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# QUANTITATIVE ASSESSMENT OF TEXTILE WASTE AND RECYCLING EFFICIENCY

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## ABSTRACT

*Textile waste has become a major environmental concern because of increasing clothing production, changing fashion trends, and the growing consumption of textile products. Effective recycling can reduce waste disposal, conserve resources, and support the development of a circular textile economy. This study aims to quantitatively assess textile waste generation and recycling efficiency by examining waste quantities, material recovery rates, fibre composition, and recycling methods. A quantitative research approach is proposed, using data collected from textile manufacturing units and recycling facilities through structured questionnaires and available waste management records. Descriptive statistics, correlation analysis, and multiple regression analysis will be used to evaluate recycling performance and identify factors associated with material recovery. Previous research has highlighted the importance of textile sorting, recycling technologies, and material composition in determining recycling outcomes (Huang et al., 2024; Abagnato et al., 2024). The study is expected to provide useful insights into textile waste management and identify opportunities to improve recycling efficiency and resource utilization in the textile industry.*

## KEYWORDS

*Textile waste, recycling efficiency, textile recycling, material recovery, circular economy, waste management, quantitative analysis.*

## INTRODUCTION

The textile and fashion industries generate substantial amounts of waste during fibre production, fabric manufacturing, garment production, and post-consumer clothing disposal. Increasing textile consumption and the rapid replacement of clothing have intensified concerns about resource depletion, landfill disposal, and environmental pollution. Textile waste contains different fibre types, including cotton, polyester, and blended materials, which require different collection, sorting, and recycling processes. Effective waste management is therefore essential for reducing environmental impacts and improving resource efficiency. Abagnato et al. (2024) reviewed life cycle assessment studies related to textile reuse, recycling, and circular practices, highlighting the environmental benefits of improved textile waste management and the importance of selecting appropriate recovery strategies.Textile recycling efficiency depends on the quantity and quality of waste collected, the composition of textile materials, and the technologies used to recover usable fibres. Mechanical recycling can recover fibres through physical processing, whereas chemical recycling can separate or recover materials through chemical processes. However, fibre damage, contamination, blended fabrics, and processing losses can reduce the quantity and quality of recovered material. Huang et al. (2024) examined the industrialization of open-loop and closed-loop textile recycling and identified technical and commercial challenges affecting the development of effective recycling systems. Their research

demonstrates the importance of assessing recycling performance through measurable indicators, including waste input, recovered material output, and processing losses.

Quantitative assessment provides a systematic way to measure textile waste generation and evaluate the performance of different recycling processes. Material flow analysis can track the movement of textile materials from collection to sorting, recycling, reuse, and disposal, while recycling efficiency calculations can determine the proportion of usable material recovered from waste input. Environmental assessment methods can also help determine whether recycling processes use resources efficiently and reduce environmental burdens. Morell-Delgado et al. (2026) reviewed environmental methodologies used to assess textile circularity and highlighted the importance of reliable data, consistent measurement approaches, and improved representation of different textile materials.Despite advances in recycling technologies, the effective recovery of textile waste remains challenging because of differences in fibre composition, waste quality, collection systems, and processing capabilities. Brouwer and Maaskant (2026) examined clothing waste flows and demonstrated how textile composition and sorting strategies influence reuse and recycling outcomes. These issues indicate the need for quantitative investigations that measure textile waste generation and identify operational factors associated with recycling efficiency. Therefore, the present study proposes to assess textile waste quantities, material recovery rates, and recycling performance to identify opportunities for improving waste management practices in the textile industry.

## RESEARCH OBJECTIVES

1. To quantitatively assess textile waste generation and recycling efficiency in textile and fashion production.
2. To examine the relationship between textile waste composition, recycling methods, and material recovery rates.
3. To identify the major factors associated with improvements in textile waste recycling efficiency.

## RESEARCH QUESTIONS

1. What are the quantities and major sources of textile waste generated in textile and fashion production?
2. How do different recycling methods influence textile waste recovery rates and material efficiency?
3. Which technical and operational factors are associated with improved textile waste recycling efficiency?

## LITERATURE REVIEW

Textile waste management has become an important research area because of the environmental impacts associated with textile production, consumption, and disposal. Abagnato et al. (2024) reviewed life cycle assessment studies examining textile reuse, recycling, and other circular

practices. Their review highlighted the potential environmental benefits of reuse and recycling, while emphasizing the importance of selecting appropriate waste management strategies. The study provides a foundation for assessing textile waste through quantitative indicators and comparing alternative recovery processes.The efficiency of textile recycling depends on the composition of discarded materials, the quality of collected waste, and the technologies used to recover fibres. Huang et al. (2024) reviewed the industrialization of open-loop and closed-loop textile recycling and discussed the technical and commercial challenges associated with recycling systems. Their research highlighted limitations in recovering textile materials for new textile products. These findings suggest that recycling efficiency should be assessed using measurable indicators such as waste input, recovered material output, and processing losses.Quantitative environmental assessment can also help determine whether textile recycling systems improve resource efficiency. The study Assessment of the Eco-Efficiency of the Circular Economy in the Recovery of Cellulose from the Shredding of Textile Waste (2022) examined cellulose recovery from textile waste and the environmental considerations associated with the recovery process. Its research direction highlights the importance of evaluating material recovery alongside resource consumption. Therefore, recycling efficiency should not be measured solely by the quantity of waste processed; the amount of usable material recovered and the resources required for processing should also be considered.

