From Waste to Creativity: A Novel Approach for Upcycling Clothing Production Waste to Promote Circular Economy and Sustainable Development

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Abstract

Waste is a substantial global resource that affects the environment and human health. The clothing and textile sector generates a tremendous amount of waste, ending in landfills; this significantly affects the environment and the economy due to insufficient recycling practices. Fabric scraps can be reused or recycled to produce innovative products with high-added value to promote sustainability and preserve the environment. Recycling fabric scraps is environmentally friendly and promotes social and economic development through innovative waste-handling practices. This study reduces garment waste and achieves sustainability through circular economy principles in the Department of Home Economics at the Faculty of Women, Ain Shams University. The study uses intermediate materials – Tulle, Organza, and Water-soluble

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stabilizers – to upcycle fabric remnants and yarn leftovers into novel recycled fabrics used in seven applications. A two-part questionnaire was utilized to gather specialist and customer feedback about the suggested applications: the first is a three-axis evaluation of recycled fabric products (economic, functional, and aesthetic aspects), and the second is a two-axis evaluation of recycled fabric method (environment and sustainable development, and economic aspect). With an average acceptance rate of at least 91.5%, the findings of the response analysis on the first part of the questionnaire indicated that the proposed strategy is economically, functionally, and aesthetically acceptable. The second part of the study, which examined the recycling process, likewise showed that 98.46% of respondents admitted it for environmental and sustainable development. The high average acceptance rate, 97.80%, reflects the economic importance of the proposed method.

Keywords

Upcycling, Fabric Waste, Sustainability, Circular Economy (CE), Sustainable Development

من الهدر إلى الإبداع: نهج جديد لإعادة تدوير نفايات إنتاج الملابس لتعزيز الاقتصاد الدائري والتنمية المستدامة

المستخلص:

النفايات هي مورد عالمي كبير يؤثر على البيئة وصحة الإنسان، وقطاع صناعة الملابس يولد كمية هائلة من المخلفات، والتي تنتهي في مكبات النفايات؛ وهذا يؤثر إلى حد بعيد على البيئة والاقتصاد بسبب ممارسات إعادة التدوير غير الكافية. فقصاصات الأقمشة يمكن إعادة استخدامها أو إعادة تدويرها لإنتاج منتجات مبتكرة ذات قيمة مضافة عالية لتعزيز الاستدامة والحفاظ على البيئة. حيث يعد إعادة تدوير قصاصات القماش عملية بيئية ووسيلة مهمة لتعزيز التنمية الاجتماعية والاقتصادية من خلال الابتكار في استخدام هذه النفايات. تهدف هذه الدراسة إلى تطبيق مبادئ الاقتصاد الدائري لتحقيق الاستدامة وحل مشكلة نفايات إنتاج الملابس في قسم الاقتصاد المنزلي بكلية البنات للآداب والعلوم والتربية بجامعة عين شمس. استخدمت الدراسة طريقة إعادة تدوير مبتكرة لتحويل قصاصات القماش وبقايا الخيوط إلى قماش مبتكر مُعاد تدويره والاستفادة منه في انتاج سبع تطبيقات مختلفة. تم استطلاع رأي المتخصصين والمستهلكين في التطبيقات المقترحة للمنتجات النهائية باستخدام استبانة تنقسم فقراتها إلى قسمين: الأول لجمع الآراء حول المنتجات المصنوعة من الأقمشة المبتكرة المعاد تدويرها في ثلاثة محاور (الجوانب

الاقتصادية والوظيفية والجمالية)، والثاني لتقييم الطريقة المقترحة للأقمشة المعاد تدويرها في محورين (البيئة والتنمية المستدامة، والجانب الاقتصادي). وقد دلت نتائج تحليل الاستجابات على الجزء الأول من الاستبانة والتي لم تقل متوسط نسب القبول بها عن ٩١.٥٪ ان الطريقة المقترحة تحظى بقبول كبير من الجانب الاقتصادي والوظيفي والجمالي. وقد دلت أيضا نتائج تحليل الجزء الثاني من الاستبانة والذي يتعلق بأسلوب إعادة التدوير، في أن الأسلوب المقترح يجد قبولاً واسع النطاق في خدمة البيئة والتنمية المستدامة بمتوسط نسبة قبول وصلت الى ٩٨.٤٦٪، كما يعكس متوسط معدل القبول، ٩٧.٨٠٪، الأهمية الاقتصادية للطريقة المقترحة.

الكلمات المفتاحية: إعادة التدوير، نفايات الأقمشة، الاستدامة، الاقتصاد الدائري، التنمية المستدامة

Introduction

Textile waste adversely impacts the environment, society, and economy. According to studies conducted by UNIDO and other organizations, Egypt generates 212,000 tons of pre-consumer textile waste annually, spinning waste (11%), fabric mill waste (26%), RMG waste (39%), overproduction (9%), and deadstock (8%) (Srl, 2024) (UNIDO, 2022) About 175,700 tons are recyclable, with 103,300 tons suitable for fiber-to-fiber recycling and 72,500 tons for downcycling into upholstery or industrial applications. Up to 36,300 tons can be reused from manufacturing or sales. Due to poor segregation practices, some textile waste is incinerated without being sent to landfills (UNIDO, 2022).

Pollution causes environmental degradation and reduces air and water quality due to improper waste disposal (El Mor, Hassouna, Saad, & Zayed, 2022) Furthermore, discarding this waste means wasting the resources utilized in production, which imposes additional strain on the environment (Zaghlol, 2021) (Stella, Garofalo, Cavallini, Fino, & Deorsola, 2024) In the great Cairo and other cities, burning textile waste pollutes the air. Openly burning solid organic waste, especially textile waste, releases PM2.5 and PM10, CO2, sulfur fumes, and heavy metals like iron and lead into the atmosphere. This practice worsens air quality issues caused by vehicles, industry, and agricultural burning (Air Quality in Egypt, 2025) (Tirupathi, 2025). Air pollution from garbage burning causes 18,000 premature deaths in Cairo, 16% of total deaths. National PM2.5 values are 13.6 times WHO recommendations—toxic chemicals from burning textile waste cause respiratory ailments, cancer, and other health issues (Air Quality in Egypt, 2025).

Societal damage is represented by the negative impact on individuals' health. Textile waste burning produces fumes that contribute to air pollution and harm the health of individuals. In addition to the economic damage, which centers on increased costs needed for waste management to transport, store, and dispose of it, and which heightens the financial burdens (El Mor, Hassouna, Saad, & Zayed, 2022); the other hand, failing to recycle waste results in losing prospective job possibilities in recycling and product development (Gabr, Al Gamal, & Tawfik, 2018) (Karnad, 2023) For all these reasons, the tendency towards recycling this waste was inevitable due to its importance and positive effects on all aspects.

Literature Review and Previous Studies

Recycling Improvement for Sustainability

Recycling is a path to sustainability (Chaudhuri, Chakraborty, & Maulik, 2020), which means creating and producing garments that minimize negative environmental and societal impacts. Sustainability focuses on the integration of economic, social, and ecological requirements. Consequently, sustainable design spotlights the development of products that align with sustainability principles. It aims to reduce waste and enhance the local economy through job creation (Afify, 2019). The relationship between sustainability in clothing production and recycling waste is becoming more significant, highlighting a crucial response to environmental challenges (Wagaw & Babu, 2023).

Therefore, recycling waste can relieve landfill pressure and avoid releasing pollutants produced during degradation or burning into the environment. (Sumo, 2024). It also helps minimize the demand for fresh raw materials and reduces the consumption of natural resources and energy consumed in production (Ciolacu, 2019) (Shen & Sethi, 2021). The policy of recycling textiles and clothing from industrial waste is not only environmentally helpful but also of social importance, as it helps empower women and generates jobs, especially in low-income communities (Lejarreta-Andrés, Melià-Seguí, Bhattacharyya, Vilajosana, & Sarma, 2022) (Tang, 2023).

