sector is particularly accessible for small enterprises and startups, requiring relatively low investment while offering strong differentiation through design and sustainability.

The establishment of **recycling infrastructure** represents a more capital-intensive but strategically important direction. Developing local capacities for textile recycling would

reduce dependence on external markets and enable the creation of domestic circular supply chains.

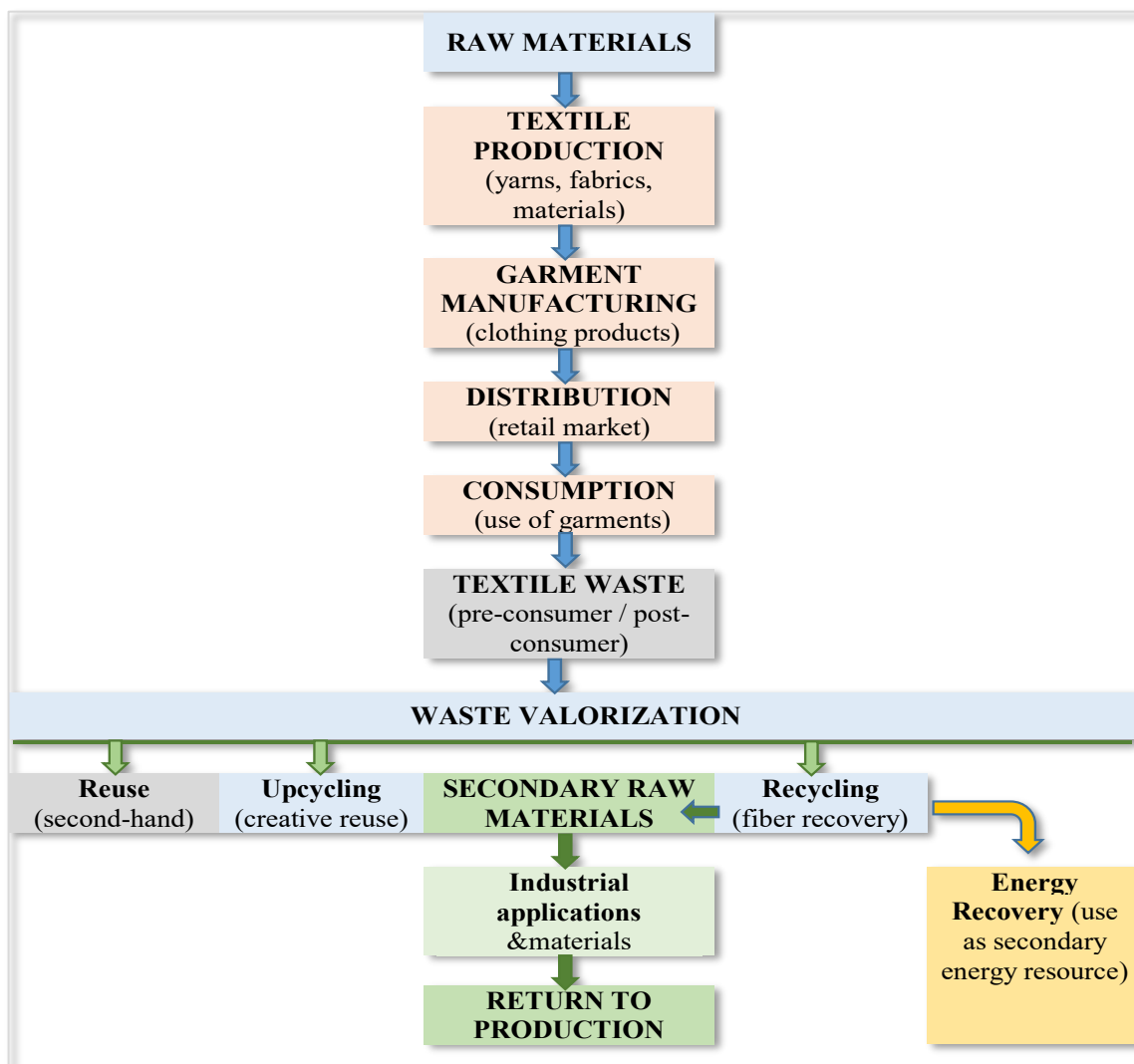


Figure 1. Proposed Conceptual Framework for Textile Waste Valorization

Source: Developed by the first authors

Furthermore, the integration of textile waste into **industrial applications** opens new avenues for cross-sector collaboration. Partnerships between textile producers and industries such as construction or automotive manufacturing can facilitate the development of innovative materials and products.

Despite these opportunities, several challenges remain, including limited infrastructure, lack of technological capabilities, and insufficient coordination between stakeholders. Therefore, the development of an effective circular textile system in Moldova requires a collaborative approach involving academia, industry, and public authorities. In this context, universities and research institutions play a key role in knowledge generation and innovation, while policymakers are responsible for creating supportive regulatory frameworks. Businesses, in turn, act as drivers of implementation, translating circular economy principles into practical solutions.

Overall, the findings suggest that textile waste valorization has the potential to become a strategic component of sustainable economic development in Moldova. However, its successful implementation depends on the creation of an integrated ecosystem that supports innovation, investment, and collaboration.

5. Conclusions

The growing volume of textile waste represents not only an environmental burden but also a significant untapped resource within emerging circular economy systems. This study has demonstrated that the transition from linear to circular models in the textile sector requires a fundamental rethinking of waste, shifting its perception from a disposal problem to a valuable input for new production and business processes.

The analysis of textile waste streams highlights their structural complexity, emphasizing the importance of distinguishing between pre-consumer and post-consumer waste in order to design efficient valorization strategies. Furthermore, the systematization of textile waste valorization pathways provides a comprehensive framework for understanding how different levels of value recovery - from direct reuse to energy recovery - can be integrated into circular value chains.

A key contribution of this study lies in framing textile waste valorization as a multidimensional process that connects environmental sustainability with economic value creation. By linking valorization pathways with potential business applications, the paper advances understanding of how circular economy principles can be operationalized within the textile and fashion sectors.

In the context of the Republic of Moldova, the findings indicate that textile waste valorization offers substantial opportunities for the development of sustainable business models, particularly in reuse, upcycling, and cross-sector applications. At the same time, the study identifies critical barriers, including limited infrastructure, technological constraints, and insufficient stakeholder coordination. Addressing these challenges requires a systemic approach supported by coherent public policies, investment in innovation, and strengthened institutional capacities.

From a policy perspective, the implementation of circular economy strategies in the textile sector should be supported through targeted regulatory instruments such as extended producer responsibility schemes, incentives for recycling and reuse initiatives, and the development of national textile waste management frameworks. In parallel, strengthening collaboration between academia, industry, and government institutions is essential for accelerating knowledge transfer and enabling innovation uptake.

The study also identifies several directions for future research. Further empirical investigations are needed to assess the economic feasibility of specific valorization pathways in the Moldovan context, as well as to examine consumer behavior and its influence on textile waste generation and reuse practices. In addition, the development of quantitative models for measuring environmental and economic impacts of textile waste valorization would provide valuable support for evidence-based policymaking.

In conclusion, textile waste valorization has the potential to become a strategic driver of sustainable development and circular transformation in the Republic of Moldova. Its successful implementation depends on the creation of an integrated ecosystem that aligns technological capacity, business innovation, and policy support. Such an approach would

not only reduce environmental pressures but also generate new opportunities for economic resilience and sustainable growth.

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