Shamsuzzaman et al. (2025) reviewed textile waste management within the circular economy and discussed waste generation, recycling strategies, environmental impacts, and implementation barriers. Their work highlighted the importance of collection systems, sorting infrastructure, recycling technologies, and coordination among stakeholders. These findings suggest that operational and organizational factors can influence the performance of recycling facilities. Quantitative analysis can help compare recycling performance and identify areas where material recovery may be improved.Morell-Delgado et al. (2026) reviewed environmental methodologies used to assess textile circularity. Their research highlighted the use of life cycle assessment, material flow analysis, and waste composition analysis for evaluating textile waste management. The review also identified challenges associated with data availability, regional assessments, and the representation of different fibre compositions. These findings support the use of transparent data collection procedures and consistent indicators when measuring textile recycling efficiency.

Brouwer and Maaskant (2026) investigated clothing waste flows and examined how textile composition and sorting strategies influence reuse and recycling outcomes. Their research highlights the importance of understanding the movement of textile materials through collection, sorting, and recovery systems. Blended fabrics and differences in material quality can complicate recycling processes and affect the amount of usable material recovered. Material flow analysis can therefore provide useful information about waste quantities, recovery rates, and material losses.Research on textile management strategies has also examined how separate collection and recycling influence environmental performance. Fois et al. (2026) compared environmental impacts associated with cotton and polyester textile management strategies. Their research highlights the importance of considering fibre type and processing requirements when evaluating textile recovery options. Overall, the literature indicates that recycling efficiency depends on

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textile composition, collection quality, sorting procedures, processing technologies, and resource consumption. The present study proposes to examine these factors quantitatively to identify opportunities for improving textile waste recovery and management.

## METHODOLOGY

This study will adopt a quantitative methodology to assess textile waste generation and recycling efficiency in textile and fashion production. Data will be collected from textile manufacturing units and recycling facilities through structured questionnaires and, where available, production and waste management records. The study will measure textile waste quantities, recycling input, recovered material output, and processing losses. Recycling efficiency will be calculated as the percentage of usable recovered material relative to total textile waste input. Additional information regarding fibre composition, sorting procedures, and recycling technologies will be collected to examine variations in recycling performance. Data collection will follow consistent measurement procedures to support reliable comparisons across participating facilities.

## RESEARCH DESIGN

A cross-sectional descriptive and comparative research design will be used to examine textile waste generation and recycling efficiency during a defined period. The target population will include textile manufacturing facilities and recycling units involved in textile waste collection, sorting, and processing. Purposive sampling may be used to select facilities that maintain relevant production and waste management records. The independent variables will include waste composition, sorting methods, recycling technology, and processing conditions, while recycling efficiency and material recovery rates will serve as the dependent variables. The design will allow comparisons between facilities and recycling methods to identify factors associated with improved material recovery.

## DATA ANALYSIS

The collected data will be analyzed using SPSS, Microsoft Excel, or equivalent statistical software. Descriptive statistics, including frequencies, percentages, means, and standard deviations, will summarize textile waste generation and recycling performance. Recycling efficiency will be calculated using the following formula.Material loss will be estimated by subtracting recovered usable material from total waste input, with other measured outputs accounted for where necessary. Correlation analysis will examine relationships between operational factors and recycling efficiency. Multiple regression analysis will identify which factors significantly predict recycling performance. Where appropriate, comparative statistical tests will be used to examine differences between recycling technologies or facility categories. Statistical significance will be evaluated at the 0.05 level, and the results will be interpreted using the actual collected data.

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## FINDINGS

Based on previous research, textile recycling efficiency is expected to vary according to fibre composition, sorting quality, processing technology, and material losses. Abagnato et al. (2024) highlighted the potential environmental benefits of textile reuse and recycling, while Huang et al. (2024) identified technical and industrial challenges associated with closed-loop textile recycling. Brouwer and Maaskant (2026) further highlighted the importance of textile composition and sorting strategies in determining recovery outcomes. These findings suggest that improved sorting, appropriate recycling technologies, and reduced processing losses may contribute to more effective textile waste management. However, the actual recycling efficiency, statistical relationships, and differences between facilities will be established only after the proposed study's data have been collected and analyzed.

## CONCLUSION

The quantitative assessment of textile waste and recycling efficiency is important for understanding material losses and improving resource utilization within the textile industry. This study proposes to measure textile waste generation, material recovery rates, and operational factors associated with recycling performance. Through descriptive statistics, correlation analysis, regression analysis, and comparisons between recycling methods, the research will identify opportunities to improve material recovery and reduce waste. The study may provide useful insights for textile manufacturers, recycling facilities, and sustainability professionals seeking to improve waste management practices. The final conclusions will be based on the statistical evidence obtained from the collected data.

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