Upcycling is a recycling process that increases the value of the materials used rather than reprocessing them into their original forms. Upcycling involves a particular innovation and creativity of transforming waste final products into something more useful or aesthetic, creating a mixture of products with more ecological or artistic added value than the original product. Upcycled products often have a higher perceived value and can be more environmentally friendly since they extend the life cycle

of materials without significant processing (Han, et al., 2017) (Aktaş & Aktaş, 2022).

Generally, recycling involves breaking down materials into raw components for reuse in new products, often resulting in lower-quality outputs (e.g., rags, insulation) (Chaudhuri, Chakraborty, & Maulik, 2020). Upcycling transforms waste into higher-value products while retaining or enhancing material properties (Li, Du, & Yang, 2025). Although recycling has an insignificant effect on climate change, it provides clear environmental advantages, especially in reducing trash and preserving water (Sandin, Lidfeldt, & Nellström, 2025). Upcycling can potentially increase efficiency by avoiding reprocessing and promoting circular design. Neither method is universally superior; hybrid approaches (e.g., combining recycling with upcycling) may yield the most impactful results (Osei & Ademtsu, 2024) (Anjimoon, et al., 2024).

Circular Economy (CE)

While current industrial linear models cause environmental damage, economic loss, and social pressures (Koszewska, Rahman, & Dyczewski, 2020), the Circular Economy (CE) concept offers a transformative framework for creating a sustainable system that minimizes waste while increasing resource use (Murray, Skene, & Haynes, 2017). This transformation is essential for promoting sustainability and addressing pressing issues such as resource-draining, pollution, and waste management. CE can reduce virgin materials by collecting used garments for recycling into new fabrics or products (Shymanovska-Dianich & Rangra, 2024). Reducing, reusing, and recycling are the three main actions and strategies of the CE concept (Chen, Memon, Wang, Marriam, & Tebyetekerwa, 2021).

It can be asserted that the linear economy has low upfront and high long-term costs; it is highly polluting and resource-depleting; and economically, it has short-term gains and long-term risks. In comparison, the circular economy has high upfront costs, reduced long-term costs, low pollution, and resource conservation. Economically, it has long-term resilience and innovation-driven growth (Sariatli, 2017).

Applying CE principles has many advantages. They improve resource management, encourage recycling, reuse, and reduction of inputs in production, and reduce waste (Saha, Dey, & Papagiannaki, 2021) (Koszewska M. , 2018). Sustainability can be improved by implementing circular practices, which involve preserving water, minimizing carbon emissions, and reducing textile chemicals (Wiegand & Wynn, 2023). CE can create new markets to satisfy shifting consumer demand and strengthen local economies (Kucińska-Król, Festinger, Walawska, & Kulczycka, 2024).

Furthermore, growing consumer awareness of sustainability stimulates the demand for circular recycled products. Also, companies are encouraged to implement circular practices to satisfy consumers' increasing environmental awareness (Saha, Dey, & Kumar, 2024).

Locally, the CE is increasingly recognized as a crucial framework for promoting sustainability in Egypt's textiles and clothing sector. This approach emphasizes minimizing waste and making the most of resources, which is particularly relevant given the environmental challenges associated with textile production and waste management. The CE approach can give Egypt sustainable solutions to solve environmental difficulties like limited resources, waste generation, and a growing population in an eco-friendly and long-term manner (Rezk, et al., 2023).

Recycling Attempts in Textiles and Clothing

There have been many recycling attempts in the clothing and textiles fields, and here are some examples: recycling old-fashioned men's ties into new furniture and light fixtures (Ragab, 2019); using recycled fabrics to make puppets for early childhood children to preserve clothes history (Deabes, El-Maghraby, Alowaidh, & Kandeel, 2023); Recycling fabric leftovers and using patchwork to enhance productive families' projects (Sweliam, 2018); another study recycled curtain and upholstery textiles to make sustainable women's apparel. The results demonstrated that recycling these fabrics is economically and environmentally beneficial (Zaghlol, 2021); research created an instructional unit to manufacture children's furniture using fabric waste. This study improved students' practical and creative skills (Khalaf, 2021); a study aimed to recycle wool fabric waste and create a mini eco-collection using the yarns produced (Ayakta, Kurtoglu, & Yilmaz, 2024); in another study, jute and shredded fabric were used to make attractive clothes, to increase awareness of recycled apparel, and to promote sustainable industry practices (Chichi, Nkrumah, Ocran, & Asinyo, 2024); creating new women's winter clothes from recycled fabrics (Jaize & K, 2024); Other researchers created antique-inspired accessories for modern garments based on Shabby Chic, an inexpensive style that mixes old, worn-out pieces with modern ones to create a simple, elegant atmosphere (Slama, et al., 2024). These studies demonstrate the growing initiatives to enhance sustainability by recycling textile waste, which improves economic, social, and environmental situations.

Upcycling Practices and Sustainable Ventures Promoting

Egypt's garment sector faces indirect pressure from EU Directive 2018/851, which mandates separate textile waste collection and 65%

recycling rates by 2030 for member states (Wojnowska-Baryła, Bernat, Zaborowska, & Kulikowska, 2024) (Lanz, Laborda, Chaine, & Blecua, 2024). On the other hand, Egypt does not have clear Extended Producer Responsibility (EPR) rules, yet ideas to encourage recycling through tax benefits for businesses utilizing at least 30% recycled content exist (Plotnic & Praporșcic, 2025). Therefore, individuals are responsible for helping the country recycle and reduce textile waste through sustainable ventures.

Sustainable ventures derive substantial advantages from upcycling clothing production waste, improving their environmental, economic, and social impacts. ***Environmental benefits:*** utilizing existing materials and upcycling minimizes the need for new resources, contributing to resource conservation and aligning with sustainable development principles (Caldera, Jayasinghe, Desha, Dawes, & Ferguson, 2022). ***Economic Advantages:*** creating value-added products enhances the profit margins for businesses engaged in upcycling, allowing them to enter sustainable niche markets. Upcycling practices led to new business models and market segments focused on sustainability (Yee & Baskaran, 2024). ***Social impact:*** upcycling initiatives enrich local economies by creating design, production, and retail jobs. Additionally, upcycling practices develop skills and enhance social cohesion for those involved in crafts communities. Besides, consumers can learn the importance of repurposing waste to shift their behavior towards more sustainable purchasing practices (Iannilli & Spagnoli, 2024).

University's Role in Sustainability Education

Universities are essential in increasing awareness about sustainability and recycling practices through education, research, and community engagement. Their role in sustainable education goes beyond providing academic information; it includes integrating sustainability into curricula (Abou Hashish & Sakr, 2023), promoting research and innovation (Mahmoud, 2023), building community partnerships (Pocol, Stanca, Dabija, Pop, & Mișcoiu, 2022), and implementing sustainable practices on campus (Abou Hashish & Sakr, 2023). Through these ways, universities try to make society aware and capable of facing future sustainability challenges and become role models for students and society. Among these practices is adding an "Environmental Culture" course to university curricula to promote sustainable development.

The Study Problem and Objectives

Home Economics Department at the Faculty of Women for Arts, Sciences, and Education, Ain Shams University, specializing in teaching students dressmaking and handicrafts over four academic years, resulting

in large amounts of fabric waste from cutting fabrics and yarn leftover from handicrafts such as crochet, knitting, embroidery, and others. This waste ends up being thrown away or burned in landfills. Therefore, this study aims to propose an innovative solution to recycle this waste and produce innovative products with added value as sustainable ventures. That was why collecting these wastes to achieve maximum benefit by using the upcycling method to make new recycled fabrics. Innovative fabrics have been created by collecting these scraps and yarns, sewing them with intermediate materials, and using them as new fabric pieces for different applications.

