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CENTRE FOR RESEARCH & INNOVATION IN SCIENCE ARTS & TECHNOLOGY

BUFT
BGMEA University of Fashion & Technology

Textile Research Conference

TRC 2026

31 October 2026, Dhaka, Bangladesh

7th Textile Research Conference

in collaboration with

BGMEA University of Fashion & Technology (BUFT)

Book of Abstracts

5MRC FIVE MINUTE RESEARCH COMPETITION

CRISAT - CENTRO DIGITAL FASHION CATWALK COMPETITION

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Textile Research Conference 2026 - Programme
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09:00 am to 10:00 am Registration

Parallel Technical Session A-1
Chair: Dr. M. Reaz us Salam Elias, Dean, Faculty of Engineering Studies Co-chair: Dr. Nazia Muhsin, Associate Professor, Department of IE, BUFT

10:30 am- 10:50 am **Md. Azhar Uddin (Decor Global/BUFT)** – Quality Performance Improvement in a Garment Washing Plant Following Six Sigma DMAIC Methodology: A Case Study

10:50 am- 11:10 am **Md. Moslem Uddin (BJRI)** – Effect of Bio-Based Laminated Jute Cotton Union Fabrics for Food Packaging.

11:10 am- 11:30 am **Mahmood Hasan Gahon (BRAC University)** – Fabric Dyeing with Biodegradable Dye Produced from Microorganism

Parallel Technical Session A-2
Chair: Prof. Dr. Muhammad Abdul Goffar Khan, Professor & Director, IQAC
Co-chair: Dr. Umme Magreba Takebira, Associate Professor & Head, Department of AMT, BUFT 10:30 am- 10:50 am **Dr. Mohammad Raza Miah (BUFT)** – Hybrid Biobased Epoxy Composites Reinforced with Glass and Jute Fibers

10:50 am- 11:10 am **Ayon Saha (AIUB)** – Statistical Modelling and Forecasting of Textile Waste Generation Using Time-Series Methods

11:10 am- 11:30 am **Md. Rakibul Hasan Pavel (BUFT)** – MXene-based smart textiles: material design, manufacturing strategies, and application prospects.

Parallel Technical Session A-3
Chair: Dr. Ranajit Kumar Nag, Dean, Faculty of Textile Engineering, BUFT
Co-chair: Sabbir Ahmed Abir, Assistant Professor & Head, Department of AMM, BUFT

10:30 am- 10:50 am **Dr. Sweety Shahinur (BJRI)** – Design and Development of Biodegradable Jute-PLA Filaments for FDM 3D Printing"

10:50 am- 11:10 am **Abdullahi Kabiru Shehu (Kano State Polytechnic)** – Promoting Circular Economy in the Textile Sector Through Sustainable Textile Waste Management: A Case Study of Saka Sustainable Textiles

11:10 am- 11:30 am **Dr. Md. Sohag Miah (BUFT)** – Enhancing durability properties of Recycled fibers reinforced Gypsum plaster composites with Calcium Carbonate fillers for building components.

Parallel Technical Session A-4
Chair: Prof. Dr. Md. Abdul Jalil, Dean, Faculty of ES, Sciences, BUFT
Co-chair: Farhana Jannat, Assistant Professor, Department of AMM, BUFT

10:30 am- 10:50 am **Prof. Dr. Engr. Mohammed Rubaiyat Chowdhury (BUFT) –** Renewable Energy and its effect in the Apparel Sector in Bangladesh

10:50 am- 11:10 am **Mahjabin Haque (KUET) –** Natural Fiber Geotextiles in Sustainable Civil Infrastructure: A Review of Soil–Textile Interactions, Bio-Coatings, and Controlled Degradation Mechanisms

11:10 am- 11:30 am **Shamina Jafrin (BJRI)** – A sustainable Adsorbent from jute Klason lignin for Dye Elimination in Industrial wastewater

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Parallel Technical Session A-5
Chair: Prof. Dr. ANM Ahmed Ullah, Professor & Director, BITAR, BUFT
Co-chair: Dr. Biman Barua, Associate Professor, Department of CSE, BUFT

10:30 am- 10:50 am **Saadman Faisal (BRAC University)** – Establishing a National Energy Baseline for Bangladesh's RMG Sector: A 339-Factory Assessment.

10:50 am- 11:10 am **Moriom Islam Sumona (BUFT)** – Smart Adaptive Sewing Line (SASL): An AI-Assisted Predictive Framework for Defect Prevention and Production Optimization in Garment Manufacturing (10 Min)

11:30 am- 12:00 pm Tea Break

Parallel Technical Session B-1
Chair: Prof. Dr. Engr. Ayub Nabi Khan, Vice Chancellor, BUFT
Co-chair: Farhana Jannat, Assistant Professor, Department of AMM, BUFT

12:00 pm- 12:30 pm **Keynote: Professor Engr. Dr. Hafsa Jamshaid**, **National Textile University (NTU), Pakistan** - Beyond Recycling: Transforming Textile Waste into High-Value Technical Textiles and Advanced Materials

12:30 pm- 12:50 pm **Md. Yeasin Ali (BUFT)** – Integration of AI with central ERP for real time buyer communication and effective production tracking in RMG industry.

Parallel Technical Session B-2
Chair: Prof. Dr. Engr. Mohammed Rubaiyat Chowdhury, Dean, Faculty of Apparel Studies
Co-chair: Sabbir Ahmed Abir, Assistant Professor & Head, Department of AMM, BUFT

12:00 pm- 12:30 pm **Keynote: Nihong Pang (Chengdu Qinggong Polytechnic University, Chengdu, China)** Policy Adaptation and Industry-level Compliance Strategies for Textile Exports Under EU Carbon and Chemical Regulatory Constraints

12:30 pm- 12:50 pm **Tasnuva Tasnim (BUFT)** – AI Hallucination in Fashion Design: Exploring the Gap Between Generative Fashion Aesthetics and Wearable Reality

Parallel Technical Session B-3
Chair: Prof Md Alamgir Hossain, PhD, pro-VC (Acting) and Treasurer, BUFT
Co-chair: Dr. Nazia Muhsin, Associate Professor, Department of IE, BUFT

12:00 pm- 12:20 pm **Dr. Md. Sohag Miah (BUFT)** – Sustainable Processing of Recycled and Virgin Textiles through Methoxylated Pectin Surface Modification for Mitigation of Fiber Particle and Microfiber Release

12:20 pm- 12:40 pm **Khan Md Salman Adib Fuad (BUFT**) – Hydrogel-based smart sensors for intelligent textile applications Keywords: Hydrogels, 3d printing, smart sensors, smart textiles, wearable electronics, flexible electronics.

Parallel Technical Session B-4
Chair: Prof. Dr. Md. Emdad Sarker, BUTEX
Co-chair: Dr. Umme Magreba Takebira, Associate Professor & Head, Department of AMT, BUFT

12:00 pm- 12:20 pm **Md. Abu Darda (BUFT**) – Effect of Waste Cotton Fiber Content on the Mechanical Properties of Epoxy-Based Hybrid Composites Reinforced with PET Flakes and Wood Dust

12:20 pm- 12:40 pm **Rumi Akter (BRAC University)** – Embedding Sustainability: Institutionalizing Recycling Practices in the Garment and Textile Industries of Bangladesh

01:00 pm- 02:00 pm **Break: Prayer and Lunch**

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Plenary Session

02:00 pm- 02:10 pm	**Welcome Speech** Prof. Dr. Engr. Mohammed Rubaiyat Chowdhury, Dean, Faculty of Apparel Studies, BUFT.
02:10 pm- 02:20 pm	**Opening Address** Dr. Abu Sadat M. Sayem, Founder, Crisat & Programme Leader (Textile), Loughborough University, UK
02:20 pm- 02:30 pm	**Addressed by the Keynote Speaker** Nihong Pang (Chengdu Qinggong Polytechnic University, Chengdu, China)
02:30 pm- 02:40 pm	**Addressed by the Keynote Speaker** Professor Engr. Dr. Hafsa Jamshaid, National Textile University (NTU), Pakistan
02:40 pm- 02:50 pm	**Addressed by the Guest of Honor**
02:50 pm- 03:00 pm	**Addressed by the Guest of Honor**
03:00 pm- 03:10 pm	**Addressed by the Guest of Honor**
03:10 pm- 03:25 pm	**Addressed by the Special Guest** Mr. Mahmud Hasan Khan, President, BGMEA
03:25 pm- 03:40 pm	**Addressed by the Special Guest** Mr. Mesbha Uddin Ali, Chairman, Board of Trustees, BUFT
03:40 pm- 04:00 pm	**Addressed by the Chief Guest** Prof. Dr. Mamun Ahmed, Chairman, University Grants Commission (UGC) of Bangladesh
04:00 pm – 04:10 pm	**Addressed by Chair** Prof. Dr. Engr. Ayub Nabi Khan, Vice Chancellor, BUFT
04:10 pm – 04:40 pm	**BUFT – CRISAT – CENTRO Digital Fashion Catwalk Competition (DFCC) 2026** Presentations by Finalists (7 Participants × 3 Minutes)
04:40 pm – 05:10 pm	**CRISAT – (Name to be Finalized) 5-Minute Research Competition 2026** Presentations by Finalists (5 Participants × 5 Minutes)
05:10 pm – 05:15 pm	**Addressed by the Special Guest** from CENTRO
05:15 pm – 05:30 pm	**Prize-Giving Ceremony** BUFT – CRISAT – CENTRO Digital Fashion Catwalk Competition (DFCC) 2026
05:30 pm – 05:40 pm	**Prize-Giving Ceremony** BUFT – CRISAT 5-Minute Research Competition 2026
05:40 pm – 05:50 pm	**Vote of Thanks** Prof. Dr. Md. Abdul Jalil, Dean, Faculty of ES, Sciences, BUFT
05:50 pm – 06:00 pm	**Closing Ceremony, Vote of Thanks & Group Photo Session**

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A Case Study on Renewable Energy Efficiency in the Apparel Industry of Bangladesh

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INTRODUCTION

Bangladesh's apparel industry is a key contributor to the national economy and export sector, but its manufacturing processes require substantial amounts of energy. Dependence on conventional energy sources increases operational costs and environmental impacts. Renewable energy, particularly solar energy, provides an opportunity to reduce conventional energy consumption, improve energy efficiency, and support sustainable manufacturing [1]. However, limited studies have assessed the practical impact of renewable energy adoption at the factory level in Bangladesh. Therefore, this study evaluates renewable energy utilization in a selected apparel manufacturing facility, focusing on energy efficiency, energy savings, renewable energy contribution, and potential environmental benefits [2, 3].

METHODOLOGY

A descriptive and exploratory mixed-method case-study approach was adopted. Primary information was collected through structured questionnaires, semi-structured managerial interviews, and, where possible, on-site observation of solar installations. Secondary information was obtained from factory energy reports, sustainability disclosures, BGMEA publications, government renewable-energy documents, and relevant academic literature. The study considered selected industrial cases including DBL Group, Rising Knit Textiles Ltd, Natural Denims Ltd, AMAN Graphics Ltd, JM Fabrics Ltd, K A Design Ltd, Hams Garments Ltd, SQUARE Fashions Ltd, and other reported installations. Quantitative analysis included installed solar capacity, estimated annual electricity generation, solar contribution to electricity demand, avoided electricity cost, and investment considerations. Solar generation was estimated using installed capacity, annual operating hours, and capacity-utilization assumptions; qualitative responses were reviewed thematically to identify adoption drivers and barriers.

Quantitative Approach

Used to measure:
- Installed solar capacity
- Energy generation (kWh)
- Percentage contribution to total electricity consumption
- Cost savings (BDT)
- ROI and payback period

Qualitative Approach

Used to explore:
- Management perspectives on renewable investment
- Challenges in installation
- Worker awareness of green initiatives
- Strategic advantages of solar adoption

RESULTS AND DISCUSSION

The case studies demonstrate a growing use of rooftop solar PV across the selected factories, although the scale of adoption differs considerably. Installed solar capacity ranged from approximately 0.428 MW at K A Design Ltd to 8.35 MW at Rising Knit Textiles Ltd. Rising Knit Textiles was estimated to generate about 9.52 million kWh of solar electricity annually, while DBL Group's 5.42 MW installation was estimated to generate approximately 9.89 million kWh/year. Natural Denims Ltd, JM Fabrics Ltd, and Aman Graphics Ltd were estimated to generate approximately 7.96, 2.16, and 1.19 million kWh/year, respectively.



Figure 1. Solar panel in Aman Graphics Ltd.

Solar energy contributed approximately 10–20.57% of total electricity demand across the selected cases. JM Fabrics Ltd showed the highest reported contribution at about 20.57%, followed by Aman Graphics Ltd at 18.27% and DBL Group at 17.7%. Natural Denims Ltd showed an estimated contribution of about 12.7%. These findings indicate that solar PV currently functions primarily as a supplementary electricity source rather than a complete replacement for grid and conventional generation [4]. The results also suggest that larger systems generate more electricity in absolute terms, whereas medium-sized factories can achieve a relatively higher solar share when system capacity is better matched with factory demand.

The economic assessment indicates substantial potential for reducing electricity expenditure. Estimated annual energy values were approximately BDT 10.88 crore for DBL Group, BDT 10.46 crore for Rising Knit Textiles Ltd, BDT 2.37 crore for JM Fabrics Ltd, and

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BDT 1.30 crore for Aman Graphics Ltd. The cases also show that net metering can allow surplus electricity generated during low-production periods to be exported to the national grid and credited against electricity bills. Reported or estimated payback periods for several installations were around 3.5–5 years. However, the analysis also identified major barriers, including high initial investment, limited access to finance and incentives, shortage of technical expertise, rooftop and infrastructure constraints, and policy or regulatory limitations.

Table 1. Comparison of rooftop solar system adoption in some selected factories.

Factory	Capacity (MW)	Solar Generation (M kWh/yr)	Solar Share (%)
DBL Group	5.42	9.89	17.70
Rising Knit	8.35	9.52	15.60
Natural Denims	4.42	7.96	12.70
JM Fabrics	3.92	2.16	20.57
Aman Graphics	4.71	1.19	18.27
K A Design	0.428	1.98	17.89



Figure 2. Solar panel in Square Fashions Ltd.

CONCLUSION

The case-study findings demonstrate that rooftop solar photovoltaic (PV) systems have significant potential to improve energy efficiency and support sustainable manufacturing in Bangladesh's apparel industry. The selected factories have achieved substantial solar electricity generation, with solar contributing approximately 10–20.57% of their total electricity demand and providing considerable potential for reducing electricity expenditure. Net metering further enhances the economic benefits by allowing surplus electricity to be exported to the national grid. However, solar PV remains a supplementary energy source, as grid and conventional generation continue to meet a substantial share of industrial demand. Wider adoption therefore requires improved access to green financing, technical expertise, supportive policies and incentives, and better rooftop and infrastructure integration. Strengthening collaboration among manufacturers, buyers, policymakers, and financial institutions can accelerate renewable-energy adoption and enhance the long-term environmental and economic sustainability of Bangladesh's apparel industry.

REFERENCES

1. Halder, P. K., Paul, N., Joardder, M. U., & Sarker, M. (2015). Energy scarcity and potential of renewable energy in Bangladesh. Renewable and Sustainable Energy Reviews, 51, 1636-1649.

2. Hossain, M. F., Hossain, S., & Uddin, M. J. (2017). Renewable energy: Prospects and trends in Bangladesh. Renewable and Sustainable Energy Reviews, 70, 44-49.

3. Islam, M. T., Shahir, S. A., Uddin, T. I., & Saifullah, A. Z. A. (2014). Current energy scenario and future prospect of renewable energy in Bangladesh. Renewable and Sustainable Energy Reviews, 39, 1074-1088.

4. Masud, M. H., Nuruzzaman, M., Ahamed, R., Ananno, A. A., & Tomal, A. A. (2020). Renewable energy in Bangladesh: current situation and future prospect. International Journal of Sustainable Energy, 39(2), 132-175.