Methodology

The study follows the experimental, analytical method; it focuses on utilizing novel recycled fabrics in various applications and studies the effect of the used upcycling strategy on the environment, society, and economy through sustainable ventures. The aim of the study was achieved by following the following steps:

1. Collecting, sorting, and preparing clothing production waste

During the academic year, in the Home Economics Department at the Faculty of Women for Arts, Sciences, and Education, Ain Shams University, fabric scraps, and yarn leftovers were collected and separated from the other wastes. Two baskets were prepared to collect waste, one for the fabric scraps and the other for yarn leftovers. The two baskets were made of recycled water bottles covered with waste fabrics, as shown in Figure 1. The collected fabric scraps and yarn leftovers have been sorted according to color, material, and size. Figure 2 shows the collected waste after sorting.

Figure (1): The recycled water bottles prepared for collecting fabric scraps and leftover yarn.

Figure (2): The collected fabric scraps and yarn leftovers after sorting them into:
(a) Small sizes fabric scraps – (b) Large size fabric scraps – (c) Yarn leftovers

2. *Identifying intermediate materials*

The intermediate materials refer to the transparent materials used to assemble waste between two layers, such as (Tulle/Organza/Water Soluble Stabilizer/Plastic Sheets), as shown in Figure 3. These intermediate materials facilitate sewing the fabric scraps/yarn leftovers using the sewing machine without hindering their movement during operation. At the same time, they are transparent to ensure that the fabric scraps/yarn leftovers are not obscured between the two layers after they are sewn together.

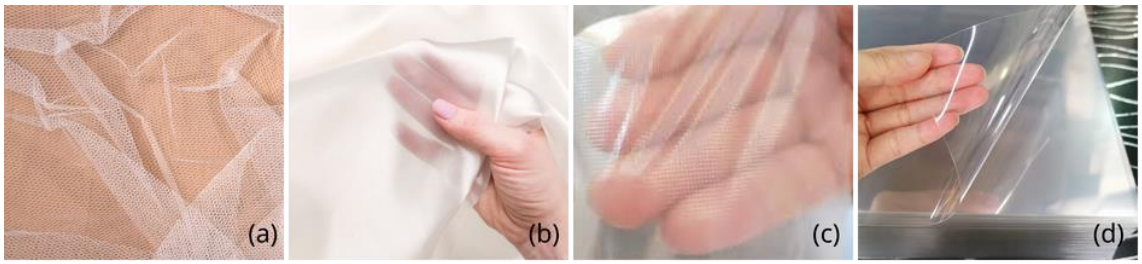


Figure (3): The transparent intermediate materials:
(a) Tulle – (b) Organza – (c) Water-soluble Stabilizer – (d) Plastic Sheet

3. *Recycled fabric preparation*

Two different techniques were used to make recycled fabric. The first technique involves fabric scraps and/or yarn leftovers being distributed between two layers of transparent intermediate materials and then regularly or randomly sewn together using the sewing machine to create innovative fabric ready for use in various applications, as shown in Figure 4. This technique used Tulle, Organza, and plastic sheets as intermediate materials.

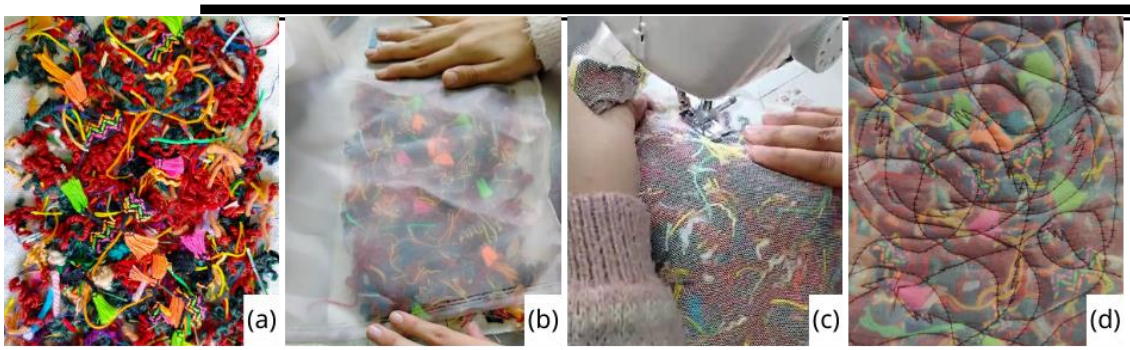


Figure (4): The first technique of creating recycled fabric:
(a) assembling wastes on a layer of fabric – (b) applying another layer of intermediate fabric – (c) sewing fabric layers together – (d) final recycled fabric

The second technique was applied using the water-soluble stabilizer to make recycled fabrics. After sewing, the fabric was washed well with cold water until the stabilizer dissolved. The fabric scraps/yarn leftovers remain attached to form a cohesive piece, as shown in Figure 5. In this case, the resulting recycled fabric preserves the fabric scraps/yarn leftovers' appearance more clearly.

Figure (5): The second technique of creating the recycled fabric using the water-soluble stabilizer: (a) assembling and sewing wastes between two layers of water-soluble stabilizer – (b) washing using cold water – (c) recycled fabric appearance after washing.

Final Products

Seven suggested products have been created using recycled fabrics from the previously explained techniques: five using the recycled fabric of the first technique and two using the recycled fabric of the second technique.

Product (1): Jean Jackets

Figure (6): Product (1)

Table [1]: Product (1) Description

Product Name:	Two jean jackets with a piece of recycled fabric at the back
Clothing production waste type:	Fabric scraps
Intermediate material:	Tulle
Product Description:	The recycled fabric in these two jackets was made by assembling fabric scraps between two layers of Tulle and then sewing them with a sewing machine. The recycled piece of fabric was then sewn to replace an emptied part of the fabric from the jacket's backside.

Product (2): Modern Pillowcase

Figure (7): Product (2)

Table [2]: Product (2) Description

Product Name:	Modern Pillowcase
Clothing production waste type:	Fabric scraps
Intermediate material:	Tulle
Product Description:	The pillowcase was made of recycled fabric, which was made by assembling fabric scraps between two layers of Tulle and then sewing them with a sewing machine.

Product (3): Crossbody Phone Bag

Figure (8): Product (3)

Table [3]: Product (3) Description

Product Name:	Crossbody Phone Bag
Clothing production waste type:	Fabric scraps and yarn leftovers
Intermediate material:	Organza
Product Description:	The crossbody phone bag was made of recycled fabric, which was made by assembling fabric scraps and yarn leftovers between two layers of Organza and then sewn together using the sewing machine.

Product (4): Pouch

Figure (9): Product (4)

Table [4]: Product (4) Description

Product Name:	Pouch
Clothing production waste type:	Yarn leftovers
Intermediate material:	Tulle
Product Description:	The recycled fabric in this product was made by assembling yarn leftovers between two layers of Tulle and securing them with a sewing machine. The recycled fabric was then used to create a pouch with a zipper and an inner lining.

Product (5): Table Runner

Figure (10): Product (5)

Table [5]: Product (5) Description

Product Name:	Table Runner
Clothing production waste type:	Yarn leftovers
Intermediate material:	Water-soluble stabilizer
Product Description:	The table runner was made by assembling yarn leftovers between two layers of water-soluble stabilizer in a predetermined dimension, then sewn by the sewing machine. The sewn piece has been washed with cold water and then dried.

Product (6): Tote Bag

Figure (11): Product (6)

Table [6]: Product (6) Description

Product Name:	Tote Bag
Clothing production waste type:	Fabric scraps and yarn leftovers
Intermediate material:	Water-soluble stabilizer
Product Description:	The Tote Bag face was made of recycled fabric. It was made by assembling fabric scraps and yarn leftovers on a layer of jeans fabric, adding another layer of water-soluble stabilizer, sewing them with the sewing machine, and then washing them with cold water. Finally, the recycled fabric was used to make the tote bag by sewing the backside and handles from the jeans' fabric.

Product (7): Picnic Mat

Figure (12): Product (7)

Table [7]: Product (7) Description

Product Name:	Picnic Mat
Clothing production waste type:	Fabric scraps
Intermediate material:	Transparent Plastic Sheets
Product Description:	This product was made by assembling fabric scraps between two layers of transparent plastic sheets, then sewn by the sewing machine.

Results and Discussion

The products and the upcycling method of clothing production waste were evaluated using a questionnaire (Google Forms). The questionnaire items were divided into two parts: the first was to collect opinions about the products made of innovative recycled fabrics in three axes (economic, functional, and aesthetical aspects), as shown in Table [8], and the second was to evaluate the suggested method of upcycled fabrics in two axes (environment and sustainable development, and economic aspect), as shown in Table [9].

A group of specialists in the textile and clothing sectors revised the questionnaire to ensure its validity. After a few changes, like rephrasing some phrases, they all agreed that it was valid to determine a precise evaluation for the suggested applications and the proposed method for recycling fabric scraps and yarn leftovers. Cronbach's alpha test (Alpha Cronbach) was also employed to calculate the reliability coefficient, which yielded a value of 0.861. This value is near the correct one, which confirms the questionnaire's reliability, which is why it is regarded as high.

The questionnaire was finalized in two parts; the first part was to evaluate the products; it contains three axes: the first axis (two topics), the second axis (three topics), and the third axis (four topics). The second part evaluated the upcycling method; it contains two axes: the first axis (three topics) and the second axis (four topics). The questionnaire items are shown in Tables [8] and [9].

Table [8]: The questionnaire topics (part 1) for product evaluation.

	Axis	Topic	Agree	To Some Extent	Disagree
Products Evaluation	***First axis:*** The economic aspects.	1. The final product is marketable.			
		2. The product can be sold if available at a competitive price.			
	Second axis: The functional aspects.	3. Used (fabric scraps/yarn leftovers are compatible with the functional aspect of the final product.			
		4. The intermediate material (Tulle / Organza / Water-soluble Stabilizer / Plastic) is compatible with the functional purpose of the final product.			
		5. The final product is complete and suitable for use.			
	Third axis: The aesthetic aspects.	6. The final product's design is modern and innovative.			
		7. The essential design elements (line, color, shape, and material) are consistent in the final product.			
		8. The final product is in line with modern fashion trends.			
		9. Transparent intermediate materials (Tulle / Organza / Water-soluble Stabilizer / Plastic) helped increase the aesthetic value and their role in fixing (fabric scraps/yarn leftovers).			

Table [9]: The questionnaire topics (part 2) for upcycling method evaluation.

	Axis	Topic	Agree	To Some Extent	Disagree
Upcycling Method Evaluation	***First axis:*** The environment and sustainable development.	1. The method is suitable for reusing clothing production waste in creative and unconventional ways.			
		2. This method helps utilize clothing production waste to achieve sustainability and environmental conservation.			
		3. This method helps to utilize clothing production waste and raises awareness among clothing manufacturers about environmentally friendly fashion and sustainable development.			
	Second axis: The functional aspects.	4. The method used to benefit from clothing production waste suits as a small project.			
		5. The method is easy and does not require specific skills (anyone can make it).			
		6. The method used increased the added value of the product.			
		7. The project based on this method is considered a low-cost project.			

Seventy-two gathered responses included specialists in the clothing and textile sector and consumers. The responses were rated according to Likert's three-point scale: Disagree (one score), Neutral (two scores), and Agree (three scores). The response percentages for the questionnaire in the three axes of product evaluation are shown in Table [10].

Table [10]: Products Evaluation: Response percentages (%) for the questionnaire in the three axes.

	Topics	Product (1)	Product (2)	Product (3)	Product (4)	Product (5)	Product (6)	Product (7)
First Axis *(Economic aspects)*	1. The final product is marketable.	97.22	97.22	93.00	93.06	97.22	96.67	96.76
	2. The product can be sold if available at a competitive price.	97.69	97.69	90.00	95.83	96.67	96.76	96.76
	Average (%)	**97.45**	**97.45**	**91.50**	**94.44**	**96.94**	**96.71**	**96.76**
Second Axis *(Functional aspects)*	3. Used (fabric scraps/yarn leftovers are compatible with the functional aspect of the final product.	97.22	97.22	92.00	92.13	96.30	96.76	96.30
	4. The intermediate material (Tulle / Organza / Water-soluble Stabilizer / Plastic) is compatible with the functional purpose of the final product.	98.61	98.61	96.00	96.30	97.67	97.69	97.22
	5. The final product is complete and suitable for use.	97.22	97.22	97.69	97.22	97.67	96.00	96.30
	Average (%)	**97.69**	**97.69**	**95.23**	**95.22**	**97.21**	**96.81**	**96.60**
Third Axis *(Aesthetic aspects)*	6. The final product's design is modern and innovative.	96.76	95.33	95.37	96.30	97.69	95.67	95.83
	7. The essential design elements (line, color, shape, and material) are consistent in the final product.	99.07	99.07	97.67	97.69	98.00	96.00	96.30
	8. The final product is in line with modern fashion trends.	99.54	99.54	97.67	97.69	96.00	96.30	96.30
	9. Transparent intermediate materials (Tulle / Organza / Water-soluble Stabilizer / Plastic) helped increase the aesthetic value and their role in fixing (fabric scraps/yarn leftovers).	97.22	95.67	93.00	93.06	96.76	92.33	93.06
	Average (%)	**98.15**	**97.40**	**95.93**	**96.18**	**97.11**	**95.07**	**95.37**

According to the questionnaire responses, Figure 13 shows the response percentages of the first axis topics for product evaluation regarding the economic aspects. It is noticed that products (1), (2), and (5), jean jacket, pillowcase, and Table runner, respectively, show the highest acceptability as a marketable final product, which can be sold if available at affordable prices, followed by product (7) and (6), picnic mat and tote bag respectively.

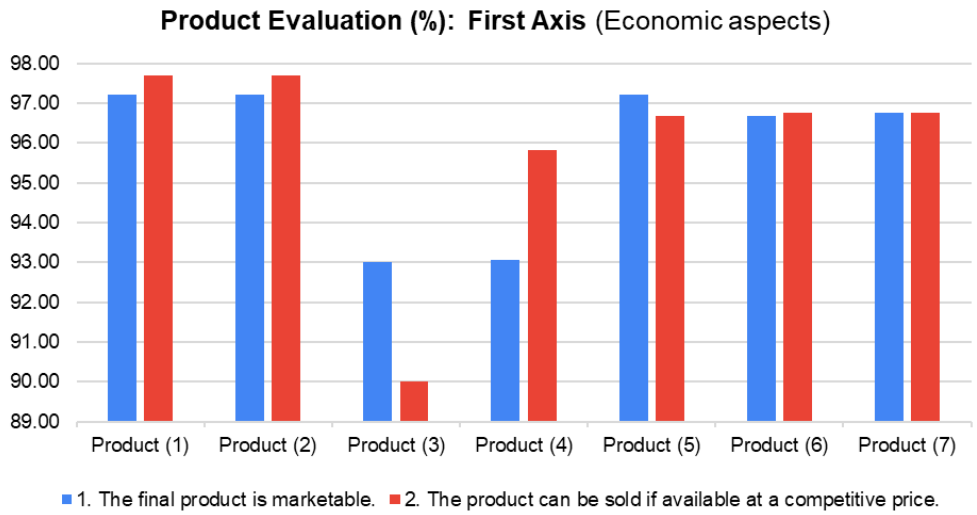


Figure 13: The response percentages of the first axis topics for product evaluation.

Figure 14 shows the response percentages for the second axis of the functional aspect, ranging from 95.2% to 97.69%; this indicates that the intermediate material and used fabric scraps are compatible with the functional element, the final products are complete and usable, and the yarn leftover and used fabric scraps are compatible with the functional aspect of the final products.