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Design and Development of Biodegradable Jute-PLA Filaments for FDM 3D Printing

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ABSTRACT

the development of sustainable materials for fdm 3d printing has gained attention due to the demand for renewable and biodegradable natural alternatives. this study investigates the fabrication and characterization of jute particle-reinforced polylactic acid (pla) composite filaments for fdm applications. jute particles were incorporated into pla at different loadings (0, 5, 7.5, and 10 wt.%) through single extrusion, followed by filament production using a controlled winding system to maintain dimensional stability. the effects of jute addition on filament processability, mechanical performance, thermal behavior, moisture absorption, and surface morphology were assessed. the incorporation of jute particles improved the tensile properties of pla composites, with significant enhancement observed at moderate fiber loading. with an increase in particle content, tensile strength decreases, brittleness increases, and caused extrusion instability, which affects 3d printability. thermal analysis showed that jute particle incorporation did not significantly improve thermal stability, while water uptake increased with increasing jute content. the results demonstrate the feasibility of producing sustainable jute-pla composite filaments for fdm 3d printing.

keywords: jute filament; fdm 3d printing; single screw extruder, tensile strength; printability

INTRODUCTION

Growing environmental awareness has promoted the use of bio-based thermoplastics in fused deposition modeling (FDM) applications. Polylactic acid (PLA), a biodegradable polymer derived from renewable resources (starch), has emerged as a promising alternative. However, its inherent brittleness and moderate mechanical performance limit broader applications. Reinforcing PLA with natural fibers offers a viable approach to improving its properties while maintaining eco-friendliness (Kacem, et al., 2025).

Jute fiber, abundantly available and biodegradable, possesses good specific mechanical properties and low cost, making it a suitable reinforcement material. Incorporating jute particles into PLA for filament production can support sustainable material development and promote agro-based resources (Somsuk, et al., 2025).

This study focuses on the fabrication of jute-PLA filaments for FDM applications, addressing key challenges related to processing, mechanical performance, and printability.

The Extruder Filaboat 6EX machine has no filament cooling system or filament winding system during filament production. Generally, a spooler spools the filament with a force and speed that maintains filament thickness. Without these portions, it isn't easy to obtain a uniform thickness of the fabricated jute filament. As a result, the 3D printing machine cannot intake the filament properly, and the mechanical properties also vary. Due to this, the 3D filament fabrication process is hampered. Therefore, our objective is to control the thickness of the jute filament by developing a filament winding system. After 3D printing of the test specimen, the printed specimen will be characterized and compared with the PLA filament.

EXPERIMENTAL METHODOLOGY

PLA granules were used as the matrix, and mechanically processed jute fibers were used as reinforcement. Composite filaments were prepared with fiber contents of 0, 5, 7.5, and 10 wt.% using a single-screw extrusion process at a temperature of 150°C. To improve filament quality, a semi-automated winding system was developed, incorporating microprocessor-based control, tension regulation, and a real-time diameter monitoring screen. This system ensured consistent filament diameter and reduced diameter variability during jute filament fabrication. The schematic diagram of the methodology is shown in Figure 1.

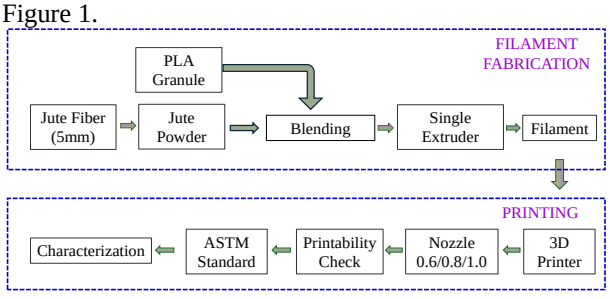

Figure 1. Schematic diagram of 3D filament development

Mechanical properties were determined through tensile (ASTM D638) tests. Thermal stability was assessed using thermogravimetric analysis (ASTM D3850), while water uptake behavior was evaluated according to ASTM D570.

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Microscopic analysis was performed to examine fiber dispersion and interfacial bonding.

RESULTS AND DISCUSSION

The fabricated filaments are shown in Figure 2(a), and their diameter distribution in Figure 2(c). The SEM (Figure 2(b)) revealed that there is a gap between the fiber and matrix, which influences the mechanical and water uptake properties. The diameter of the fabricated filament is maximum at 1.7mm as shown in Figure 2(c).

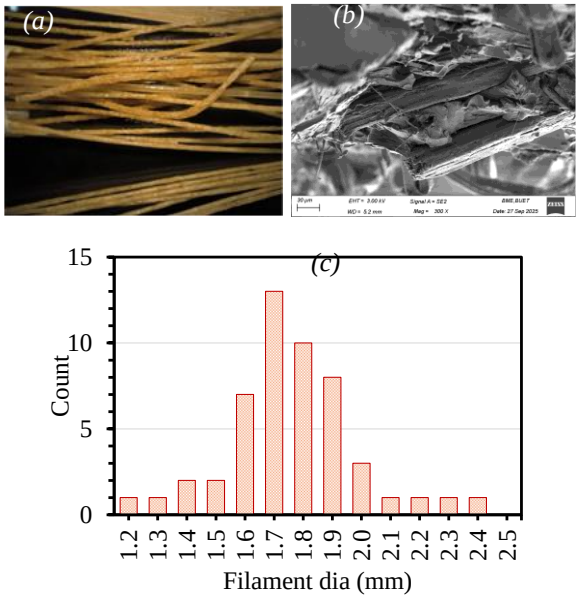
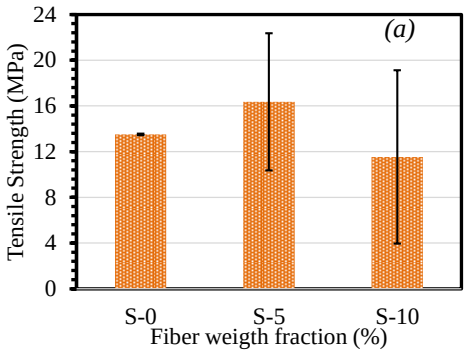


Figure 2. (a) Jute filament (b) variation of diameter (c) fracture surface of jute filament

The tensile, thermal, and fluid uptake properties of the jute 3D filament are shown in Figure 3. Tensile strength increased from ~12 MPa (S-0) to ~16 MPa (S-5) as shown in Figure 3(a). And modulus lies between 1.5 and 2.5 GPa. A limitation was observed: the jute filament becomes brittle at higher fiber content, and continuous extrusion is difficult. Figure 3 (a) reveals that strength increases with the jute fiber incorporation in the PLA matrix. The shift in the TGA (Figure 3(b)) graph and residue indicates the flammability properties of the filament.



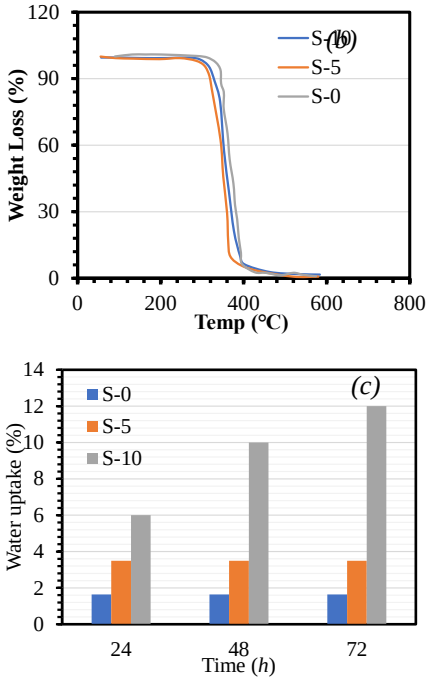


Figure 3. (a) Tensile properties, (b) thermal properties, and (c) fluid uptake of jute filament

The TGA revealed that the thermal stability of the jute filament is slightly lower compared to pure PLA. The figure also reveals that as jute particle incorporation in PLA increases, water uptake properties (see Figure 3(c)). The deviation of absorbency depicted the presence of defects in the fabricated filament. As jute is a material with a negative CO_2 footprint, defect-free jute filament development is an open research topic.

CONCLUSION

The study demonstrates the successful fabrication of jute-PLA composite filaments using a semi-automatic system with locally available resources. Results show that incorporating jute fibers enhances both mechanical and thermal performance while reducing water uptake. The printing speed of the test specimen was very low due to clogging, which will be minimized in our future work.

REFERENCES

Dananjaya, V. et al., 2025. Design and Evaluation of 3D-Printed Polylactic Acid Composites Reinforced with Biodegradable Bamboo Powder and Jute Powder. *Advanced Engineering Materials*, 27(10), p. 2402835.

Kacem, M. A. et al., 2025. Development and 3D printing of PLA bio-composites reinforced with short yucca fibers and enhanced thermal and dynamic mechanical performance. Journal. *Journal of Materials Research and Technology*, Volume 36, pp. 1243-1258.

Somsuk, N. et al., 2025. Mechanical performance of natural fiber-reinforced PLA composites for 3D printing. *Journal of Composites Science*, 9(4), p. 180.

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A sustainable Adsorbent from Jute Klason Lignin for Dye Elimination in Industrial Wastewater

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ABSTRACT

Adsorbent Jute Klason lignin (JKlL) were explored to eliminate toxic cationic Congo red (CR) dyes from industrial wastewater. Eco-friendly JKlL adsorbate were prepared by drying jute sample treated with 72% sulfuric acid thereafter diluted and reflux it 5-6 hours, filtered, dried to obtained JKlL. It was examined by UV-vis analysis, X-ray diffraction, FTIR, SEM test and BET analysis. Point of zero charge (pHpzc) and interfering agent effect also observed. From industrial wastewater at a concentration (0.005g, 0.01g, 0.015g and 0.020g) JKlL/liter, 10, 20, 30, 40, 50, 60, 90 and 120-minutes contact time and at a pH of 2, 4, 6, 8, 10 and 12 different parameters have been used to remove CR dye at 30ºC. 769.230mg/g CR dye have absorbed from industrial wastewater at 30ºC temperature, 30min contact time, 2 pH and 0.015g dose of JKlL. In XRD, the broad peak of JKIL was found at 12.5°C which indicated the amorphous characteristic of JKlL lignin. The SEM revealed that surface of JKlL was highly irregular, rough and uneven. 6.4 pHpzc found for CR dye absorption. Among the Freundlich, Temkin and Langmuir isotherm models, it was found that the Langmuir isotherm models (R^2> 0.996) were appropriate for eliminating CR dye from industrial wastewater.

1.0 INTRODUCTION

Many synthetic dyes resist biodegradation, posing risks to both environmental and human health due to their toxic, carcinogenic, or mutagenic effects found in dye-contaminated industrial waste water (Forgacs et al., 2004; Robinson et al., 2001). Among the available treatment methods, adsorption is considered one of the most effective, economical, and environmentally friendly approaches for dye removal. Lignin, sawdust, pine bark, coconut husk, tea, and rice husk are examples of industrial and agricultural by-products that have been extensively researched as modern, low-cost adsorbents. The pulp and paper industry produces between 50 and 70 million tons of lignin each year. Only 1-2% of lignin from the Kraft process is chemically transformed into specialty chemicals and products, the most popular chemical pulping method, whereas 98–99% of all lignin produced worldwide is burned directly or indirectly to produce heat and power. Lignin has long been viewed as a waste or low-value by-product due to ignorance, yet with chemical modification, it is now used as an adsorbent.

In this study, Congo red (CR), a hazardous anionic dye, was removed from aqueous solution using jute stick Klason lignin, a low-cost and sustainable lignocellulosic by-product. Jute sticks lignin exhibits promising adsorption ability for dye uptake because of its aromatic structure and abundance of hydroxyl functional groups. The study assessed CR's potential as an environmentally friendly adsorbent for wastewater treatment and examined its adsorption behavior onto lignin under various operating circumstances. Every year, 50 million tons of lignin are produced in the world, however, 99-98% of lignin is burned to produce energy. But we can used this lignin as a valuable product. In this research, lignin has been collected from O-795 varieties of jute and used as a adsorbate for dye elimination from industrial wastewater.

2.0 MATERIALS AND METHODS

The experiment was set up in Dhaka University of Engineering Technology, Gazipur-1707 and BJRI, Dhaka. The jute was used as a main raw material for preparing Klason lignin. Sulfuric acid (H_2SO_4 purity 98%,) (MERCK, Germany) was used in this experiment. Congo red ($C_{32}H_{22}N_6Na_2O_6S_2$) dye is synthetic and organic dye.

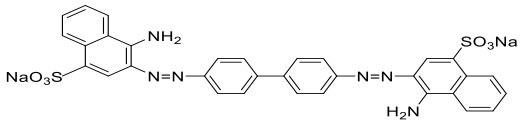

Figure 1: Structure of Congo red (CR) dye

2.1 ADSORBATES PREPARATION FROM JUTE

Jute sample was washed and dried in the open air. It was cut into 5-10cm and grind in the grinding m/c. This jute sample was hydrolyzed with 72% sulfuric acid and continues stirring for 1-2 hours. After that, this solution was diluted into 4% sulfuric acid with adding distil water. The solution was refluxed for six hours, filtered and dried in the oven at 102±2°C and weighted to obtain Lignin.

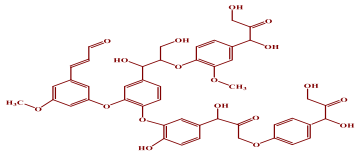

Figure 2: Chemical Structure of Jute Lignin

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Klason lignin was characterized by different parameters (pH, UV-Vis, FTIR, SEM etc.).

2.2 SPECTROPHOTOMETER FOR UV-VIS

This technique measured different light wavelengths from the jute lignin. In contrast to a blank sample, the JKlL's composition was revealed by visible light passing through it. The absorbance of dye and Klason lignin were measured using a UV-Vis spectrophotometer (Jasco V-730, Japan).

2.3 FTIR ANALYSIS

The JKlL's functional groups were identified using Fourier Transform Infrared Spectroscopy (FTIR). It used the FTIR machine (FT/IR-4600LE JASCO, Japan) to measure mid-infrared light absorption over a range of 4000 cm^{-1} to 500 cm^{-1} with a resolution of 4 cm^{-1} to guarantee accurate results by internal wavelength measurements.

2.4 X-RAY DIFFRACTION (XRD) ANALYZER

At Jahangirnagar University (JU), Bangladesh, X-ray diffraction was measured for the lignin sample. The crystalline structure of the lignin was determined using this technique.

2.5 SCANNING ELECTRON MICROSCOPY

It was a high-performance, energy-embedded scanning electron microscope. The JKlL was morphologically analyzed using the SEM test, which involved scanning it with a high-energy electron beam. In this instance, the JKlL image analysis was performed using a SEM equipment (JEOL JSM-6490LA-Japan).

2.6 ZERO CHARGE POINT

The draft approach was used to find the lignin's point of zero charge. 20 mL of 0.01 M NaCl solution was added to multiple Erlenmeyer flasks containing 0.05 g of JKlL in order to determine zero charge. After adjusting the solution's initial pH (which ranged from 2 to 10) with 0.01 M HCl and NaOH, the samples' equilibrium pH was determined after a 24-hour period and was calculated.

2.7 INTERFERING AGENT'S EFFECT

Two types of alkalis (NaOH and KOH) and two types of acids (HCl and HNO_3) were used to determine the effect of interfering agents. In each case, twenty milliliters of acid or alkali were mixed with twenty milliliters of lignin-adsorbing CR dye solution in a same ratio The processing parameters were used. After the mixture was centrifuged at 3000 rpm for 10 min, UV spectroscopy and FTIR were performed to assess whether there was any significant change in absorbance.

3.0 REULTS AND DISCUSION

3.1 ISOTHERM AND KINETICS ADSORPTION

The Langmuir isotherm describes homogeneous, single-layer adsorption with a strong R^2 value (>0.996), while the Freundlich isotherm models heterogeneous surfaces, also showing a strong fit (>0.996). The Temkin model, relating thermal adsorption to the coating, was acceptable (>0.93). The maximum single-layer adsorption capacity for CR dye on the bio-based adsorbent JKlL was 770.0 mg/g at 30°C, comparable to other lignocellulosic adsorbents. Kinetics analysis focused on intra-particle diffusion (IPD), pseudo-second-order (PSO), and pseudo-first-order (PFO) models. The pseudo-second-order model showed a strong correlation with experimental data (R^2 = 1.0), indicating its accuracy for describing sorption rates.

3.2 REACTION MECHANISM

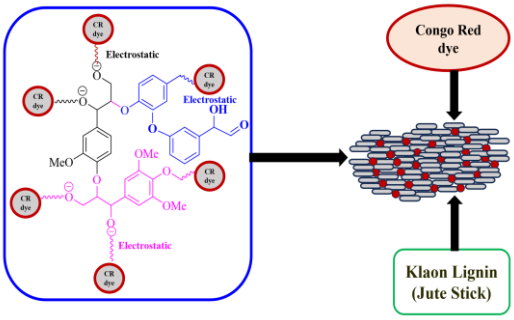

Figure 2. Possible adsorption mechanism of CR Dye on polymeric Jute lignin surface

4.0 CONCLUSION

It was found that 0.015g JKlL is enough to adsorb at 50gm/L concentrated CR dye by treatment for 30min in an acidic pH. The CR dye adsorption process of lignin was investigated using the linear pseudo first order (PFO), pseudo second order (PSO), and intra-particles diffusion (IPD) models. With a high correlation value of R^2 = 1.0, the PSO model showed better agreement for a 50 ppm CR dye. The Temkin, Freundlich, and Langmuir isotherm models were also investigated. At 30°C, it was found that the highest monolayer dye adsorption capacity was 769.230mg/g, which is comparable to several other lignocellulose absorbents that have been previously reported. A strong value R^2 > 0.99 demonstrated that the isotherm parameters were perfectly fitted to the Langmuir and Freundlich model.