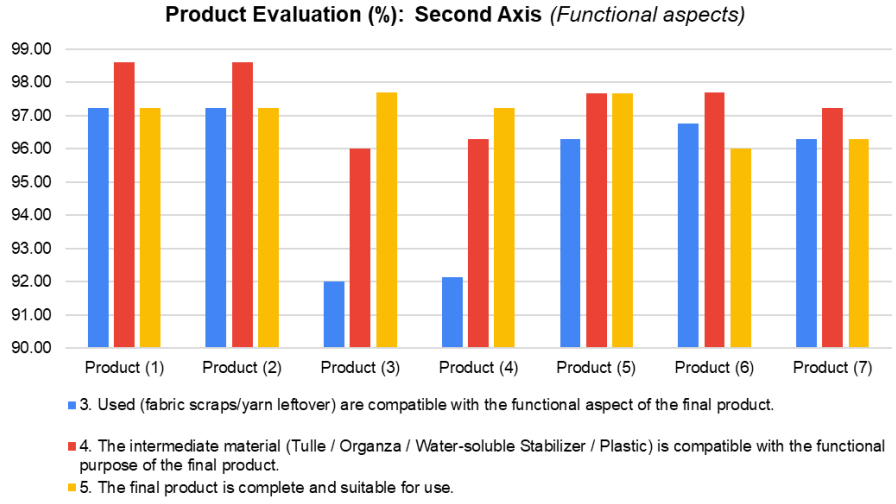


Figure 14: The response percentages of the second axis topics for product evaluation.

The responses to the third axis are concerned with the aesthetic aspects of the products, as shown in Figure 15. They indicated that products (1) and (2), jean jacket and pillowcase, are highly accepted in terms of modernity, creativity, and aesthetic appeal, which reflects the appearance and acceptability of the final product, followed by products (5), (4), (3), (7), and (6) with highly accepted percent ranged from 97.11% to 95.07%.

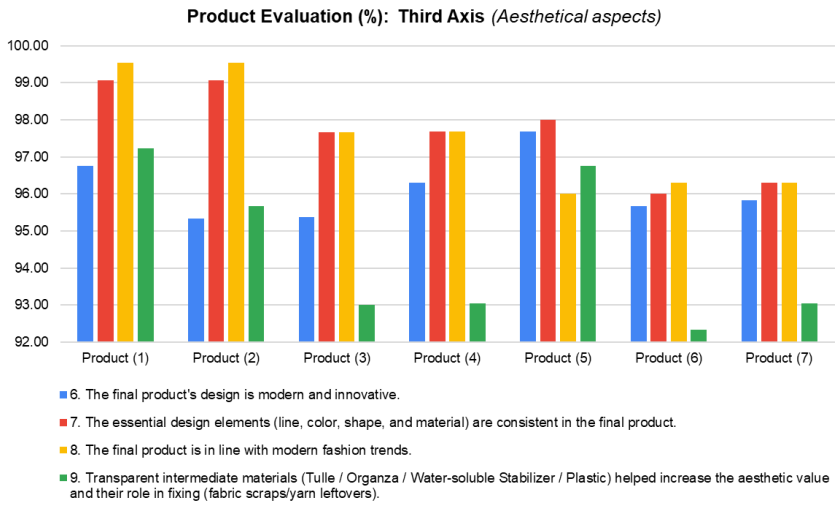


Figure 15: The response percentages of the third axis topics for product evaluation.

The average percentage of product evaluation on the three axes is shown in Figure 16. The collected results indicated the superiority of product (1), the jean jacket, for the three axes of the questionnaire. The product is highly rated as marketable, with functional and accepted aesthetic aspects for a final product. In second place comes product (2), the modern pillowcase, and in third place comes product (5), the table runner.

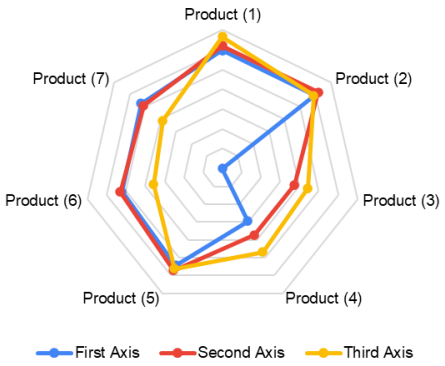


Figure 16: The average percentage of product evaluation on the three axes.

Table [11] shows the responses standard deviation (Std Dev) for the three axes of product evaluation. The results are statistically significant in assessing the degree of consensus or divergence of ideas regarding the various subjects across the three axes of the questionnaire for the proposed products. A lower standard deviation indicates greater consensus on the

questionnaire topic, while conversely, a higher standard deviation suggests less agreement.

Table [11]: Products Evaluation: Response standard deviation (Std Dev) for the questionnaire in three axes.

	Topics	Product (1)	Product (2)	Product (3)	Product (4)	Product (5)	Product (6)	Product (7)
First Axis *(Economic aspects)*	1. The final product is marketable.	0.11	0.22	0.23	0.83	0.15	0.13	0.47
	2. The product can be sold if available at a competitive price.	0.07	0.14	1.10	0.39	0.11	0.09	0.44
	Average (Std Dev)	**0.09**	**0.18**	**0.67**	**0.61**	**0.13**	**0.11**	**0.46**
Second Axis *(Functional aspects)*	3. Used (fabric scraps/yarn leftovers are compatible with the functional aspect of the final product.	0.11	0.08	0.29	0.84	0.17	0.05	0.41
	4. The intermediate material (Tulle / Organza / Water-soluble Stabilizer / Plastic) is compatible with the functional purpose of the final product.	0.04	0.04	0.15	0.38	0.07	0.12	0.32
	5. The final product is complete and suitable for use.	0.11	0.15	0.12	0.22	0.07	0.18	0.48
	Average (Std Dev)	**0.08**	**0.09**	**0.19**	**0.48**	**0.10**	**0.12**	**0.40**
Third Axis *(Aesthetic aspects)*	6. The final product's design is modern and innovative.	0.12	0.18	0.26	0.31	0.21	0.17	0.42
	7. The essential design elements (line, color, shape, and material) are consistent in the final product.	0.03	0.17	0.07	0.21	0.08	0.18	0.55
	8. The final product is in line with modern fashion trends.	0.01	0.01	0.07	0.21	0.15	0.13	0.52
	9. Transparent intermediate materials (Tulle / Organza / Water-soluble Stabilizer / Plastic) helped increase the aesthetic value and their role in fixing (fabric scraps/yarn leftovers).	0.08	0.14	0.23	0.73	0.02	0.35	1.11
	Average (Std Dev)	**0.06**	**0.13**	**0.16**	**0.36**	**0.11**	**0.21**	**0.65**

Figure 17 shows the standard deviation average for each product on the three evaluation axes. The collected results indicate the consensus of opinions about the product (1), the jean jacket, in achieving economic, functional, and aesthetic aspects.

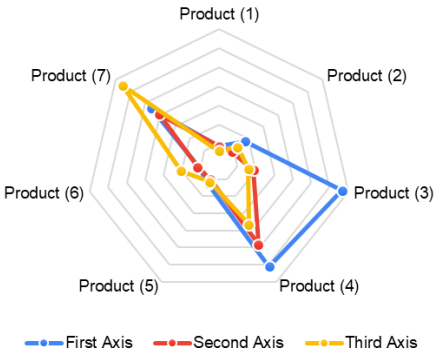


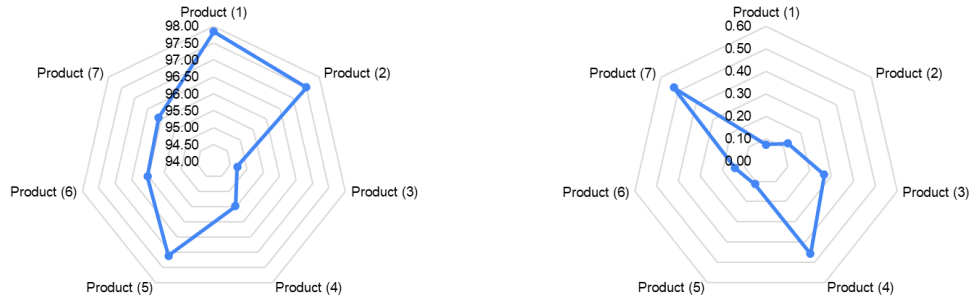
Figure 17: The average standard deviation of product evaluation on the three axes.