REFERENCES

Forgacs, E., Cserháti, T., & Oros, G. (2004). Removal of synthetic dyes from wastewaters: a review. *Environment International*, *30*(7), 953–971. https://doi.org/10.1016/J.ENVINT.2004.02.001

Robinson, T., McMullan, G., Marchant, R., & Nigam, P. (2001). Remediation of dyes in textile effluent: a critical review on current treatment technologies with a proposed alternative. *Bioresource Technology*, *77*(3), 247–255.https://doi.org/10.1016/S0960- 8524(00)00080-8

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AI Hallucination in Fashion Design: Exploring the Gap between Generative Fashion Aesthetics and Wearable Reality

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0.1 INTRODUCTION

Fashion design is both creative and technical discipline. While originality and aesthetic expression are fundamental to successful design, garments must also meet practical requirements before they can become wearable products. Every fashion product must demonstrate appropriate structural integrity, suitable material behaviour, ergonomic comfort, functional construction, and manufacturing feasibility. The success of a garment therefore depends not only on how attractive it appears but also on whether it can be realistically produced and worn.

Recent advances in generative artificial intelligence have introduced new possibilities for fashion designers. Text-to-image models such as DALL·E, Midjourney, Stable Diffusion, and other generative systems allow designers to transform written descriptions into detailed fashion illustrations within seconds. These tools have become increasingly popular during the conceptual design stage because they enable rapid experimentation with silhouettes, colours, fabrics, and styling directions. Designers can now generate multiple design alternatives in a fraction of the time required by conventional sketching methods, creating opportunities for faster design exploration and enhanced creativity.

However, the visual sophistication of AI-generated fashion images often masks significant technical limitations. Many generated garments contain impossible seam placements, unrealistic draping behaviour, inconsistent garment proportions, inaccessible openings, unsupported structural elements, or decorative features that cannot be physically constructed. Such outputs may appear convincing from an artistic perspective while remaining unsuitable for actual garment production. Consequently, there is an increasing need to distinguish visually appealing AI-generated concepts from designs that are technically achievable within existing apparel manufacturing systems.

In artificial intelligence research, outputs that appear plausible despite containing fabricated or unrealistic information are commonly described as hallucinations. Although hallucination has been widely examined in natural language processing and computer vision, relatively little attention has been paid to its manifestation within fashion design. Unlike textual hallucinations, fashion hallucinations involve failures related to garment engineering, textile behaviour, construction logic, body fit, and manufacturing constraints. These issues directly influence the practical value of AI-generated fashion concepts and therefore deserve systematic investigation.

Current literature demonstrates substantial interest in AI-assisted creativity, digital fashion, virtual garments, consumer acceptance, and collaborative human–AI design. Nevertheless, few studies evaluate whether AI-generated garments satisfy the technical standards expected by fashion professionals. Questions relating to wearability, structural realism, construction feasibility, and manufacturing practicality remain largely unanswered. This gap is particularly important because professional fashion design requires the successful integration of aesthetics with technical execution. A visually attractive concept that cannot be manufactured has limited practical value for designers and the apparel industry.

To address this limitation, the present study proposes an expert-based evaluation of AI-generated fashion designs. Fashion academics and industry professionals will assess a series of AI-generated garments using a structured evaluation framework based on six technical dimensions: structural realism, material realism, wearability, ergonomic compatibility, construction feasibility, and manufacturing feasibility. Rather than attempting to measure AI hallucination directly, the study interprets weaknesses across these dimensions as manifestations of hallucination within AI-generated fashion design. By focusing on technical feasibility instead of visual appeal alone, this research seeks to establish a more comprehensive approach for evaluating AI-assisted fashion design and to provide practical insights for designers, educators, and apparel manufacturers.

LITERATURE REVIEW

2.1 Generative Artificial Intelligence in Fashion Design The rapid advancement of generative artificial intelligence (GenAI) has significantly transformed creative industries by enabling users to generate high-quality visual content from natural language prompts. In fashion design, text-to-image models such as DALL·E, Midjourney and Stable Diffusion are increasingly being adopted during concept development, trend exploration and digital prototyping. Unlike conventional computer-aided design systems, these models generate multiple design alternatives within seconds, allowing designers to rapidly visualize ideas and expand creative exploration (Bommasani et al., 2021; Karras et al., 2023).

Recent studies suggest that AI functions as a collaborative design partner rather than a replacement for human creativity. Designers use AI to accelerate brainstorming, generate unconventional silhouettes and explore new colour combinations while maintaining human control over final design decisions (McCormack et al., 2019; Ko et al., 2024). AI-assisted design has also demonstrated potential to reduce development time, improve design efficiency and support personalised fashion experiences (Nayak & Padhye, 2022). Consequently, luxury brands, fast-fashion retailers and independent designers are increasingly integrating generative AI into their creative workflows.

Despite these advantages, researchers have also highlighted limitations associated with AI-generated fashion imagery. While generated designs often appear aesthetically convincing, they may ignore the physical behaviour of textiles, garment construction principles and manufacturing constraints. As a result, visually appealing outputs are not always technically feasible for

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real-world apparel production (Nayak & Padhye, 2022; Ko et al., 2024).

2.2 AI Hallucination and Visual Generation

The concept of AI hallucination originally emerged within natural language processing, referring to outputs that appear plausible but contain fabricated or inaccurate information (Ji et al., 2023). With the rapid evolution of multimodal generative models, hallucination has become equally relevant to image generation, where AI systems may produce unrealistic visual elements despite generating aesthetically convincing images.Ji et al. (2023) describe hallucination as one of the most significant challenges affecting the reliability of generative AI systems because fabricated outputs are often difficult for users to identify. Similarly, Huang et al. (2025) argue that hallucinations reduce user trust by generating content that appears realistic while violating factual or physical constraints. Within image generation, hallucinations may appear as impossible object relationships, inconsistent spatial structures or physically implausible details.

Although AI hallucination has received extensive attention in computer science, its application within fashion design remains largely unexplored. Fashion differs from many visual domains because every design must ultimately satisfy the physical requirements of garment construction, material behaviour and human wearability. Consequently, a fashion illustration may appear visually attractive while remaining impossible to construct or manufacture. This disconnect suggests that hallucination in fashion should be evaluated not only through visual realism but also through technical feasibility.

2.3 Wearability and Technical Feasibility in Apparel Design

Wearability represents one of the fundamental principles of apparel design and extends beyond visual appearance. Watkins and Dunne (2015) explain that successful garments must balance functionality, comfort, fit, protection and aesthetic value. Likewise, Lamb and Kallal's Functional–Expressive–Aesthetic (FEA) Consumer Needs Model demonstrates that effective apparel design requires simultaneous consideration of functional performance, expressive value and aesthetic quality (Lamb & Kallal, 1992). These principles remain central to both apparel education and industrial product development. Garment feasibility also depends on appropriate pattern engineering, seam construction, fabric properties and manufacturing capability. Designs that ignore these technical considerations frequently encounter production challenges, increased manufacturing costs or complete production failure (Cooklin, 1997; Aldrich, 2015). Therefore, evaluating AI-generated fashion concepts solely on their visual appeal provides an incomplete assessment of their practical value. Building on these established theories, the present study proposes that AI-generated fashion designs should be evaluated using six technical dimensions: structural realism, material realism, wearability, ergonomic compatibility, construction feasibility and manufacturing feasibility. Together, these dimensions provide a structured approach for identifying manifestations of AI hallucination within apparel design while linking computational image generation with established principles of fashion product development.

2.4 Research Gap

Existing literature demonstrates substantial progress in AI-assisted fashion design, digital creativity and generative image synthesis. However, most previous studies have evaluated AI-generated fashion outputs from the perspectives of creativity, aesthetics or consumer perception. Few studies have systematically investigated whether AI-generated garments satisfy the technical requirements necessary for physical production. Furthermore, no widely adopted framework currently exists for identifying manifestations of AI hallucination through expert evaluation of garment realism and production feasibility. Addressing this gap is essential as generative AI becomes increasingly integrated into professional fashion design practice. The present study therefore proposes an expert-based evaluation framework that assesses AI-generated fashion designs using established apparel design principles, providing a practical method for distinguishing visually persuasive concepts from technically feasible garments using expert evaluation rather than consumer opinion, the study provides a systematic approach for assessing the practical reliability of AI-generated fashion designs. The questionnaire items were adapted and modified from established literature on apparel design, functional clothing, garment engineering, and apparel manufacturing to suit the evaluation of AI-generated fashion designs.

3. Research Methodology

3.1 Research Design

This study adopts a quantitative cross-sectional research design to investigate how manifestations of AI hallucination influence the technical feasibility of AI-generated fashion designs. Unlike previous studies that primarily examine consumers' aesthetic preferences or the creative capabilities of generative AI, this research evaluates AI-generated garments from a professional fashion design perspective. The emphasis is placed on determining whether visually convincing AI-generated garments satisfy the technical requirements necessary for physical apparel production. The research follows four sequential stages. First, standardized prompts are developed to generate fashion images using a single generative AI platform. Second, the generated images are screened and selected based on predefined quality criteria. Third, fashion experts evaluate each design using a structured questionnaire. Finally, quantitative and qualitative analyses are conducted to identify the most common manifestations of AI hallucination and to examine their influence on garment feasibility. By controlling the image-generation process and

3.2 Fashion Hallucination Assessment Framework (FHAF)

To evaluate AI-generated fashion designs systematically, this study proposes the Fashion Hallucination Assessment Framework (FHAF). The framework is developed by integrating established principles of apparel design, garment engineering, ergonomics, and apparel manufacturing with the concept of AI hallucination from artificial intelligence literature. Rather than treating hallucination as a purely computational phenomenon, FHAF conceptualizes fashion hallucination as the presence of visually convincing yet technically unrealistic design characteristics that reduce the feasibility of translating AI-generated concepts into wearable garments. The framework consists of three higher-order domains**,** each represented by two evaluation dimensions.

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✓ **Domain I: Visual Realism**
Visual realism examines whether the AI-generated garment appears technically believable from a design perspective before considering production requirements.
Structural Realism: Logical garment construction; Appropriate garment proportions; Realistic seam placement; Physically plausible silhouette
Material Realism: Realistic fabric behaviour, Appropriate drape characteristics; Logical textile texture; Consistency between fabric type and garment structure
✓ **Domain II: Functional Realism**
Functional realism evaluates whether the garment can realistically function as wearable apparel.
Wearability: Practical usability; Comfort; Appropriate garment coverage; Ease of wearing
Ergonomic Compatibility: Freedom of movement; Human body compatibility; Functional armhole, sleeve and neckline design; Appropriate fit for intended use
✓ **Domain III: Production Realism**
Production realism assesses whether the garment can be manufactured using existing apparel production technologies.
Construction Feasibility: Pattern-making possibility; Sewing feasibility; Construction sequence; Assembly practicality
Manufacturing Feasibility: Industrial production capability; Commercial scalability; Material availability; Production efficiency

Together, these six dimensions provide a comprehensive framework for identifying manifestations of AI hallucination within fashion design while linking computational image generation with the practical realities of apparel product development**.**

Conceptual figure: AI Prompt → AI-Generated Fashion Image → FHAF (Visual Realism, Functional Realism, Production Realism) → Expert Evaluation → Identification of AI Hallucination Manifestations

3.3 AI Image Generation

AI-generated fashion designs will be created using a single generative AI platform to ensure methodological consistency throughout the study. Using one platform minimizes variations arising from differences in image-generation algorithms and allows the evaluation to focus on the technical characteristics of the generated garments rather than differences between AI systems.

A standardized prompt engineering protocol will be developed before image generation. Each prompt will contain identical design parameters, including garment category, target consumer, silhouette, fabric type, colour palette, construction details, rendering style, body pose, and presentation format. Maintaining consistent prompts across all designs reduces experimental bias and improves the reproducibility of the study.

Five apparel categories representing different levels of design complexity will be included:

- Casual Wear; Streetwear; Sportswear; Evening Wear; Avant-garde Fashion

Three designs will be generated for each category, resulting in a total of fifteen AI-generated garments. Prior to expert evaluation, all images will be reviewed to remove duplicated outputs, incomplete renderings, severe anatomical distortions, or images with obvious technical errors unrelated to the research objectives.

3.4 Participants

The study will employ purposive sampling to recruit fashion professionals with relevant academic or industrial expertise. Approximately **180-200 experts** will participate in the evaluation.

Eligible participants may include:

- Fashion Designers; Pattern Engineers; Apparel Merchandisers
- Product Developers; Garment Technologists; Fashion Academics
- Production Managers; Quality Assurance Specialists

Participants will possess a minimum of two years of professional or academic experience within the fashion and apparel sector. Expert evaluation is considered appropriate because the research requires specialized knowledge of garment construction, textile behavior, apparel manufacturing, and product development.

3.5 Instrument Development

A structured questionnaire will be developed based on the FHAF framework and supported by previous literature on apparel design, functional clothing, garment engineering, ergonomics, and AI-generated image evaluation.

Each evaluation item will be measured using a seven-point Likert scale ranging from 1 (Strongly Disagree) **to** 7 (Strongly Agree)**.**

The questionnaire consists of six constructs:

- Design Realism (DR); Wearability (WR); Production Feasibility (PF); Perceived AI Hallucination (AH)

Each construct contains three to four measurement items adapted from established apparel design principles and refined for AI-generated fashion evaluation.

An additional open-ended section allows experts to describe unrealistic design characteristics that cannot be adequately captured using numerical ratings.

3.6 Pilot Validation

Prior to the main survey, the questionnaire will undergo expert review involving five to seven senior academics and industry specialists. Participants will evaluate the clarity, relevance, and comprehensiveness of each measurement item.

Feedback obtained during the pilot study will be used to improve questionnaire wording, eliminate ambiguous statements, and establish content validity before the main data collection.

3.7 Data Analysis

Data analysis will be conducted using IBM SPSS Statistics. Descriptive statistics will summarize expert evaluations across the six dimensions of the FHAF framework. Internal consistency will be assessed using Cronbach's alpha. Pearson correlation analysis will examine relationships among the evaluation dimensions, while one-way ANOVA or the Friedman test (depending on data distribution) will compare expert evaluations across different garment categories. Qualitative comments will be analyzed using thematic analysis to identify recurring manifestations of AI hallucination, including unrealistic seam placement, implausible fabric behavior, construction inconsistencies, ergonomic limitations, and manufacturing constraints. The integration of quantitative and qualitative findings will provide a comprehensive understanding of how AI hallucination influences the technical feasibility of AI-generated fashion designs and will further validate the proposed Fashion Hallucination Assessment Framework.

4. RESEARCH hypotheses

H1: Design realism has a significant negative effect on perceived AI hallucination.
H2: Wearability has a significant negative effect on perceived AI hallucination.
H3: Production feasibility has a significant negative effect on perceived AI hallucination.

References

Aldrich, W. (2015). *Metric Pattern Cutting for Women's Wear* (6th ed.). Wiley.
Bommasani, R., Hudson, D. A., Adeli, E., Altman, R., Arora, S., von Arx, S., ... & Liang, P. (2021). *On the Opportunities and Risks of Foundation Models*. Stanford Center for Research on Foundation Models. https://arxiv.org/abs/2108.07258
Cooklin, G. (1997). *Garment Technology for Fashion Designers*. Blackwell Science.
Ji, Z., Lee, N., Frieske, R., Yu, T., Su, D., Xu, Y., Ishii, E., Bang, Y., Madotto, A., & Fung, P. (2023). Survey of hallucination in natural language generation. *ACM Computing Surveys, 55*(12), 1–38. https://doi.org/10.1145/3571730
Lamb, J. M., & Kallal, M. J. (1992). A conceptual framework for apparel design. *Clothing and Textiles Research Journal, 10*(2), 42–47. https://doi.org/10.1177/0887302X9201000207
Nayak, R., & Padhye, R. (2022). *Artificial Intelligence in Fashion Industry*. Springer. https://doi.org/10.1007/978-981-16-8820-1
Russell, S., & Norvig, P. (2021). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson.
Watkins, S. M., & Dunne, L. E. (2015). *Functional Clothing Design: From Sportswear to Spacesuits*. Fairchild Books.
OpenAI. (2023). *GPT-4 Technical Report*. https://arxiv.org/abs/2303.08774
Ramesh, A., Dhariwal, P., Nichol, A., Chu, C., & Chen, M. (2022). Hierarchical text-conditional image generation with CLIP latents. *arXiv*. https://arxiv.org/abs/2204.06125
Rombach, R., Blattmann, A., Lorenz, D., Esser, P., & Ommer, B. (2022). High-resolution image synthesis with latent diffusion models. *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, 10684–10695. https://doi.org/10.1109/CVPR52688.2022.01042

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Policy Adaptation and Industry-level Compliance Strategies for Textile Exports Under EU Carbon and Chemical Regulatory Constraints

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1. Introduction

The global trading system is undergoing a profound transition towards green and low-carbon development. Traditional tariff barriers are gradually being replaced by non-tariff green barriers based on environmental standards, carbon regulations, and ecological safety requirements. The European Union, as a leading region in global green trade rule-making, has been continuously updating its regulatory framework. A series of legislative instruments have been introduced, including the Carbon Border Adjustment Mechanism (CBAM), the REACH Regulation on chemicals, the ZDHC (Zero Discharge of Hazardous Chemicals) standards, and the Ecodesign for Sustainable Products Regulation (ESPR). These regulations collectively cover the entire lifecycle of textile products, from raw material sourcing to production, trade, and end-of-life disposal, significantly raising the compliance barriers for textile exports entering the EU market.

Although CBAM has not yet covered textile products in its initial phase—currently limited to iron, steel, aluminium, cement, fertilisers, hydrogen, and electricity—the EU has signalled a clear intention to expand its scope. In July 2026, the European Parliament's Committee on the Environment voted to support the extension of CBAM to downstream products including textiles, with full sectoral coverage expected by 2030 (European Parliament, 2026). This signals that the inclusion of textiles in the carbon tariff regime is no longer a matter of "if" but "when".

As China is the world's largest textile exporter, with approximately 15% of its textile and garment exports destined for the EU (Wang et al., 2025), the potential impact of these dual carbon and chemical regulations on China's textile industry is substantial. Quantitative studies have estimated that if CBAM were extended to textiles at a carbon price of €80/tCO_2, China's textile and garment sector would face an additional tax burden of approximately RMB 11.74 billion, with industrial output declining by about 8% (Liu et al., 2023).

Meanwhile, the REACH regulation, with its SVHC (Substances of Very High Concern) candidate list now containing 253 substances, imposes strict limits on hazardous chemicals, while the ESPR requires mandatory digital product passports (DPPs) to trace product composition and carbon footprint across the entire life cycle.

Despite the growing stringency of these regulations, existing studies in China have predominantly focused on micro-level enterprise case analyses, with limited systematic industry-wide adaptation frameworks that address the combined effects of multiple EU green regulations. This paper aims to fill this gap by analysing the differentiated characteristics of green barriers across major textile markets—namely the EU, the US, and Southeast Asia—and by proposing a universal and implementable industry-level compliance system.

2. Research Methods

This study adopts a qualitative research approach combining literature review, cross-border policy comparison, and industry case validation. The literature review covers academic papers, policy documents, and industry reports on green trade barriers, carbon compliance, and textile export transformation. The policy comparison analyses the regulatory frameworks of the EU (CBAM, REACH, ZDHC, ESPR), the US, and Southeast Asian countries, focusing on their differences in stringency, coverage, and implementation. The industry case validation draws on publicly available information from Yibin Grace Group, a leading Chinese textile fibre manufacturer that has successfully implemented a full-chain green compliance system.

No empirical modelling or quantitative data analysis is conducted in this study, as the research is primarily normative and policy-oriented, aiming to provide strategic guidance and practical frameworks for the textile export industry.

3. Key Regulatory Constraints and Industry Challenges

3.1 The EU Regulatory Framework

The EU has established a multi-layered, comprehensive, and highly stringent green regulatory system for the textile sector. Four core regulatory instruments are particularly relevant:

CBAM (Carbon Border Adjustment Mechanism): While current coverage is limited to six carbon-intensive sectors, the EU has embedded a review and expansion clause in the legislation. The July 2026 vote by the European Parliament's Environment Committee confirmed the intention to extend CBAM to textiles and other downstream products by 2030 (European Parliament, 2026). This will impose a direct carbon cost on Chinese textile exports, effectively raising the market access barrier.

REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals): As the cornerstone of EU chemical regulation, REACH applies throughout the textile production process. It strictly limits the use and residues of heavy metals, persistent organic pollutants, and other hazardous substances. By

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February 2026, the SVHC candidate list had reached 253 substances. REACH compliance is a legal prerequisite for entering the EU market.

ZDHC (Zero Discharge of Hazardous Chemicals): Unlike REACH, which is a legal requirement, ZDHC is an industry self-regulatory standard promoted by a coalition of brands and retailers. The ZDHC MRSL (Manufacturing Restricted Substances List, currently V3.1) prohibits the intentional use of hazardous chemicals during production. It has become a de facto mandatory condition for major Western brands.

ESPR (Ecodesign for Sustainable Products Regulation): Effective from July 2024, ESPR requires textiles to meet mandatory ecodesign requirements (durability, repairability, recyclability) from the design stage. The Digital Product Passport (DPP) is required to disclose product composition, carbon footprint, and other life-cycle data. Since 19 July 2026, the destruction of unsold garments and footwear has been prohibited (European Commission, 2024).

3.2 Industry Challenges in China

Drawing on the regulatory landscape and current industry conditions, four major challenges are identified:

First, lagging compliance system development. Many textile exporters lack systematic carbon management, chemical control, and risk response mechanisms, often reacting passively to overseas compliance inspections. The gap between average industry practice and leading enterprises—such as Yibin Grace Group, which has obtained 33 international certifications—is significant.

Second, insufficient full-chain carbon tracing and disclosure capacity. A standardised life-cycle carbon footprint accounting framework is lacking in the industry. Most enterprises are unable to meet the EU's requirements for digital tracing and carbon data verification, exposing them to market access restrictions.

Third, limited green supply chain development. Green standards are inconsistent across the upstream and downstream segments of the textile value chain. Issues such as irregular chemical use and inadequate clean production practices remain widespread.

Fourth, slow progress in industrial circular transition. Textile waste recycling and circular production models have not yet achieved scale across the industry, with traditional high-energy, high-waste production models still prevailing.

4. Proposed Industry-Level Compliance Strategies

Based on the analysis, a four-dimensional compliance system is proposed, supported by practical insights from Yibin Grace Group's implementation:

4.1 Green Supply Chain Optimisation

A unified green raw material procurement standard should be established, requiring suppliers to meet environmental certification and compliance criteria. The supply chain should be standardised, integrated, and traceable. As exemplified by Yibin Grace Group, the "three green manufacturing" system includes: (a) green raw materials—90% of purchased wood pulp is FSC-certified, and recycled pulp from 100% post-consumer textiles is used; (b) green production—bipolar membrane technology enables recycling of water, chemicals, and semi-cellulose, with the factory receiving STeP by OEKO-TEX's highest rating and being recognised as a national "Green Factory"; and (c) green energy—hydroelectric power is used, with comprehensive energy consumption dropping 43.3% between 2021 and 2023. The company has also established a green supply chain alliance with 167 partners across 47 countries.

4.2 Standardised Chemical Management

The industry should proactively align with REACH and ZDHC standards to establish a chemical management, monitoring, and testing system. As demonstrated by Yibin Grace Group's RMB 240 million investment in green production upgrades, including R&D of solvent-free spinning technology in collaboration with research institutes, chemical compliance requires systematic process transformation rather than merely end-product testing. All 12 ZDHC MMCF wastewater indicators achieved Grade A in 2023.

4.3 Full-Chain Carbon Footprint Tracing and Disclosure

The industry should adopt life-cycle assessment (LCA) methods covering raw material sourcing, production, warehousing, transport, and cross-border export stages. Digital product passports should be integrated with EU traceability requirements. Yibin Grace Group has participated in drafting three industry carbon standards, has published its first carbon footprint report on yarn products, and has set a "30% carbon reduction by 2030, carbon neutrality by 2050" target.

4.4 Industrial Circular Transition

Circular production models—recycling, re-manufacturing, and reusing textile waste—should be promoted. Yibin Grace Group's T2T (Textile-to-Textile) pilot line, with an investment of RMB 53 million and a capacity of 2,000 tonnes/year of waste textiles, reduces CO_2 emissions by approximately 10,000 tonnes annually. The circular model has generated annual profits of around RMB 8 million, demonstrating both environmental and economic feasibility.

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5. Conclusion

Under the accelerating global transition towards green trade, the EU's dual carbon and chemical regulations impose significant constraints on China's textile exports. While CBAM has not yet covered textiles, its extension is imminent. REACH and ZDHC together form a multi-tiered chemical compliance system, and ESPR introduces comprehensive ecodesign requirements. The industry faces challenges in compliance systems, carbon tracing, supply chain development, and circular transition. However, the practical experience of leading enterprises shows that systematic green transformation—including green raw material sourcing, clean production, international certification, and circular economy models—can turn regulatory barriers into competitive advantages. The four-dimensional compliance framework proposed in this paper provides a reference for the industry to systematically build a sustainable and resilient green compliance system in response to evolving international trade rules.

6. References

European Commission. (2024). Regulation (EU) 2024/1781 establishing a framework for the setting of ecodesign requirements for sustainable products.

European Parliament. (2026). Vote of the Committee on the Environment, Public Health and Food Safety on the extension of CBAM to downstream products (July 2026).

Liu, X., Liang, B., & Ding, X. (2023). New green trade barriers: The impact of EU carbon border adjustment mechanism on the development of China's textile and garment industry. Price Monthly, (3), 23-31.

Wang, L., Dong, X., Hu, S., & Li, M. (2025). Analysis of the impact of EU carbon border adjustment mechanism on China's textile and garment product exports. Modern Business, (4), 114-117.

Yibin Grace Group. (2024). Sustainability Report 2024.

Yibin Grace Group. (2025). Public information on T2T textile-to-textile recycling pilot line.

ZDHC. (2025). ZDHC Manufacturing Restricted Substances List (MRSL), Version 3.1.

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Beyond Recycling: Transforming Textile Waste into High-Value

Technical Textiles and Advanced Materials

Keynote talk:

The textile and apparel industry across the globe is going through a principal transformation which is driven by increase in textile waste, constraints of resources, concerns regarding environment and ever-growing demand of high performance and sustainable materials. For countries like Pakistan and Bangladesh, which are major countries with production of textiles, this significant challenge is also providing opportunity to switch from conventional methods of recycling and convert the wastes into high value, innovative and need based products which are high in demand. The future of sustainable textiles requires a transition from simple recycling of waste into materials which are engineered to cater the applications, impart properties and defined structures.

This keynote will present a perspective driven by research, to transform textile waste materials into protective products, high value technical textiles, fiber reinforced composites and high value technical textiles. Drawing upon research in fabric structures, recycled materials, sustainable and circular textiles, fiber reinforced composites and protective textiles, it will be demonstrated on how recovered materials of textiles can be enhanced in terms of value by selecting appropriate selection of fibers, formation of yarn, fabric architecture, development of non-woven, composite design and hybridization.

Premiere focus will be on establishment of relationship between structure, material, performance and processing. The wastes extracted from textile are never a uniform mix and it is dependent over factors like length of fibers, composition of fibers, mechanical characteristics, morphology and previous history of processing which define a particular use of the extracted waste. A successful valorization of waste is dependent on approach of engineering which considers the selection based over requirement of performance with respect to application, structural design and characterization of materials. Textile wastes and recycled fibers can be engineered to develop non-woven as well as functional fabrics with application in filtration, protection, thermal management and acoustics, while suitable waste streams can also be used for constituent materials in polymeric and other composite system.

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The keynote will introduce a value-oriented circular pathway:

Textile Waste → Material Recovery → Structural Engineering → Performance Enhancement → Technical Application → Added Value

This approach will help in shifting the focus from volume-based recycling to valorization based over performance, where the objective is not only recovery of material but retention and creation of value through design and engineering. There will be examples from nonwoven structures, functional textiles, recycled yarns and reinforced textile-based composites which will explain how development from sustainable materials can be done while keeping performance requirements intact.

A country like Bangladesh with its significant presence in global markets, there are opportunities to strengthen the connection between research, management of textile wastes, industrial innovation and development of technical textiles. A greater bonding and collaboration among brands, universities, recycling plants, manufacturers of textile products and technology transfer can be helpful in conversion of wastes materials of textiles into high value-added products. The same opportunities are visibly available with strong footings for south east Asia where manufacturing capabilities are stronger and these can help in providing the foundation for development of local technologies relevant to their product and production lines.

The presentation will conclude by considering future directions including waste separation, functional and protective textiles, advanced recycling, separation and segregation of waste, digital and data driven material development and a stronger linkage and collaboration of industry academia. The central idea and proposal is that textile waste should not be considered as life cycle end of raw material but it can become more important and functional by engineering and developing it into functional, high performance, next generation sustainable and technical materials.

Keywords: Textile Waste Valorization; Circular Textiles; Technical Textiles; Sustainable Materials; Nonwovens; Protective Textiles; Textile Structures; Fibre-Reinforced Composites; Circular Economy

Modern Translations and Digitalization Applications of Traditional Silk Patterns from China and Bangladesh

From Traditional Cultural Genes to AI-Assisted Design

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Abstract: Traditional textile patterns embody regional culture, artisanal expertise, and aesthetic concepts; their contemporary application requires balancing cultural identity, formal innovation, and production adaptability. This study takes plant, geometric, and animal motifs from traditional textiles in China and Bangladesh as research subjects, employing comparative analysis, case studies, and design extrapolation methods to explore the visual characteristics of representative motifs, contemporary reinterpretation approaches, and digital-ethical application on pathways. By distinguishing core identifying features from variable design elements, the study proposes a design workflow comprising resource acquisition, feature annotation, cultural semantic analysis, generation rule formulation, and human review. This workflow is illustrated through application cases of chequered-pattern scarves and garments. The research concludes that the digital- ethical reinterpretation of traditional motifs should be grounded in cultural understanding—transforming motif structures, compositional principles, and medium-specific requirements into actionable design constraints. This approach fosters synergy between AI-generated designs and human designer judgment, thereby providing methodological references for contemporary expression of traditional textile patterns in China and Bangladesh.

Keywords: Traditional textiles of China and Bangladesh; Pattern translation; Cultural genes; Digital and intelligent design;

Sustainable Processing of Recycled and Virgin Textiles through Methoxylated Pectin Surface Modification for Mitigation of Fiber Particle and Microfiber Release

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1.0 INTRODUCTION

During textile processes fibers released from textile materials that can enter wastewater and subsequently reach aquatic environments. Except for this, during daily life washing of garments the fiber shedding took place, that also enter aquatic environments, so textile fiber shedding has become an increasing environmental concern. The amount of fiber release depends on fiber type, fabric construction, yarn characteristics, mechanical treatment, and washing conditions and fiber-release concerns are not limited to synthetic textiles [1] [2][5].

As the fiber shedding depended on textile structure and surface characteristics the modification of these can be a potential solution to this big issue. A bio-based polymers are particularly suitable because they can provide functional surface properties while offering an alternative to conventional synthetic finishing materials leads to no environmental damage [3][4][5]. One study showed, when pectin-based finishing treatment applied on polyamide fabrics, the treatment formed a continuous coating on the fabric surface and significantly reduced microfiber [1].

This study examined that pectin-based surface modification as a sustainable approach for reducing fiber shedding from both virgin and recycled textile fabrics. Here, Cotton, viscose, polyester, and recycled-fiber-based woven and knitted fabrics were treated with a low-viscosity pectin formulation with $CaCl_2$, and their fiber shedding was compared with untreated fabrics. In this procedure the effect of different material-to-liquor ratios was also investigated.

2. MATERIALS AND METHODS

2.1 Materials

In this research CVC knitted fabric, 95% viscose knitted fabric, terry knitted fabric, recycled denim woven fabrics were selected for the investigation. The fabrics were tested to determine the effect of pectin/$CaCl_2$ treatment on fiber shedding and weight loss during repeated washing to.

Here, pectin was used as the primary bio-based treatment material and calcium chloride ($CaCl_2$) was used as an auxiliary binding or crosslinking agent. Distilled or laboratory water was used for preparation of the treatment liquor.

2.2 Preparation of 3% Stock Solutions

To prepare 3% pectin stock solution, 3 g of pectin was thoroughly dissolved in 100ml of water. The pectin was dispersed and mixed thoroughly at approximately 60–70°C**,** and continuously stirring was done until a homogeneous stock solution was obtained. 3 g of $CaCl_2$ was dissolved in the 100 ml of water to prepare a 3% $CaCl_2$ stock solution. The treatment liquor was maintained at approximately pH 6–7.