Table [12] highlights the overall evaluation average for the three axes, which includes the mean, standard deviation, and percentage averages, to determine the level and ranking of the proposed products.

Table [12]: Overall Products Evaluation according to the total axes

	Mean	Standard Deviation	Percentage (%)	Level	Rank
Product (1)	2.94	0.07	97.84	Excellent	1
Product (2)	2.93	0.13	97.51	Excellent	2
Product (3)	2.84	0.27	94.71	Excellent	7
Product (4)	2.86	0.46	95.47	Excellent	6
Product (5)	2.91	0.11	97.11	Excellent	3
Product (6)	2.88	0.14	96.02	Excellent	5
Product (7)	2.88	0.52	96.09	Excellent	4

The two radar charts in Figure 18 represent the seven products' overall percentages and standard deviations. Remarkably, product (1), the jean jacket, received the most significant percentages in the evaluation, and there were only little variances in opinions regarding the three evaluation axes.



(a) Overall percentages (b) Overall standard deviation

Figure 18: Overall product evaluation by total axes

Table [13] shows the overall evaluation of responses for the upcycling method according to two evaluation axes. The Table included the mean, standard deviation, and percentages of the responses to each topic. In addition, the response average for each axis has been calculated.

Table [13]: Overall Upcycling Method Evaluation according to two axes.

	Topics	Mean	Standard Deviation	Percentage (%)	Significance
First Axis *(Environment and sustainable development)*	1. The method is suitable for reusing clothing production waste in creative and unconventional ways.	2.96	0.04	98.61	Agree
	2. This method helps utilize clothing production waste to achieve sustainability and environmental conservation.	2.96	0.04	98.61	Agree
	3. This method helps to utilize clothing production waste and raises awareness among clothing manufacturers about environmentally friendly fashion and sustainable development.	2.94	0.05	98.15	Agree
	Average	**2.95**	**0.04**	**98.46**	Agree
Second Axis *(Economic effect)*	4. The method used to benefit from clothing production waste suits as a small project.	2.99	0.01	99.54	Agree
	5. The method is easy and does not require specific skills (anyone can make it).	2.86	0.12	95.37	Agree
	6. The method used increased the added value of the product.	2.97	0.03	99.07	Agree
	7. The project based on this method is considered a low-cost project.	2.92	0.08	97.22	Agree
	Average	**2.93**	**0.06**	**97.80**	Agree

Figure 19 shows the response percentages for the topics of the two axes for upcycling method evaluation. For the first axis, 98.61% of respondents agreed that upcycling is suitable for reusing clothing production waste creatively and that the proposed upcycling method achieves sustainability and environmental conservation. 98.51% agreed that this method helps to utilize clothing production waste and raises awareness among clothing manufacturers about environmentally friendly fashion and sustainable development.

Regarding the second axis, which is related to the economic effect of the suggested upcycling method, with an excellent acceptance percentage of 99.54% of respondents, it was agreed that the method used to benefit from clothing production waste suits was a small project. 95.37% and 99.07%, respectively, accepted that the method is easy and does not require specific skills (anyone can make it) and increased the product's added value. 97.22% of respondents agreed that the project based on this method is considered low-cost.

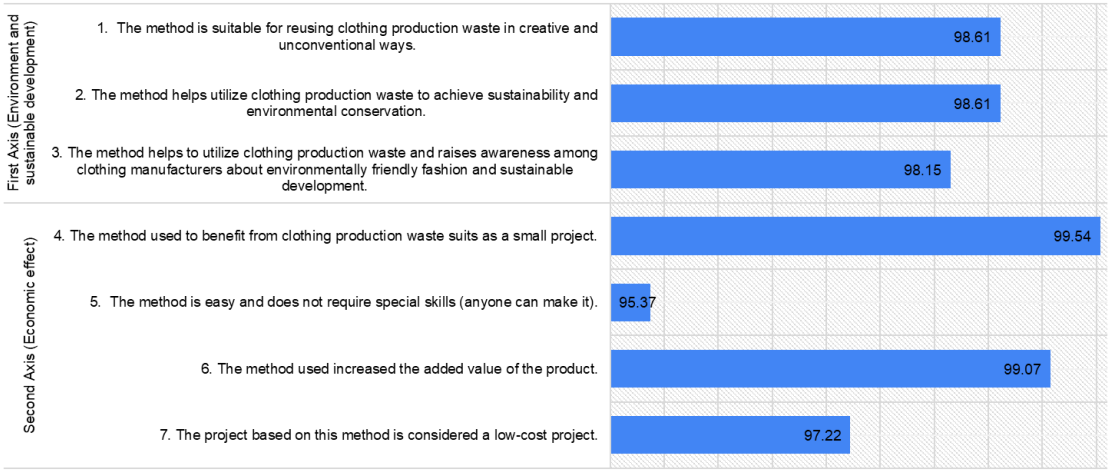
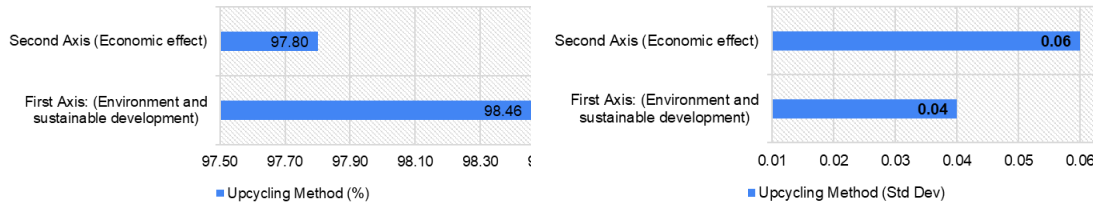


Figure 19: The response percentages for topics of the two axes for upcycling method evaluation

Figure 20 shows the upcycling method evaluation average for the two axes. The overall remarks for the second part of the evaluation, which concerned the upcycling method, are that the suggested method finds wide acceptance in serving the environment and sustainable development, and a high acceptance ratio reflects the proposed method's economic importance.



(a) Overall percentages (b) Overall standard deviation

Figure 20: Overall upcycling method evaluation by total axes

Conclusion

The study aimed to solve the problem of clothing production waste in the Home Economics Department at the Faculty of Women for Arts, Sciences, and Education, Ain Shams University, by using a novel approach to the upcycling method to achieve environmental and sustainable development reflected in society and the economy. The waste generated annually varies according to the number of students enrolled in the department. However, the method has contributed to eliminating waste because it accommodates even tiny sizes of fabric scraps and yarn leftovers. The suggested upcycling method produced a novel recycled fabric suitable for different applications. The researchers found no significant problems handling intermediate materials or fabricating and integrating yarn leftovers and fabric scraps in the proposed upcycling method. Furthermore, incorporating fabric scraps and yarn leftovers into the intermediate materials increased the fabric's durability and enhanced its aesthetic appearance.

The questionnaire, conducted to measure the products' acceptance and the suggested recycling method, revealed its success in achieving sustainable development's environmental, social, and economic goals and the possibility of utilizing it as a sustainable venture.

The questionnaire respondents positively accepted the proposed products. Although there is a slight difference in opinions, they are all ranked excellent. Product (1), the jean jacket, is highly ranked among the seven suggested products. The respondents believed they could be marketed and would buy them if they were priced reasonably. They agreed that (fabric scraps/yarn leftovers) are compatible with the functional aspect of the final product, and the intermediate materials (Tulle / Organza / Water-soluble Stabilizer / Plastic) fit the product's function, resulting in a usable final product. The proposed products also achieved the aesthetic aspects of modernity, innovation, and following current fashion trends.