2.3 Calculation of Treatment Liquor

For proper evaluation, the material-to-liquor (M:L) ratio was varied from process to process. M:L of 1:30, 1:20, and 1:10 were used.

2.4 Treatment of Fabrics

For the CVC knitted fabric, the initial fabric weight was 7.68 g, and for this the M:L 1:30 was used. The calculated pectin and $CaCl_2$ treatment liquors were prepared, and the fabric was completely immersed and processed in a laboratory dyeing machine at 50°C for 60 min. Likewise 95% viscose fabric and terry fabric treatment was performed at 60°C for 60 min. For better performance, the temperature was being changed.

After treatment, the fabrics were dried using an oven dryer before their final weights were determined.

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2.5 Treatment of Woven Fabrics

For the woven fabrics, recycled denim fabrics of different amounts of recycled cotton were tested for better evaluation.

The size of the samples was 12 × 10 cm, and the amount recycle cotton present in the fabric was different. The treatment was performed at 70°C for 60 min.

The other woven fabric contained 20% and 29% recycled cotton, 1% elastane, and the remaining proportion virgin cotton. The samples were cut to 12 × 10 cm and treated using an M:L of 1:10.

2.6 Repeated Washing Procedure

For the recycled-cotton-containing fabrics, a three-stage washing assessment was conducted at 70°C for 60 min per washing stage. The other sample from same fabric was cut into same size and was treated with pectin/$CaCl_2$. At first, the wash was performed using normal water, the second wash was performed using the pectin/$CaCl_2$ treatment liquor, and the final wash was performed using normal water.

The samples were dried at 60^0C for 30 min after each washing stage and weighed. The change in weight was recorded after each stage to evaluate fiber loss.

2.7 Determination of Weight Loss

The initial and later on weights of all samples were recorded using a weighing balance. For repeated washing experiments, weight loss after each stage was calculated relative to the original sample weight. Lower weight loss was represented as good fiber retention means less fiber shedding.

3.0 RESULTS AND DISCUSSION

3.1 Weight Loss of Knitted Fabrics

The washes were done on knitted fabrics, and the comparison were among them was done to determine the differences in fabric structure's effect on fiber loss. The weight-loss results of the knitted fabrics are presented in Table 1.

Table 1. Weight loss of knitted fabrics after treatment/washing

Fabric Type	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (%)
CVC Knitted	7.68	6.86	0.82	10.68
95% Viscose	8.77	8.08	0.69	7.87
Fleece	5.54	5.51	0.03	0.54

The lower loss observed for terry may be associated with its pectin/$CaCl_2$ liquor, fabric structure and surface characteristics, which can influence fiber retention. On the opposite side, the higher wt. reduction of the CVC and viscose fabrics suggests greater susceptibility to material removal under the applied washing/treatment conditions where the M:L ratio of pectin/$CaCl_2$ liquor was a big factor.

3.2 Comparison of Recycled Denim Specimens

To identify the pectin/$CaCl_2$ liquor effect the recycled denim samples were treated in 2 phases, treated with pectin/$CaCl_2$ liquor and untreated or normal water wash. It showed different levels of weight loss after the treatment/washing assessment.

Table 2. Weight loss of recycled fabrics

Sample	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (%)
Recycled Denim 1	4.81	4.65	0.16	3.33
Recycled Denim 2	4.76	4.54	0.22	4.62

Here in table 2, it can be seen that high recycled fabrics has bigger weight loss tendency. The difference indicates that sample-to-sample variation may occur because of pectin/$CaCl_2$ liquor or surface condition samples. Therefore, repeat testing is in both treated and untreated pectin/$CaCl_2$ liquor condition is important before

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concluding that the treatment produces a statistically significant difference.

3.3 Repeated Washing of Fabric Containing 29% Recycled Cotton

For further improvement the repeated washing was involved. A clearer difference was seen in the repeated-washing experiment on the fabric containing 29% recycled cotton and 1% elastane, with the remaining portion consisting of virgin cotton.

Table 3. Repeated washing results for 29% recycled-cotton fabric

Washing Stage	Normal Water Sample (g)	Pectin + $CaCl_2$ Treatment Sample (g)
Initial Weight	6.62	4.45
After 1st Wash	6.38	4.19
After 2nd Wash	4.98	3.87
After 3rd Wash	3.98	3.73
Total Weight Loss (g)	2.64	0.72
Total Weight Loss (%)	39.88	16.18

In table 3, it is seen that the pectin/$CaCl_2$-treated washing samples showed approximately 59.42% lower cumulative weight loss than the normal-water sequence: The results showed greater weight retention in the samples treated with the pectin/$CaCl_2$ liquor.

3.4 Repeated Washing of Fabric Containing 20% Recycled Content

In terms of other recycled fabric containing 20% recycled content and 1% elastane and rest virgin cotton, the results are shown in Table 4.

Table 4. Repeated washing results for 20% recycled-content fabric

Washing Stage	Pectin + $CaCl_2$ Treatment Sample (g)	Normal Water Sample (g)
Initial Weight	4.56	5.83
After 1st Wash	4.33	5.65
After 2nd Wash	4.13	4.87
After 3rd Wash	3.99	3.92
Total Weight Loss (g)	**0.57**	**1.91**
Total Weight Loss (%)	**12.50**	**32.76**

In table 4 all washes result for the other recycle fabric are shown. This result is consistent with the observation coming from the 29% recycled-cotton fabric, where the pectin/$CaCl_2$ treatment sample also resulted in considerably lower total weight loss.

3.5 Overall Effect of Pectin/$CaCl_2$ Treatment

From all the assessments of the repeated-washing experiments showed a consistent trend for the two recycled-fiber-containing fabrics. The samples showed to the pectin/$CaCl_2$ liquor treatment stage retained more mass than the specimens treated only with normal-water washing.

Table 5. Summary of pectin effects on fiber shedding of recycled fabric

Fabric Composition	Treatment/Washing Condition	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (%)
29% Recycled Cotton + 1% Elastane	Normal Water	6.62	3.98	2.64	39.88
29% Recycled Cotton + 1% Elastane	Pectin + $CaCl_2$ Sequence	4.45	3.73	0.72	16.18
20% Recycled + 1%	Pectin + $CaCl_2$ Sequence	4.56	3.99	0.57	12.50

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Fabric Composition	Treatment/Washing Condition	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (%)
Elastane					
20% Recycled + 1% Elastane	Normal Water	5.83	3.92	1.91	32.76

Overall information and assessment shown in table 5, here the reduction in weight loss can be reasoned by the formation of a pectin-containing surface layer. Pectin has the properties that can form films on material surfaces and potentially improve the cohesion of loose or protruding fibers. The Ca^{2+} presences may further contribute to the integrity of the pectin layer through interactions with carboxyl-containing pectin chains that the result of this study also showed.

So, improved fiber cohesion through a bio-based surface treatment could therefore be beneficial in reducing further fiber loss during subsequent wet processing, laundering and in reducing environment pollution.

4.0 CONCLUSION

This research work on the potential of pectin/$CaCl_2$ treatment as a bio-based medium for reducing textile material and fiber loss during washing. The results showed considerable variation in weight loss among the tested knitted and woven fabrics based on their structure and pectin/$CaCl_2$ treatment. In terms of knitted fabrics, CVC showed the highest weight loss of 0.82 g (10.68%), while terry showed the lowest loss of 0.03 g (0.54%) in which the pectin ratio was higher than CVC and viscose.

The woven recycled-fabric washing experiments gave stronger evidence of the beneficial effect of the pectin/$CaCl_2$ treatment. For the ample containing 29% recycled cotton, the pectin/$CaCl_2$ washing sequence resulted in 16.18% total weight loss, compared with 39.88% for normal-water washing. Same for the fabric containing 20% recycled content, the pectin/$CaCl_2$ sequence resulted in 12.50% weight loss, compared with 32.76% for the normal-water sequence. These results indicate substantially higher fiber retention when the pectin/$CaCl_2$ treatment was incorporated into the washing sequence.

The observed reduction in weight loss can be given to the film-forming and binding characteristics of pectin where the potentially enhanced by calcium-ion interactions with the pectin matrix.

REFERENCES

1. Vassilenko, E., et al., *Domestic laundry and microfiber pollution: Exploring fiber shedding from consumer apparel textiles.* Plos one, 2021. **16**(7): p. e0250346.
2. Zhou, H., L. Zhou, and K. Ma, *Microfiber from textile dyeing and printing wastewater of a typical industrial park in China: Occurrence, removal and release.* Science of the Total Environment, 2020. **739**: p. 140329.
3. Chan, S.Y., et al., *Pectin as a rheology modifier: Origin, structure, commercial production and rheology.* Carbohydrate polymers, 2017. **161**: p. 118-139.
4. De Falco, F., et al., *Pectin based finishing to mitigate the impact of microplastics released by polyamide fabrics.* Carbohydrate polymers, 2018. **198**: p. 175-180.
5. Thakur, B.R., et al., *Chemistry and uses of pectin—A review.* Critical Reviews in Food Science & Nutrition, 1997. **37**(1): p. 47-73.



Figure 1. Readymade Pectin powder sourced from Molychem.

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Embedding Sustainability: Institutionalising Recycling Practices in the Garment and Textile Industries of Bangladesh

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INTRODUCTION

The ready-made-garment (RMG) sector is said to be one of the largest polluters of the environment in terms of greenhouse gas emissions (GHGs) (World Bank, 2019). The RMG sector also produces a lot of production waste, mostly fabric waste, which is the major material for manufacturing clothes. The production of fabric materials also comes with the cost of CO_2 emissions. However, the production waste of fabric material can be a good source of raw material for another production chain if reused and recycled efficiently. Hence, the recycling of fabric waste in the textile and garment industry can enhance the sector's sustainability through circularity. Despite its huge potential worth US$ 4 billion (Rahman and Uddin, 2023), the textile and garment recycling industry of Bangladesh mostly operates in an informal setting, posing a challenge for this transition. For instance, since the industry functions informally, there is a lack of traceability and transparency of the recycled and reused products of the sector and their final whereabouts, and this transparency and traceability will be a prior requirement of the upcoming EU laws. For instance, the newly proposed Ecodesign for Sustainable Products Regulations will issue digital product passports based on certain required information, including—product durability, reusability, upgradability and reparability; presence of substances that inhibit circularity; energy and resource efficiency; recycled content; remanufacturing and recycling; carbon and environmental footprints. Without this information, EU countries can decline the products to enter its market. These EU legal requirements will surely create a challenge for Bangladesh's RMG exports to the EU market if Bangladesh does not align itself accordingly.

OBJECTIVE AND RESEARCH QUESTION

Holding the second lead position in exporting RMG in the world (Zaman, 2023), Bangladesh also produces a lot of garment waste, and Bangladesh has the potential to become a large-scale global textile recycling hub if the sector is managed sustainably (The Business Standard, 2023). Hence, the formal stakeholders of this sector are coming forward to institutionalize and formalize the informal textile recycling sector of Bangladesh. This study aims to explore the related initiatives taken by the formal stakeholders to ensure sustainable practices within the industry to make it resilient and sustainable. One way to enhance sustainability in the RMG sector is the transition towards a circular economy. Hence, the formal stakeholders of the industry are taking circular initiatives such as circular economy-based projects, research studies, training, and others, aiming at formalizing the textile recycling value chain through transparency and traceability. The core objective of this study is to map the relevant stakeholders in the garment and textile recycling industries in Bangladesh and to understand how they engage with the local context. To explore the level of engagement of the actors and initiatives promoting increased sustainability for the garment and textile recycling industry of Bangladesh, this study aims to answer the following research questions—

1. What are the key initiatives aimed at promoting sustainability for the garment and textile recycling industry in Bangladesh, and who are the key actors involved? Why are these actors entering this policy space now?

2. Which visions of "sustainable recycling" are they seeking to promote? How do these actors and stakeholders engage with the local institutions, entrepreneurs, waste handlers, etc.?

RESEARCH METHODS AND SIGNIFICANCE

This research is drawn from a study that employed qualitative research methods in collecting, processing, and analysing data. The major data were key informant interviews, facilitated with a semi-structured interview guide. Fourteen in-depth interviews with industry experts, including brands, business associations, government organizations, inter-governmental organisations (IGOs), and recyclers, were conducted. Respondents were selected via purposive and snowball sampling based on their expertise. The interviews, lasting about an hour each, were conducted both online and in-person, based on the availability of the respondents, and recorded with the respondents' consent. Both English and Bengali were used in the interviews, which were subsequently transcribed, with Bengali transcriptions translated into English.

RECYCLING CLUSTERS IN BANGLADESH

The garment and textile recycling industry, locally known as the jhut industry in Bangladesh, is mainly based on clusters which are in Dhaka, Gazipur, Narayanganj, and Pabna.

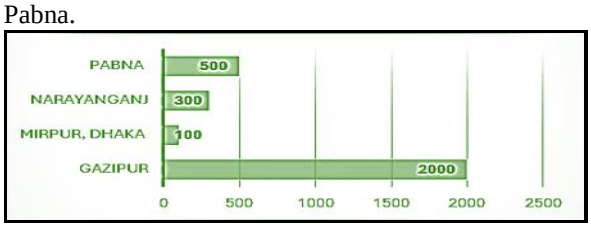

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Figure 1. Estimated Numbers of Waste Handlers in Each Cluster

These jhut clusters are intricately linked, facilitating the continuous inflow and outflow of jhut within and between each other. However, while all are involved in trading jhut, each cluster has unique characteristics (Akter and Alexander, 2024).

Table 1. Main Inputs and Activities in the Clusters

Clusters	Main Inputs	Activities
Gazipur	Garment swatches, end-of-roll, intact, half-intact, cut pieces, cutting and sewing waste	Sorting, exporting
Mirpur, Dhaka	Knit, woven, polyester fabrics, plastics, bobbins, buttons, laces, chains, needles, cartons, etc.	Sorting, recycling
Narayanganj	Fabric waste, rejected garments, plastics, cartons, etc.	Sorting, recycling
Pabna	Intact, half-intact, cut pieces	Manufacturing upcycling clothes

STAKEHOLDERS AND THEIR INITIATIVES

Various stakeholders from multiple sectors, including brands, trade associations, IGOs, recyclers, non-governmental organisations, and government organisations, are carrying out activities to build knowledge and offer support in the jhut industry. Many of these activities seek to formalize the garment and textile recycling industry in Bangladesh.



Figure 2. Key Activities Seeking to Promote Circularity in Bangladesh's Textile Recycling Industry

Establishing Recycling Facilities

Building new recycling facilities is one type of action that can expand Bangladesh's recycling capacity. Some garment manufacturers are establishing their own recycling facilities. For instance, DBL has built its own recycling facility, which they use for their own production waste. Recover, a Spain-based recycling company, also collaborated with the Beximco group of Bangladesh to create a facility that produces fibre from fabric scraps and supplies it to the Beximco group.

Research Studies

Many organisations have recently been conducting research into the jhut industry. This research can help to shape future policies and interventions by providing insights and identifying recommendations. Such studies include Impact of Circular EU Textile Policies on Trade Partners, Employment Study Program, Formalizing the Jhut Sector, and SWITCH2CE Project.

Training

A variety of stakeholders are also organizing training sessions for the manufacturers, waste handlers, and waste sorters (see Figure 2). For example, Reverse Resources and Cyclo train the manufacturers about improved systems for waste collection and segregation. Cyclo trains RMG factories to collect the fabric scraps directly from the factory cutting tables**,** which enhances the quality by reducing contamination and improving the usability of the feedstock. In addition, Reverse Resources trains factories about segregation based on colour and composition. These trainings also focus on promoting transparency and traceability of the waste supply chain and making it more efficient and formal. Furthermore, the lack of banking practices and digital literacy also keeps the sector inefficient and informal. Cyclo is training waste handlers who work as its suppliers and operate in the informal sector on financial literacy. This helps both Cyclo and the waste handlers to engage in digital transactions rather than physical cash payments.

Shaping Policies

Another way that stakeholders are seeking to support sustainable growth of the jhut industry is through seeking to shape relevant policies. Several domestic actors are seeking to slow down the introduction of new policies to allow industry players to adapt. For example, BGMEA has contributed to discussions in the EU by promoting the idea of allocating Bangladesh more time to adapt to incoming EU policies. Also, the Bangladesh Textile Mills Association (BTMA) is urging the government of Bangladesh to withdraw existing taxes on fabric scraps and fibre to boost the industry by encouraging local recycling (Abdullah, 2024).

CONCLUSION

This research shows that many diverse interventions are being implemented at the same time. Focusing on the implementation of these activities shows that the industry needs breathing time for these interventions to have an impact and for the industry to evolve sustainably. Achieving sustainable development in the recycling industry requires a cohesive and inclusive approach involving all stakeholders to resolve existing structural challenges. Collaborative efforts across the public and private sectors can enable a smooth and just transition toward a more circular economy. Such measures are critical for fostering sustainability, enhancing competitiveness, and securing Bangladesh's position in

the global textile market. However, it is important to consider that the process will take time.

REFERENCES

1. Abdullah, S. (2024). What BTMA demands for primary textile sector in the upcoming budget. *Textile Today*. Retrieved from https://www.textiletoday.com.bd/btma-demands-to-maintain-corporate-tax-rate-in-textile-sector-till-2030

2. GIZ (2024). Study for a Regulatory Framework to Enable Recycling of Post-Industrial Waste (JHUT) for the RMG Industry in Bangladesh. Retrieved from https://asiagarmenthub.net/resources/2024/internal-stile-jhut-sector-project-preliminary-doc-06-june-24-1final-3-pdf.pdf

3. Akter, R., and Alexander, R. (2025). Garments and Textile Recycling in Bangladesh. In P. Lund-Thomsen (Ed.), Global Value Chains and Climate Change: Reconfiguring the Garment and Textile Industries (pp.) Edward Elgar Publishing: UK.

4. Karim, N. (2021). Bangladesh garment industry could save $500 million a year by recycling cotton. *Reuters*. Retrieved from https://www.reuters.com/article/world/bangladesh-garment-industry-could-save-500-million-a-year-by-recycling-cotton-idUSKCN2DS11O/

5. Rahman & Uddin. (2023). How recycling RMG waste can cut 15% in cotton imports – and earn billions. *The Business Standard*. Retrieved from https://www.tbsnews.net/economy/rmg/how-recycling-rmg-waste-can-cut-15-cotton-imports-and-earn-billions-766438

6. World Bank (2019). How Much Do Our Wardrobes Cost to the Environment? Retrieved from https://www.worldbank.org/en/news/feature/2019/09/23/costo-moda-medio-ambiente

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Promoting Circular Economy in the Textile Sector Through Sustainable Textile Waste Management: A Case Study of SAKA Sustainable Textiles

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1.0 INTRODUCTION

The global textile and apparel industry is one of the largest manufacturing sectors and plays a significant role in economic growth, employment generation, and international trade. However, the industry is also among the highest contributors to environmental pollution due to excessive consumption of natural resources, high water and energy use, and the generation of large volumes of pre-consumer and post-consumer textile waste. In many developing countries, including Bangladesh and Nigeria, textile waste is commonly disposed of through landfilling or open burning, resulting in environmental degradation, greenhouse gas emissions, and the loss of valuable raw materials.

The concept of the circular economy has emerged as an effective alternative to the traditional linear model of "take–make–dispose." Circular economy principles encourage reducing waste, extending product life cycles, reusing materials, repairing products, remanufacturing components, and recycling textile resources into new products. Implementing these principles can reduce environmental impacts while creating new economic opportunities within the textile value chain.

SAKA Sustainable Textiles is a sustainability-driven initiative that seeks to promote responsible textile waste management through recycling, upcycling, stakeholder engagement, and international collaboration. This study investigates how SAKA Sustainable Textiles can contribute to advancing circular economy practices and strengthening sustainability cooperation between Bangladesh and Nigeria.

2.0 METHODOLOGY

This research adopted a qualitative case study approach. Information was collected through an extensive literature review of journal articles, industry reports, policy documents, and sustainability frameworks related to circular economy and textile waste management. In addition, observations of industrial practices and the operational vision of SAKA Sustainable Textiles were used to evaluate practical opportunities for implementing circular economy principles within textile manufacturing and post-consumer waste management.

The study focused on identifying sustainable waste management strategies including waste segregation, textile collection systems, recycling, upcycling, stakeholder awareness, and cross-sector collaboration between academia, industry, and policymakers.

3.0 RESULTS AND DISCUSSION

The analysis indicates that sustainable textile waste management offers significant environmental, economic, and social benefits. Recovering textile waste through recycling and upcycling reduces the volume of waste sent to landfills while conserving natural resources such as cotton, water, energy, and chemicals required for virgin fibre production.

The study also highlights the important role of SAKA Sustainable Textiles in promoting sustainability awareness and encouraging circular business models. Through educational programs, research collaboration, and community engagement, SAKA provides a platform for increasing public awareness of textile waste reduction and responsible consumption.

Bangladesh, as one of the world's largest textile and garment manufacturing countries, possesses extensive industrial expertise and recycling potential. Nigeria, on the other hand, represents an emerging textile market with growing opportunities for sustainable industrial development. Strengthening collaboration between these two countries can facilitate technology transfer, capacity building, investment in recycling infrastructure, and knowledge exchange on sustainable textile production.

Furthermore, adopting circular economy principles can create green employment opportunities, stimulate innovation in recycled textile products, improve resource efficiency, and enhance the international competitiveness of textile manufacturers by meeting growing global sustainability requirements.

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Despite these opportunities, several challenges remain, including limited recycling infrastructure, inadequate policy implementation, insufficient public awareness, fragmented waste collection systems, and financial constraints affecting investment in advanced recycling technologies.

This study demonstrates that sustainable textile waste management is an essential pathway toward achieving a circular economy in the textile sector. The case study of SAKA Sustainable Textiles illustrates how industry-led initiatives can promote resource efficiency, environmental protection, and sustainable business development through recycling, upcycling, education, and collaborative partnerships.

The findings suggest that stronger government policies, increased investment in textile recycling technologies, industry-academic partnerships, and international cooperation between Bangladesh and Nigeria are necessary to accelerate the transition toward a sustainable and circular textile economy. Future research should include quantitative assessments of textile waste recovery rates, life cycle environmental impacts, and economic feasibility analyses to further support policy development and industrial implementation.

6.0 CONCLUSION

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Keywords: *Circular Economy; Textile Waste Management; Sustainability; Recycling; Upcycling; SAKA Sustainable Textiles; Bangladesh; Nigeria.*

REFERENCES

1. Ellen MacArthur Foundation. A New Textiles Economy: Redesigning Fashion's Future. 2017.

2. European Environment Agency. *Textiles and the Environment*. 2022.

3. United Nations Environment Programme (UNEP). Sustainability and Circularity in the Textile Value Chain. 2023.

4. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232.

5. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production, 143,757–768.

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Enhancing durability properties of Recycled fibers reinforced Gypsum plaster composites with Calcium Carbonate fillers for building components.

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INTRODUCTION

Rapid expansion of human population and industrial factories, a massive amount of waste is being accumulated, which insists researches on sustainable waste and resource management [6]. For interior decorations such as false ceilings, Gypsum Plaster (GP) is utilized frequently due to light weight and fire resistance [4, 5]. It has been observed that Gypsum Plaster (GP) is brittle and prone to cracking under stress [1, 2, 8]. This study investigates the development of a sustainable GP composite utilizing discarded fabric cutting waste (acrylic yarn and denim) and calcium carbonate of eggshell powder for strengthening [7]. During the investigation, the synthetic yarn (acrylic yarn) reinforced composites have shown significant tensile strength and moisture resistance compared to natural yarn (cotton yarn) [3][6]. This approach aims to enhance the mechanical integrity of the GP matrix while reducing environmental pollution and material costs.

MATERIALS AND METHODS

There are three main materials used for the composites; Gypsum Plaster as the matrix, waste yarn (14 Ne denim & 2/32 Nm or, ≈ 9,45 Ne acrylic) as reinforcement and calcium carbonate of eggshell powder as the filler. First, waste acrylic yarn and denim fabrics were cleaned. Then, yarns from the denim fabric were extracted. Concurrently, discarded eggshells were boiled, dried and crushed into a fine powder. The eggshell powder is soaked into the water at 1:2 weight ratio and stirred. After a few minutes, the floating residues (eggshell membrane) are removed and the water is drained to acquire the cleaned calcium carbonate powder. The composite specimens were fabricated via a manual hand lay-up process, alternating layers of the prepared GP-eggshell slurry and waste yarns (2 layers of uniformly distributed yarn) to ensure uniform distribution. Here, the ratio of GP, egg shell powder and waste yarn (both types) are 75:24:1 respectively. The fabricated samples were then cured at room temperature for 24 to 48



Figure 1. Composite specimen showing at side and top view.

hours to achieve maximum strength and dimensional stability.

RESULT AND DISCUSSION

Acrylic reinforced composites were shown to have high tensile strength (up to 1.927 MPa) and very good exten-

Table1. Properties of Acrylic (A-GP) and Denim (D-GP) Reinforced Composites

Composite Type	Sample	Cross-sectional Area (mm²)	Max Tensile Force (N)	Ultimate Tensile Strength (MPa)	Initial Modulus (GPa)	Elongation at Break (%)
Acrylic-GP	Comp 1	151.500	292	1.927	0.020	118.178
Acrylic-GP	Comp 2	157.812	252	1.597	0.487	62.287
Acrylic-GP	Comp 3	159.075	144	0.905	0.038	53.917
Denim-GP	Comp 1	176.750	266	1.505	0.746	≥ 17.744
Denim-GP	Comp 2	164.125	194	1.182	0.236	20.783
Denim-GP	Comp 3	174.225	88	0.505	0.224	≥ 11.619

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-sibility (up to 118.178%). In contrast to this, denominated GP was stiffer, having a value for initial modulus of 0.746 GPa, while being less ductile. The water absorption experiments showed that A-GP had a water uptake of 27.31%, while D-GP took up 30.289% of its weight in 24 hours, which was caused by hydrophilicity of cellulose cotton fibers. From the FTIR spectroscopy results it can be concluded that both types of composites have a physical bonding mechanism, which involves mainly hydrogen bonding and mechanical locking without creation of any new chemical bonds.

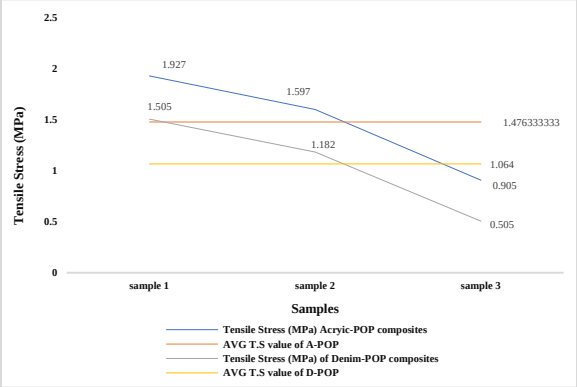

Figure 2. Tensile strength of samples.

The tensile strength analysis of the GP composites shows that using acrylic yarn as reinforcement leads to much higher tensile strength and better structural integrity compared to using denim yarn. In every test run the specimens with acrylic yarn performed better than those with denim yarn. The best acrylic-reinforced sample reached a tensile strength of 1.927 MPa and a maximum tensile force of 292 N. The best denim-reinforced sample only reached 1.505 MPa and 266 N. Even though both types of materials showed a drop in mechanical performance as the samples changed the acrylic-reinforced composites still maintained stronger resistance to stress. Their lowest strength was 0.9056 MPa while the lowest strength for the denim-reinforced samples was 0.505 MPa. In the end the results show that although both reused textiles can act as fillers, acrylic yarn creates a much stronger load-bearing structure, within the composite.

CONCLUSION

This study has showcased the investigation of application of textile waste for sustainable composite material. The unique approach also contributed as a cost-effective method to replace traditional and expensive materials in the construction industry. Although synthetic yarn (acrylic) has outperformed natural yarn (cotton/denim) with superior tensile strength (up to 1.927 MPa), elongation (initial modulus up to 0.746 GPa) and lower water absorbency (27.31%), its success remains subject to sustainability concerns and the performance of natural reinforcements is not far behind. Ultimately, these findings establish a viable, eco-friendly alternative for low-cost interior construction panels.

REFERENCES

1. Agbozuadu, A. S. (2012). A comparison of plaster of Paris made from cement and water sachet with British Standard plaster of Paris. Federal University of Technology Minna, Nigeria.
2. Airpetous, D. (1986). Architectural material science. Moscow, Russia: Mir Publishers.
3. Aladenika, A. K., Olanrewaju, O. M., & Olaitan, S. K. (2021). Comparative investigation of the mechanical properties of coconut coir fibre and synthetic fibre reinforced plaster of Paris (POP) based composites for ceiling applications. Journal of Materials Science Research and Reviews, 4(2), 127–132.
4. Anonaba, A. U., Eze, F. C., Ndukwe, I. C., & Iroegbu, C. (2024). Thermophysical and mechanical properties of plaster of Paris ceilings modified with oil palm mesocarp fibre for application in buildings. Építőanyag – Journal of Silicate Based and Composite Materials, 76(1), 4–9.
5. Anowai, S. I., Tok, D. Y., & Sunday, A. J. (2020). Comparative study of performance of plaster of Paris ceiling boards reinforced with imported sisal fibre and locally sourced okra fibre. International Journal of Modern Trends in Engineering and Research, 7(6), 40–44.
6. Besar, B., Gani, H., Afiqah, A., Nabil, A., & Aina, T. M. S. (2024). Effect of banana peel in plaster of Paris composite: A sustainable reinforcement material. International Journal of Synergy in Engineering & Technology, 5(2), 71–79.
7. Carranza, T., Osquila, I., Guerrero, P., de la Caba, K., & Tejo-Otero, A. (2025). Eggshell-derived powder as reinforcement for structures manufactured by digital light processing. International Journal of Precision Engineering and Manufacturing–Green Technology.
8. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (2nd ed.). Harlow, England: Pearson Education Limited.

Textile Waste Growth and Public Recycling Awareness in Bangladesh: A Secondary-Data Analysis of Industry Activity, Material Flows, and Clothing Disposal Behavior

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INTRODUCTION

The environmental cost of textiles is no longer a peripheral issue. The United Nations Environment Programme estimates that roughly 92 million tons of textile waste are generated worldwide each year, while the sector also consumes large quantities of water, energy, chemicals, and fossil-based feedstocks [5], [6]. These pressures are especially important for Bangladesh because the country's development model is closely connected to textile and ready-made garment (RMG) exports. Growth in the sector has generated employment and foreign exchange, but it has also expanded the volume of cutting scraps, yarn loss, faulty fabric, deadstock, and overproduction moving through formal and informal markets.

Available estimates of Bangladesh's textile waste differ because they use different boundaries. Some reports discuss only apparel-factory waste, while others include spinning, fabric mills, direct RMG waste, deadstock, and overproduction. The 2025 Switch2CE policy report, drawing on Reverse Resources material-flow estimates, placed total post-industrial textile waste in 2023 at about 830 kt when the full upstream chain was included [2]. Earlier studies and industry initiatives often cited narrower totals of approximately 400–577 kt [4], [7]. These figures are not necessarily contradictory; they refer to different parts of the value chain. Treating them as interchangeable would create an avoidable measurement error.

Consumer behavior is the second half of the circularity problem. Clothing that is donated, repaired, passed to relatives, resold, repurposed, or recycled remains in use longer than clothing placed in general waste. Yet awareness does not guarantee formal recycling. Bangladesh has a strong culture of donation and household reuse, but public access to dedicated textile collection points remains limited. A published survey of 207 respondents found high self-reported use of sustainable disposal routes, although the sample was dominated by young, educated, urban respondents [3]. Consequently, the figures are informative about the sampled group but cannot be treated as national prevalence estimates.

This paper addresses a practical research gap by joining industrial and consumer evidence in one transparent secondary-data framework. It asks four questions: (1) how did Bangladesh's RMG export activity change between 2010 and 2025; (2) what does the 2023 material-flow account reveal about the location and intensity of textile waste; (3) what constant-intensity waste pressure would be implied if the 2023 waste-to-export relationship were applied to earlier and later years; and (4) what do published aggregate survey counts indicate about awareness and disposal choices? The intention is not to manufacture precision where public data are incomplete. Instead, observed values, recalculated statistics, and scenario-based estimates are kept visibly separate.