In evaluating the method used to recycle clothing production waste, it was found that the following upcycling method allowed innovative and unconventional reuse of waste to achieve sustainability and environmental conservation and educate manufacturers about sustainable fashion. This method also has an economic effect; small businesses can use it to build sustainable ventures. With low capital and minimum skills, innovative recycled high-added-value products can be created.

Recycling clothing production waste can enhance many sectors, contributing to economic, societal, and environmental sustainability. Implementing recycling policies can benefit the clothing and fashion

industry by using clothing production waste as raw materials to make new fabrics, reducing reliance on virgin sources, and promoting sustainability. It also expands production possibilities and fosters the development of creative products, hence increasing market diversity. On the other hand, the environmental sector benefits from recycling garment waste. It helps reduce solid waste that goes to landfills, thus contributing to protecting the environment. These practices also help provide job opportunities by teaching women how to reuse fabric scraps and leftover yarns in profitable entrepreneurial projects, which helps economically support communities.

In conclusion, the research has presented a way to recycle clothing production waste. The researchers hope this approach will be widely used because of its anticipated benefits to the economy, society, the environment, and sustainable development.

Recommendations

- Developing the idea using different intermediate materials and various applications to improve the quality of the final product.
- Researchers recommend a fixed and specific system for collecting yarn leftovers and fabric scraps. This system should be implemented in all educational facilities, especially Home Economics.
- Providing workshops to teach the proposed upcycling method to promote circular economy and sustainable development.
- Conduct a study to calculate the mass production cost of the upcycled products following this method to help achieve an appropriate profit margin and market recycled products.
- A permanent faculty exhibition of recycled objects is vital to spreading the idea of recycling, promoting sustainability, and encouraging small projects.

Ethical Approval

This study was approved by the research ethics committee of the Faculty of Women for Arts, Science, and Education – Ain Shams University (Register Study Code: sci1532501001).

References

[1] Abou Hashish, H. Z., & Sakr, E. M. (2023). Yarn Graffiti in The Handicraft Experiential Learning to Improve Students' Soft Skills and Attain Sustainability. *Journal of Design Sciences and Applied Arts, 4*(2), 59-69. doi:https://dx.doi.org/10.21608/jdsaa.2023.171176.1234

[2] Afify, N. (2019). E-Learning and sustainable development of the field of Apparel design in the knowledge economy. *Journal of Architecture, Arts and Humanitistic Sciences, 4*(16), 550-570. doi:https://doi.org/10.21608/mjaf.2019.10347.1017

[3] *Air Quality in Egypt*. (2025, March 27). Retrieved from IQ Air: https://www.iqair.com/egypt

[4] Aktaş, K. O., & Aktaş, B. C. (2022). Fostering Circular Economy in Urban Areas. In *Handbook of Research on Sustainable Development Goals, Climate Change, and Digitalization* (R. Castanho ed., pp. 165-178). IGI Global Scientific Publishing. doi:https://doi.org/10.4018/978-1-7998-8482-8.ch011

[5] Anjimoon, S., A, V., Gurnani, J., Khan, I., Paul, S., & Al-Jawahry, H. (2024). Innovations and Opportunities in Sustainable Textile Recycling. *E3S Web of Conferences*. doi:https://doi.org/10.1051/e3sconf/202450701065

[6] Ayakta, D. Y., Kurtoglu, S. A., & Yilmaz, D. (2024). Opportunities to reduce environmental burden by recycling fabric waste in a woollen fabric company. *International Journal of Clothing Science and Technology, 36*(5), 776-802.

[7] Caldera, S., Jayasinghe, R., Desha, C., Dawes, L., & Ferguson, S. (2022). Evaluating Barriers, Enablers and Opportunities for Closing the Loop through 'Waste Upcycling': A Systematic Literature Review. *Journal of Sustainable Development of Energy, Water and Environment Systems, 10*(1). doi:https://doi.org/10.13044/j.sdewes.d8.0367

[8] Chaudhuri, A., Chakraborty, L., & Maulik, S. R. (2020). Recycling– an Approach towards Sustainability. *International Journal for Modern Trends in Science and Technology, 6*(9S), 169-174. doi:https://doi.org/10.46501/IJMTST0609S28

[9] Chen, X., Memon, H. A., Wang, Y., Marriam, I., & Tebyetekerwa, M. (2021). Circular Economy and Sustainability of the Clothing and Textile Industry. *Materials Circular Economy, 3*(12). doi:https://doi.org/10.1007/s42824-021-00026-2

[10] Chichi, A. C., Nkrumah, E., Ocran, S. P., & Asinyo, B. K. (2024). Expanding Fashion Creativity through Jute and Shredded Waste Fabric Concept. *African Journal Of Applied Research, 10*(1), 511-525. doi:http://dx.doi.org/10.26437/ajar.v10i1.745

[11] Ciolacu, I. (2019). Golden Rules for Ethical Fashion Design. *Circular Human, 4*(1). Retrieved from https://zine.tcbl.eu/ethical-fashion-design/

[12] Deabes, R., El-Maghraby, R., Alowaidh, R., & Kandeel, D. (2023). Recycling the fabrics to produce puppets contributes to enhancing the clothing heritage of the Kingdom of Saudi Arabia among children of early childhood. *HSS, 20*(4). doi:https://doi.org/10.36394/jhss/20/4/16

[13] El Mor, D. F., Hassouna, A. M., Saad, E. R., & Zayed, A. M. (2022). The strategy of designing women apparel with high quality thats achieves the economic dimension of sustainability. *Journal of Architecture, Arts and Humanistic Sciences, 7*(34), 396-412. doi:https://doi.org/10.21608/mjaf.2020.48683.2047

[14] Gabr, B., Al Gamal, G., & Tawfik, N. (2018). Quality Control of Rubber Band in Clothing Products. *Journal of Architecture, Arts and Humanistic Sciences, 3*(10), 144-164.

[15] Han, S. L., Chan, P. Y., Venkatraman, P., Apeagyei, P., Cassidy, T., & Tyler, D. J. (2017). Standard vs. Upcycled Fashion Design and Production. *Fashion Practice, 9*(1), 69-94. doi:http://dx.doi.org/10.1080/17569370.2016.1227146

[16] Iannilli, V. M., & Spagnoli, A. (2024). Conscious Fashion Culture: Rethinking consumption in contemporary fashion. *Fashion Highlight*(3), 8-15. doi:https://doi.org/10.36253/fh-2875

[17] Jaize, K., & K, N. (2024). Creating New Women's Winter Clothes from Recycled Fabrics. *IJIRT, 10*(12), 2183-2186.

[18] Karnad, V. A. (2023). Evaluation of Potential for Textile Waste Management using the PROMETHEE Method. *Environmental Science and Engineering, 2*(3), 15-24. doi:https://doi.org/10.46632/ese/2/3/3

[19] Khalaf, E. g. (2021). A new educational unit to enhance the skillful performance of home economics students in the graduation project. *Journal of Architecture, Arts and Humanistic Sciences, 6*(27), 188-210. doi:https://doi.org/10.21608/mjaf.2020.29198.1601

[20] Koszewska, M. (2018). Circular Economy — Challenges for the Textile and Clothing Industry. *Autex Research Journal, 18*(4), 337-347. doi:https://doi.org/10.1515/aut-2018-0023

[21] Koszewska, M., Rahman, O., & Dyczewski, B. (2020). Circular Fashion – Consumers' Attitudes in Cross-National Study: Poland and Canada. *Autex Research Journal, 20*(3), 327-337. doi:https://doi.org/10.2478/aut-2020-0029

[22] Kucińska-Król, I., Festinger, N., Walawska, A., & Kulczycka, J. (2024). Study of Lodz Society's Knowledge of the Circular Economy in the Textile and Clothing Industry. *FIBRES & TEXTILES in Eastern Europe, 32*(3), 10-20. doi:https://doi.org/10.2478/ftee-2024-0015

[23] Lanz, I. E., Laborda, E., Chaine, C., & Blecua, M. (2024). A Mapping of Textile Waste Recycling Technologies in Europe and Spain. *Textiles, 4*(3), 359-390. doi:https://doi.org/10.3390/textiles4030022

[24] Lejarreta-Andrés, J., Melià-Seguí, J., Bhattacharyya, R., Vilajosana, X., & Sarma, S. (2022). Toward Low-Cost RF-Based Bulk Fabric Classification for the Textile Industry. *IEEE SENSORS JOURNAL, 22*(16), 16586-16594.