SECTIONS

TABLE I
RECONSTRUCTED 2023 WASTE COMPOSITION

Category	kt	Share
RMG production	312.043	37.61%
Spinning	225.390	27.16%
Fabric mills	132.646	15.99%
Deadstock	89.309	10.76%
Overproduction	70.371	8.48%
Total	829.759	100.00%

TABLE II
REANALYZED DISPOSAL PROPORTIONS

Route	n	%	Wilson 95% CI
Donation	92	44.44	37.84–51.25
Family/friends	30	14.49	10.34–19.94
Recycle	21	10.14	6.73–15.01
Household reuse	60	28.99	23.23–35.50
Throw away	4	1.93	0.75–4.86

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FIGURES/CAPTIONS

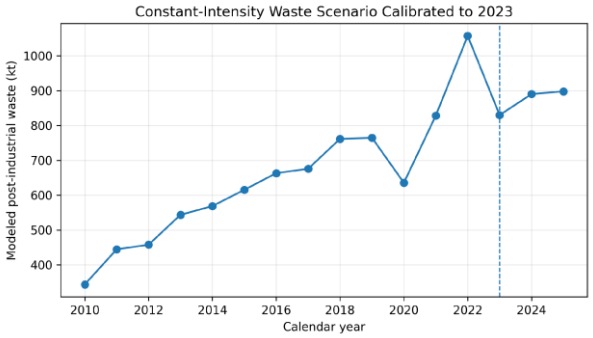

Fig. 2. Constant-intensity waste scenario calibrated to the 2023 material-flow estimate. Values outside 2023 are modeled, not observed.

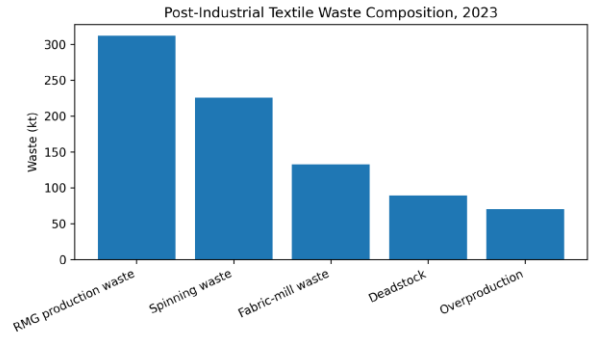

Fig. 3. Composition of estimated post-industrial textile waste in 2023. Recalculated from [2].

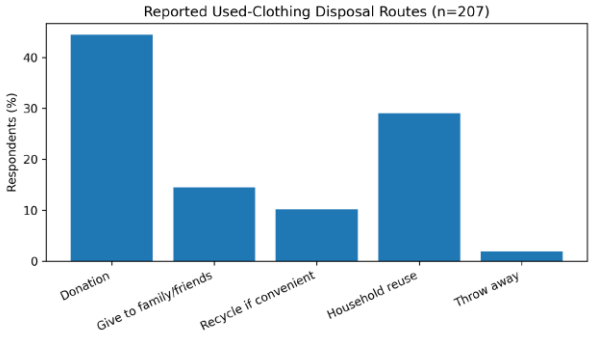

Fig. 4. Used-clothing disposal routes reported in the published convenience sample (n = 207) [3].

CONCLUSION

Bangladesh's RMG export activity increased substantially between 2010 and 2025, with a robust long-run trend near USD 1.6 billion per year. The best available full-chain estimate for 2023 indicates 829.759 kt of post-industrial textile waste, with meaningful losses in spinning, fabric production, direct garment manufacturing, deadstock, and overproduction. The consumer evidence suggests that awareness and informal reuse are common within the published sample, but formal recycling remains a minor disposal route. The practical implication is clear: Bangladesh does not need only more recycling machinery. It also needs reliable measurement, cleaner segregation, prevention of deadstock and overproduction, transparent waste trading, and convenient consumer collection systems. A circular textile transition will be credible when material flows can be measured from factory input to final recovery and when consumers can act on their stated willingness through accessible services.

REFERENCES

[1] Bangladesh Garment Manufacturers and Exporters Association, "Export Performance," calendar-year apparel export data, accessed Aug. 3, 2026. [Online]. Available: https://www.bgmea.com.bd/page/Export_Performance

[2] H. Alam, M. Reaz, and P. Schröder, Policy Packages for Bangladesh's Circular Garment and Textile Transition. Switch to Circular Economy Value Chains, Feb. 2025. [Online]. Available: https://www.switchtocircular.eu/sites/default/files/publications/18-Feb-2025_Switch2CE_Policy-Report_Bangladesh-Circular-Textile-Transition.pdf

[3] S. S. Urmi, A. S. Emu, and S. Khan, "A study on sustainable disposal behaviour of used clothes & motivational factors towards such behaviour in Bangladesh," in Proc. 1st Int. Conf. Textile Science and Engineering (ICTSE), Bangladesh University of Textiles, Dhaka, Bangladesh, 2022, pp. 57–67.

[4] M. M. K. Akter, U. N. Haq, M. M. Islam, and M. A. Uddin, "Textile-apparel manufacturing and material waste management in the circular economy: A conceptual model to achieve sustainable development goal (SDG) 12 for Bangladesh," Cleaner Environmental Systems, vol. 4, Art. no. 100070, 2022, doi: 10.1016/j.cesys.2022.100070.

[5] United Nations Environment Programme, Sustainability and Circularity in the Textile Value Chain: A Global Roadmap, 2023. [Online]. Available: https://www.unep.org/resources/publication/sustainability-and-circularity-textile-value-chain-global-roadmap

[6] United Nations Environment Programme, "Unsustainable fashion and textiles in focus for International Day of Zero Waste 2025," Mar. 27, 2025. [Online]. Available: https://www.unep.org/news-and-stories/press-release/unsustainable-fashion-and-textiles-focus-international-day-zero

[7] UNICEF, Child Rights and Informal Textile Waste Recycling in Bangladesh, 2024. [Online]. Available: https://www.unicef.org/childrightsandbusiness/media/1201/file/FullReport-ChildRights-Textile-Waste-Recycling-Bangladesh-2024.pdf

[8] I. Ajzen, "The theory of planned behavior," Organizational Behavior and Human Decision Processes, vol. 50, no. 2, pp. 179–211, 1991, doi: 10.1016/0749-5978(91)90020-T.

[9] K. Laitala, "Consumers' clothing disposal behaviour—A synthesis of research results," International Journal of Consumer Studies, vol. 38, no. 5, pp. 444–457, 2014, doi: 10.1111/ijcs.12088.

[10] H. B. Mann, "Nonparametric tests against trend," Econometrica, vol. 13, no. 3, pp. 245–259, 1945, doi: 10.2307/1907187.

[11] M. G. Kendall, Rank Correlation Methods, 4th ed. London, U.K.: Griffin, 1975.

[12] P. K. Sen, "Estimates of the regression coefficient based on Kendall's tau," Journal of the American Statistical Association, vol. 63, no. 324, pp. 1379–1389, 1968, doi: 10.1080/01621459.1968.10480934.

[13] W. K. Newey and K. D. West, "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix," Econometrica, vol. 55, no. 3, pp. 703–708, 1987, doi: 10.2307/1913610.

[14] E. B. Wilson, "Probable inference, the law of succession, and statistical inference," Journal of the American Statistical Association, vol. 22, no. 158, pp. 209–212, 1927, doi: 10.1080/01621459.1927.10502953.

[15] A. Agresti, Categorical Data Analysis, 3rd ed. Hoboken, NJ, USA: Wiley, 2013.

Natural Fiber Geotextiles in Sustainable Civil Infrastructure: A Review of Soil–Textile Interactions, Bio-Coatings, and Controlled Degradation Mechanisms

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INTRODUCTION

Growing demand for environmentally responsible infrastructure has encouraged sustainable alternatives to conventional petroleum-derived geosynthetics. Natural fiber geotextiles have gained considerable attention for their renewable origin, biodegradability, low density, and reduced dependence on fossil-derived materials (Nguyen & Indraratna, 2023). Fibers such as jute, coir, sisal, hemp, and flax can be processed into geotextile structures for erosion control, reinforcement, separation, filtration, drainage, and slope stabilization (Nguyen & Indraratna, 2023; Marczak et al., 2020). Their biodegradability is especially advantageous for temporary applications, where the geotextile needs only to protect soil during the critical period of stabilization and vegetation establishment.

However, the same biodegradability that provides an environmental advantage also creates engineering challenges. Natural fibers are susceptible to moisture uptake, microbial degradation, weathering, and progressive loss of mechanical integrity (Prambauer et al., 2019). Water absorption affects dimensional and mechanical stability, while variable fiber properties and environmental conditions make reliable lifetime prediction difficult. Successful implementation therefore requires balancing sufficient mechanical and hydraulic performance against an environmentally compatible degradation rate (Sanjeevi et al., 2021).

Previous reviews have examined the materials, applications, and general geotechnical performance of natural fiber geotextiles, including reinforcement, drainage, filtration, and erosion-control functions (Wu et al., 2020). However, soil–textile interface behaviour, environmentally compatible surface modification, and degradation are often treated as separate issues, and an integrated framework linking these factors to application-specific service-life design remains lacking. This review therefore critically examines natural fiber geotextiles through three interconnected aspects: soil–textile interactions, bio-based coatings and surface treatments, and controlled degradation mechanisms, to identify how these factors collectively influence engineering performance and sustainability.

SOIL–TEXTILE INTERACTIONS AND GEOTECHNICAL PERFORMANCE

The interaction between geotextiles and surrounding soil is fundamental to their effectiveness in reinforcement, filtration, drainage, and erosion control (Nguyen & Indraratna, 2023). Interface performance is governed by fiber surface characteristics, fabric architecture, aperture size, soil particle size, normal stress, moisture condition, and interfacial friction (Li et al., 2025). In reinforcement applications, tensile forces developed within the geotextile transfer to the soil through friction and mechanical interlocking; tensile strength alone therefore does not determine reinforcing performance (Li et al., 2025).

Experimental studies on coir geotextiles demonstrate the importance of these interface characteristics; direct-shear investigations show that coir geotextiles increase the shear strength of reinforced granular soils, with the interaction influenced by soil particle size and normal stress (Prithviraj & Bhasi, 2023). Pullout testing similarly shows that peak resistance and shear-zone characteristics vary with normal stress, anchorage length, and pullout rate (Li et al., 2025). These findings indicate that natural fiber geotextiles should be evaluated not only by their intrinsic tensile properties, but by their ability to mobilize soil–textile interaction under realistic loading.

Natural fiber geotextiles also provide filtration and drainage through their porous structures. Appropriate pore size and connectivity allow water movement while limiting soil-particle migration, supporting erosion control and stabilization (Prambauer et al., 2019). Degradation, however, may progressively alter fiber morphology, pore structure, tensile strength, and fabric integrity, so long-term mechanical and hydraulic performance should be evaluated together rather than assuming initial properties remain constant.

BIO-BASED COATINGS AND ENVIRONMENTALLY COMPATIBLE SURFACE TREATMENTS

The hydrophilic nature of lignocellulosic fibers promotes moisture absorption and accelerates environmental deterioration (Kumar et al., 2022). Surface modification therefore provides an important route to improved durability, though treatments for geotechnical use must also remain environmentally compatible, since the modified material stays in direct contact with soil (Kumar et al., 2022).

Recent research shows that renewable or bio-derived materials can modify natural fiber geotextiles. Cashew nutshell liquid (CNSL), an agro-based renewable material, has been used to treat coir geotextiles and has been found to improve interface shear parameters and tensile strength relative to untreated material, demonstrating that surface modification can influence both textile properties and soil–textile interaction simultaneously (Prithviraj & Bhasi, 2023).

Lignin-based coatings offer another promising approach; a lignin coating on cellulosic textile yarns substantially delayed degradation during soil-burial testing while preserving biodegradability, with coated yarns remaining markedly more intact than uncoated yarns after extended burial, indicating potential for extending the functional lifetime of natural-fiber geotextiles (Kaya et al., 2023).

Field research similarly supports the value of protective coatings; waterproofing a Typha domingensis geotextile

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reduced field degradation, with double-layer treatment retaining more tensile performance than untreated material (Holanda et al., 2024). Surface engineering can thus improve durability, but the goal should not be maximizing resistance alone: an overly persistent coating undermines the environmental advantage of a biodegradable geotextile, while insufficient protection risks premature loss of function (Holanda et al., 2025).

Future bio-coating development should therefore balance moisture resistance, mechanical retention, soil compatibility, and eventual biodegradability, protecting the geotextile through its required service period before allowing degradation once its geotechnical function is complete.

CONTROLLED DEGRADATION AND SERVICE-LIFE DESIGN

Controlled degradation is a central challenge for reliable natural fiber geotextiles. Degradation is influenced by moisture, temperature, microbial activity, soil conditions, and weathering, which interact with fiber composition and textile structure to produce substantial differences in degradation rate across materials and field environments (Prambauer et al., 2019; Holanda et al., 2024).

The critical engineering question is therefore not simply whether a geotextile is biodegradable, but whether its degradation rate matches the required service period. Erosion-control applications may need only short functional lifetimes until vegetation establishes, whereas reinforcement and stabilization applications require longer retention of mechanical properties, making natural geotextiles better understood as service-life-tailored materials, where degradation is a design input rather than a deficiency.

Degradation can potentially be regulated through fiber selection, blending, fabric architecture, surface treatment, and bio-based coatings; protective coatings can delay water penetration and microbial attack early in service, while their eventual breakdown permits degradation of the underlying fiber, so coating characteristics combined with textile structure may provide a route to application-specific service life (Pavlovic et al., 2025).

Reliable prediction nonetheless remains a major knowledge gap; accelerated laboratory tests do not fully reproduce the combined effects of soil confinement, wetting–drying cycles, microbial activity, temperature variation, solar exposure, and mechanical loading found in the field (Pavlovic et al., 2025). Mass loss or visible degradation alone cannot describe engineering failure, since tensile strength, interfacial shear resistance, filtration, and drainage may deteriorate at different rates. Long-term field monitoring combined with standardized laboratory protocols is therefore needed to link environmental exposure, degradation kinetics, and residual performance (Pavlovic et al., 2025).

RESEARCH GAPS AND FUTURE DIRECTIONS

Despite this potential, several limitations restrict wider implementation. Soil–textile interface behavior needs more systematic study across fiber types, fabric structures, soil gradations, moisture conditions, and degradation stages. Surface treatments should be evaluated within a multifunctional framework considering mechanical enhancement, moisture resistance, soil compatibility, environmental impact, and biodegradation together. Standardized methods for evaluating degradation and residual performance are also needed to enable comparison across studies.

Future research should combine textile engineering, polymer science, materials characterization, and geotechnical testing. Long-term field studies alongside accelerated laboratory ageing and soil-burial tests would help establish realistic service-life models, while life-cycle assessment could confirm whether processing and surface treatments preserve natural fibers' overall environmental advantages. Predictive models linking degradation rate to residual tensile, hydraulic, and interfacial properties could further enable application-specific design.

Developing multifunctional natural fiber geotextiles is an important future direction: rather than maximizing only initial strength or durability, future systems should simultaneously optimize reinforcement, filtration, drainage, moisture resistance, and controlled biodegradation for the requirements of a given infrastructure application.

CONCLUSION

Natural fiber geotextiles offer a promising route toward more sustainable civil infrastructure through their renewable origin, biodegradability, and multifunctional geotechnical potential. Their successful implementation, however, depends on balancing mechanical performance, soil–textile interaction, environmental resistance, and degradation.

This review integrates soil–textile interactions, bio-based surface engineering, and controlled degradation as interconnected factors governing the performance of natural fiber geotextiles. Improving durability alone is insufficient; surface treatments and textile structures should instead retain adequate mechanical and hydraulic function for the required service period while preserving eventual biodegradation. An application-specific service-life approach can transform biodegradability from a limitation into a controllable design feature. By bridging textile materials, polymer science, and geotechnical engineering, this framework can support multifunctional natural fiber geotextiles as resilient, environmentally sustainable solutions for modern civil infrastructure.