[25] Li, L., Du, X., & Yang, S. (2025). The Upcycling of Polyester Fabric for High-Performance HDPE/WPET Composites via Solid-State Drawing. *Journal of Applied Polymer Science, 142*(10). doi:https://doi.org/10.1002/app.56567

[26] Mahmoud, K. (2023). Mechanisms for Activating the Role of Egyptian Universities in Promoting the Culture of Entrepreneurship in Light of Some Contemporary Global Trends: An Analytical Study. *Journal of University Performance Development (JUPD), 24*(1), 39-84. doi:https://doi.org/10.21608/jpud.2023.214659.1154

[27] Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*, 369–380.

[28] Osei, D. B., & Ademtsu, J. T. (2024). Revolutionizing Textile Recycling and Upcycling Practices: A Comprehensive Exploration of Innovative Approaches for Environmental

Sustainability. *International Journal of Innovative Research & Development, 13*(4). doi:https://doi.org/10.24940/ijird/2024/v13/i4/APR24038

[29] Plotnic, O., & Praporșcic, V. (2025). LEGAL ADAPTATION STRATEGIES FOR UNFORESEEN EVENTS IN THE CIRCULAR ECONOMY THROUGH THE INTEGRATION OF RESILIENCE AND MATERIAL REUSE. *EUROPEAN FINANCIAL RESILIENCE AND REGULATION*, 256-270. Retrieved from https://eufire.uaic.ro/wp-content/uploads/2025/02/19_Plotnic_256_270.pdf

[30] Pocol, C. B., Stanca, L., Dabija, D.-C., Pop, I. D., & Mișcoiu, S. (2022). Knowledge Co-creation and Sustainable Education in the Labor Market-Driven University–Business Environment. *Frontiers in Environmental Science, 10*, 1-15. doi:https://doi.org/10.3389/fenvs.2022.781075

[31] Ragab, R. M. (2019). The effectiveness of a proposed training program for young graduates for the recycling of non-fashionable men's neckties in light of sustainable development. *International Design Journal, 9*(4), 309-323. doi:https://dx.doi.org/10.21608/idj.2019.82655

[32] Rezk, M. R., Kapiel, T. Y., Piccinetti, L., Salem, N., Khasawneh, A., Santoro, D., . . . Sakr, M. M. (2023). Circular economy in Egypt: an overview of the current landscape and potential for growth. *INSIGHTS INTO REGIONAL DEVELOPMENT, 5*(3), 45-57. doi:https://doi.org/10.9770/ird.2023.5.3(3)

[33] Saha, K., Dey, P. K., & Kumar, V. (2024). A comprehensive review of circular economy research in the textile and clothing industry. *Journal of Cleaner Production, 444*. doi:https://doi.org/10.1016/j.jclepro.2024.141252

[34] Saha, K., Dey, P. K., & Papagiannaki, E. (2021). Implementing circular economy in the textile and clothing industry. *Business Strategy and the Environment, 30*(4), 1497-1530. doi:https://doi.org/10.1002/bse.2670

[35] Sandin, G., Lidfeldt, M., & Nellström, M. (2025). Exploring the Environmental Impact of Textile Recycling in Europe: A Consequential Life Cycle Assessment. *Sustainability, 17*(5). doi:https://doi.org/10.3390/su17051931

[36] Sariatli, F. (2017). Linear Economy Versus Circular Economy: A Comparative and Analyzer Study for Optimization of Economy for Sustainability. *Environmental Science, Economics, 6*(1), 31-34. doi:https://doi.org/10.1515/vjbsd-2017-0005

[37] Shen, L., & Sethi, M. H. (2021, 10 31). Sustainable Fashion and Young Fashion Designers: Are Fashion Schools Teaching Sustainability? *FIBRES & TEXTILES in Eastern Europe, 5*(149), 9-13. doi:10.5604/01.3001.0014.8036

[38] Shymanovska-Dianich, L., & Rangra, N. (2024). CIRCULAR ECONOMY: DEFINITION, POSITIVE AND NEGATIVE SIDES. *Herald of Lviv University of Trade and Economics Economic sciences*, 44-51.

[39] Slama, H., H., A., Nasef, S., Hegazy, A., H., S., & A., M. (2024). Using Shabby Chic Style in Contemporary Clothing Accessories to Achieve the Principles of Sustainable Development. *Journal of Statistics Applications & Probability, 13*(1). doi:https://dx.doi.org/10.18576/jsap/130103

[40] Srl, B. (2024). *Toward an efficient and competitive circular textile industry.* United Nations Industrial Development Organization (UNIDO). Retrieved from https://switchmed.eu/wp-content/uploads/2024/05/SWITCHMED_rm_EN_EG_01hB_WEB_final.pdf

[41] Stella, F., Garofalo, S. F., Cavallini, N., Fino, D., & Deorsola, F. A. (2024). Closing the loop: Analysis of biotechnological processes for sustainable valorisation of textile waste from the fast fashion industry. *Sustainable Chemistry and Pharmacy, 38*. doi:https://doi.org/10.1016/j.scp.2024.101481

[42] Sumo, P. D. (2024). Textile waste management and recycling opportunities and challenges for Africa. *The Holistic Approach to Environment*, 57-70.

[43] Sweliam, Z. (2018). A training program in recycling the remnants of fabrics and using them to enrich productive families' projects using the patchwork method. *Journal of Home Economics, 28*(4), 403-435. doi:https://doi.org/10.21608/mkas.2018.162969

[44] Tang, K. H. (2023). State of the Art in Textile Waste Management: A Review. *Textiles*, 454-467. doi:https://doi.org/10.3390/textiles3040027

[45] Tirupathi, V. (2025, March 27). *Urban pollution: Cairo, Egypt*. Retrieved from Rethinking The Future: https://www.re-thinkingthefuture.com/city-and-architecture/a11370-urban-pollution-cairo-egypt/#google_vignette

[46] UNIDO. (2022). *Textile waste mapping in Egypt.* United Nations Industrial Development Organization. Retrieved from https://switchmed.eu/wp-content/uploads/2022/01/MED-TEST-III-EGYPT_DA_9_TextileWasteMapping.pdf

[47] Wagaw, T., & Babu, K. M. (2023). Textile Waste Recycling: A Need for a Stringent Paradigm Shift. *AATCC Journal of Research, 10*(6), 376-385. doi:https://doi.org/10.1177/24723444231188342

[48] Wiegand, T., & Wynn, M. (2023). Sustainability, the Circular Economy and Digitalisation in the German Textile and Clothing Industry. *Sustainability, 15*(11). doi:https://doi.org/10.3390/su15119111

[49] Wojnowska-Baryła, I., Bernat, K., Zaborowska, M., & Kulikowska, D. (2024). The Growing Problem of Textile Waste Generation—The Current State of Textile Waste Management. *Energies, 17*(7). doi:https://doi.org/10.3390/en17071528

[50] Yee, C., & Baskaran, S. (2024). Conceptualizing Economic Factors to Ecological Fashion Adoption Intention, Recycling Intention Behavior as Mediator. *International Journal of Academic Research in Business & Social Sciences, 14*(4), 1048-1055. doi:http://dx.doi.org/10.6007/IJARBSS/v14-i4/21383

[51] Zaghlol, T. (2021). Recycling of hangings and furnishing fabrics waste to produce women's wear for achieve sustainability (applied study in Damietta city). *Journal of Architecture, Arts and Humanistic Sciences, 6*(29), 255-270. doi:https://doi.org/10.21608/mjaf.2020.31332.1638