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REFERENCES

1. Holanda, F.S.R., Santos, L.D.V., De Melo, J.C.R., Boge, G.M., Sussuchi, E.M., Nascimento, B.L., Santos, M.V.Q., & Oliveira, M.I.U. (2024). Resistance of the fiber-derived geotextile from Typha domingensis submitted to field degradation. Scientific Reports, 14, 8648. doi:10.1038/s41598-024-56978-3
2. Holanda, F.S.R., Santos, L.D.V., Sussuchi, E.M., Pedrotti, A., Santos, J.F., Silva, E.G., Fontes, C.S., & Araujo Filho, R.N. (2025). Resistance of Syagrus coronata fibers in waterproof-coated natural geotextiles under environmental degradation. Frontiers in Sustainability, 6, 1552255. doi:10.3389/frsus.2025.1552255
3. Kaya, C., Stegmaier, T., & Gresser, G.T. (2023). Investigation of the protective function of a lignin coating of natural fiber geotextiles against biodegradation. Materials, 16(13), 4849. doi:10.3390/ma16134849
4. Kumar, N., Kandasami, R.K., & Singh, S. (2022). Effective utilization of natural fibres (coir and jute) for sustainable low-volume rural road construction—A critical review. Construction and Building Materials, 347, 128606. doi: 10.1016/j.conbuildmat.2022.128606
5. Li, L., Li, H., & Cao, W. (2025). Experimental study on pullout behavior of coir geotextiles based on transparent soil. Applied Sciences, 15(1), 488. doi:10.3390/app15010488
6. Marczak, D., Lejcuś, K., & Misiewicz, J. (2020). Characteristics of biodegradable textiles used in environmental engineering: A comprehensive review. Journal of Cleaner Production, 268, 122129. doi: 10.1016/j.jclepro.2020.122129
7. Nguyen, T.T., & Indraratna, B. (2023). Natural fibre for geotechnical applications: Concepts, achievements and challenges. Sustainability, 15(11), 8603. doi:10.3390/su15118603
8. Pavlovic, A., Valzania, L., & Minak, G. (2025). Effects of moisture absorption on the mechanical and fatigue properties of natural fiber composites: A review. Polymers, 17(14), 1996. doi:10.3390/polym17141996
9. Prambauer, M., Wendeler, C., Weitzenböck, J., & Burgstaller, C. (2019). Biodegradable geotextiles—An overview of existing and potential materials. Geotextiles and Geomembranes, 47(1), 48–59. doi: 10.1016/j.geotexmem.2018.09.006
10. Prithviraj, R., & Bhasi, A. (2023). Interface behavior of granular soils reinforced with surface-modified coir geotextiles. Journal of Natural Fibers, 20(1). doi:10.1080/15440478.2022.2160403
11. Sanjeevi, S., Shanmugam, V., Kumar, S., Ganesan, V., Sas, G., Johnson, D.J., Shanmugam, M., Ayyanar, A., Naresh, K., Neisiany, R.E., & Das, O. (2021). Effects of water absorption on the mechanical properties of hybrid natural fibre/phenol formaldehyde composites. Scientific Reports, 11, 13385. doi:10.1038/s41598-021-92457-9
12. Wu, H., Yao, C., Li, C., Miao, M., Zhong, Y., Lu, Y., & Liu, T. (2020). Review of application and innovation of geotextiles in geotechnical engineering. Materials, 13(7), 1774. doi:10.3390/ma13071774

Effect of Waste Cotton Fiber Content on the Mechanical Properties of Epoxy-Based Hybrid Composites Reinforced with PET Flakes and Wood Dust

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1.0 INTRODUCTION

The global textiles, plastics and wood-processing industries generate large volumes of cotton fabric waste, post-consumer PET bottles and wood dust that are typically landfilled or incinerated [1,2]. Converting these waste streams into fibre-reinforced polymer composites offers a low-cost route for waste diversion and for producing lightweight boards for furniture, interior panels, and packaging [3]. Cellulosic fibers such as cotton offer low density, biodegradability and satisfactory specific strength [4-6]; recycled PET flakes can improve toughness, dimensional stability and reduce cost [1]; while wood dust is an abundant, low-cost particulate filler whose brittle, low-aspect-ratio morphology can reduce ductility and interfacial adhesion when used in excess [7,8]. Hybridization, i.e., incorporating more than one reinforcing phase into a single matrix, is a common strategy for balancing these trade-offs [9,10]. However, no three-component hybrid of waste cotton fiber, recycled PET flakes, and wood dust in an epoxy matrix has been reported. This work fabricates and mechanically characterizes three cotton fiber/wood dust ratios in a fixed epoxy/PET-flake hybrid board, evaluating tensile, flexural and impact properties, density, void content and water absorption, with one-way ANOVA used to confirm the statistical significance of the effect of fiber content.

2.0 MATERIALS AND METHODS

Waste cotton fiber was recovered from textile cutting/carding waste, recycled PET flakes were obtained by shredding post-consumer bottles, and wood dust was sourced as furniture-workshop sawdust. A room-temperature-curing epoxy/amine system (10:1 resin: hardener) was used as the matrix. Three board formulations (Composites A, B and C) were prepared by hand lay-up with fixed epoxy (50 wt%) and PET flake (10 wt%) content, and complementary cotton fiber/wood dust ratios (Table 1). The pre-mixed fillers were impregnated with resin, compacted under a 25 kg dead load for 24 h, and post-cured for 24 h before demolding. Theoretical and experimental (water-immersion) densities and void content were determined per ASTM D 570-98 and ASTM D-2734-70. Tensile (ASTM D638, 5 mm/min), flexural (ASTM D790, three-point bend, 1.4 mm/min) and Charpy impact (ASTM D256, V-notched) tests were performed on five specimens per formulation and reported as average ± standard error. Water absorption was measured on immersed specimens over 120 h (ASTM D 570-98). One-way ANOVA ($\alpha = 0.05$) was used to assess the statistical significance of the cotton fiber/wood dust ratio on mechanical properties.

Table 1. Composition of the developed hybrid composite boards

Composite	Epoxy (wt%)	PET Flake (wt%)	Cotton Fiber (wt%)	Wood Dust (wt%)
A	50	10	10	30
B	50	10	20	20
C	50	10	30	10

3.0 RESULTS AND DISCUSSION

The theoretical density increased from 0.95 g/cm³ (Composite A) to 1.14 g/cm³ (Composite C) owing to the higher density of cotton fiber (~1.54 g/cm³) relative to wood dust (~0.65 g/cm³), while void content decreased from 4.5% to 2.1% over the same range, indicating better fiber wetting and packing with increasing cotton fiber content [7,11]. As summarized in Figure 1, tensile strength, flexural strength and impact strength all increased monotonically with cotton fiber content: tensile strength rose from 2.70 ± 0.07 MPa (Composite A) to 6.30 ± 0.16 MPa (Composite C, +133%), flexural strength from 7.60 ± 0.15 MPa to 12.90 ± 0.26 MPa (+70%), and impact strength from 0.812 ± 0.02 kJ/m² to 1.603 ± 0.04 kJ/m² (+97%); tensile and flexural moduli likewise increased by 93% and 107%, respectively. The high-aspect-ratio, flexible cotton fibers form an interconnected load-bearing network that transmits stress and absorbs impact energy far more effectively than the brittle, low-aspect-ratio wood dust particles they replace, which instead act as poorly bonded stress concentrators [8,11].

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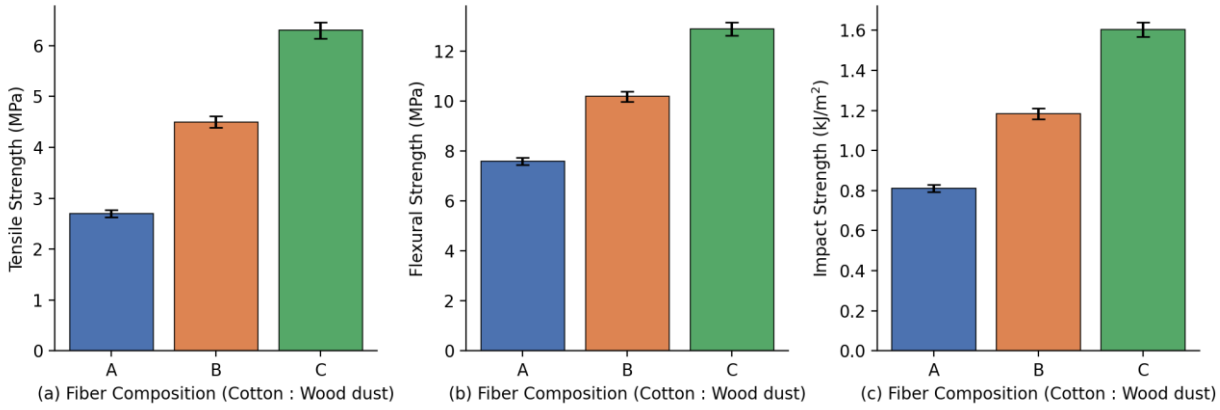

Figure 1. Comparison of (a) tensile strength, (b) flexural strength, and (c) impact strength of Composites A, B, and C

One-way ANOVA confirmed that the cotton fiber/wood dust ratio had a statistically significant effect on tensile, flexural and impact strength ($F = 238.97$, 158.51 and 202.91, respectively; $p < 0.0001$ in each case; F-critical = 3.885, $\alpha = 0.05$). Water absorption after 120 h increased with wood dust content, from 9.0% (Composite C) to 18.3% (Composite A), consistent with the higher void content and poorer interfacial wetting at higher wood-dust loadings [12]. Composite C (30 wt% cotton fiber/10 wt% wood dust) therefore gave the best overall mechanical response and the lowest moisture uptake among the formulations tested, and is recommended for non-structural, waste-valorizing applications.

4.0 CONCLUSION

- Mechanical performance was governed by cotton fiber content: tensile, flexural and impact strength increased continuously as cotton fiber replaced wood dust.
- Composite C (30 wt% cotton fiber/10 wt% wood dust) gave the best overall properties — 6.3 MPa tensile strength, 12.9 MPa flexural strength and 1.603 kJ/m² impact strength — 133%, 70% and 97% higher than Composite A, respectively.
- Void content decreased from 4.5% to 2.1% with increasing cotton fiber content, consistent with the observed mechanical improvement.
- One-way ANOVA confirmed the cotton fiber/wood dust ratio has a statistically significant effect ($p < 0.0001$) on all three mechanical properties.
- Water absorption increased with wood dust content, from 9.0% (Composite C) to 18.3% (Composite A) after 120 h, indicating better dimensional stability for cotton-fiber-dominant boards.
- The developed boards, particularly Composite C, are promising for non-structural applications such as furniture panels, interior partitions and lightweight packaging.

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REFERENCES

[1] Ali, S.S., et al. (2021). Degradation of conventional plastic wastes in the environment: A review on current status of knowledge and future perspectives of disposal. Science of the Total Environment, 771, 144719.

[2] Bhuiyan, M.A.R., Abu Darda, M., Ali, A., Talha, A.R., Hossain, M.F., Mohebbullah, M. and Islam, M.A. (2023). Heat insulating jute-reinforced recycled polyethylene and polypropylene bio-composites for energy conservation in buildings. Materials Today Communications, 37, 106948.

[3] Manikam, B., Thangaraju, J., Manoharan, M. and Admassu, Y. (2025). Experimental analysis and development of sustainable composites from waste cotton/coffee husk/sawdust for thermal insulating materials. Journal of Engineered Fibers and Fabrics, 20, 1-15.

[4] Sharma, P., Srivastava, A. and Panday, A.K. (2017). Tensile and impact strength analysis of cotton fiber reinforced polymer composites. ELK Asia Pacific Journals, 978-993.

[5] Alomayri, T. and Low, I.M. (2013). Synthesis and characterization of mechanical properties in cotton fiber-reinforced geopolymer composites. Journal of Asian Ceramic Societies, 1, 30-34.

[6] Tejyan, S. (2022). Effect of erosive parameters on solid particle erosion of cotton fiber-based nonwoven mat/wooden dust reinforced hybrid polymer composites. Journal of Industrial Textiles, 51(2S), 2514S-2532S.

[7] Megri, A.C., Achard, G. and Haghighat, F. (1998). Using plastic waste as thermal insulation for the slab-on-grade floor and basement of a building. Building and Environment, 33(2-3), 97-104.

[8] Chauhan, A. and Chauhan, P. (2014). Natural fibers reinforced advanced materials: a review. Journal of Analytical & Bioanalytical Techniques, 5(5), 1-5.

[9] Jawaid, M. and Khalil, H.P.S.A. (2011). Cellulosic/synthetic fibre reinforced polymer hybrid composites: A review. Carbohydrate Polymers, 86(1), 1-18.

[10] Mohit, H., Mavinkere Rangappa, S., Siengchin, S., Gorbatyuk, S., Manimaran, P., Alka Kumari, C., Khan, A. and Doddamani, M. (2022). A comprehensive review on performance and machinability of plant fiber polymer composites. Polymer Composites, 43(2), 608-623.

[11] Zahedi, M., Pirayesh, H., Khanjanzadeh, H. and Tabar, M.M. (2013). Organo-modified montmorillonite reinforced walnut shell/polypropylene composites. Materials & Design, 51, 803-809.

[12] Bhuiyan, M.A.R., Shaid, A., Bashar, M.M. and Sarkar, P. (2016). Investigation on dyeing performance of basic and reactive dyes concerning jute fiber dyeing. Journal of Natural Fibers, 13(5), 492-501.

Fabric Dyeing with Biodegradable Dye Produced from Microorganisms

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INTRODUCTION

Global textile manufacturing has long been associated with significant environmental degradation, primarily driven by the intensive use of synthetic dyes [1]. Modern synthetic dyes are mostly derived from petroleum carbon sources, and the dyeing process is highly resource-intensive, contributing approximately 4–10% of global carbon emissions and resulting in the consumption and contamination of 9.0 trillion liters of water waste annually. These statistics highlight the urgent need for ecological transitions in processing methodologies. To address these critical ecological concerns, this research contributes to developing an eco-friendly biodegradable textile dye using microorganisms. This novel biological dye represents a pioneering step forward for the local textile industry, designed to prevent the severe carbon emissions and water pollution disadvantages associated with conventional synthetic alternatives [2].

METHODOLOGY

Cultivation of microorganism

A non-pathogenic bacterial strain, *Serratia marcescens*, was used for the biological synthesis of the dye. The bacterial strain was cultivated in Luria-Bertani (LB) liquid culture and incubated for a duration of 24 hours under controlled conditions at 30°C to ensure optimal bio-color production [3] [4].

Extraction of bio-color

Following the 24-hour incubation period, the bio-color was extracted from the culture medium. The extraction process was carried out using hot distilled water as a solvent, and the cell biomass was subsequently separated from the dissolved colorant through high-speed centrifugation, yielding a purified biological dye solution.

Fabric dyeing procedure

Cotton fabrics of 2 cm in length with a basis weight of 50 gsm were selected for application. The dyeing process was carried out by placing the cotton fabrics into a dyebath containing the extracted microbial colorant. The concentration of the pigment in the dye solution had been optimized for this process. The dyeing process was performed strictly at room temperature of 25°C to minimize thermal energy consumption.

Testing of durability and biodegradability

The durability of the dyed cotton fabric was thoroughly evaluated. Colorfastness was examined under washing, rubbing, and sunlight exposure, adhering to standard textile testing procedures. Additionally, to verify the of the process, the discarded residues and effluent from the dyeing process were subjected to biodegradability testing across various natural media, ranging from water bodies to soil samples.

RESULTS AND DISCUSSION

Application of the bio-color on fabric

Traditional dyeing requires high temperatures (often 90°C+) and heavy metal mordants. But here, the cotton fabrics were dyed at room temperature with no use of heavy metal fixatives.

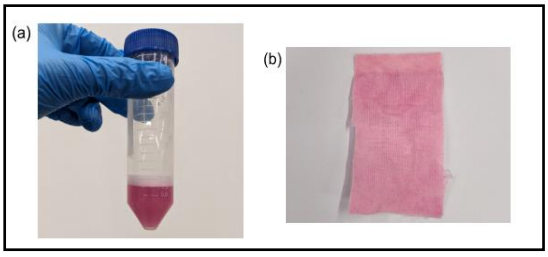

Figure 1.0: Red bio-color extracted from bacteria (a) and applied on cotton fabric (b).

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Color durability analysis

The experimental evaluation yielded highly positive results across all characterization parameters. The color durability examinations under washing, rubbing, and sunlight exposure demonstrated robust pigment-fiber bonding, indicating that the biological color holds excellent fastness properties suitable for commercial textile applications [5].

Table 1.0: Colorfastness properties of bio-color dyed cotton fabric

Color Fastness Test	Standard Method	Experimental Rating
Light	ISO 105-B02	Grade 4 (1–8 Blue Wool References)
Washing	ISO 105-C06	Grade 4 (1–5 Gray Scale)
Rubbing	ISO 105-X12	Grade 3 (1–5 Gray Scale)

CONCLUSION

This study demonstrates that microbial prodigiosin can serve as a sustainable alternative to synthetic dyes. The global dye market is expected to reach $6.1 billion by 2028 and currently, the annual demand for dyes in Bangladesh alone is around 50,000 tons. Therefore, the bio-colors' low-energy, chemical-free production and application, combined with good color fastness and complete biodegradability, highlight their potential for scalable textile dyeing and reducing the environmental impact of the textile industry.

REFERENCES

1. Ramamurthy, K., Priya, P. S., Murugan, R., & Arockiaraj, J. (2024). Hues of risk: Investigating genotoxicity and environmental impacts of azo textile dyes. *Environmental Science and Pollution Research*, *31*(23), 33190–33211. https://doi.org/10.1007/s11356-024-33444-1
2. Hale, E. (2024). Why colouring clothes has a big environmental impact. *BBC News*. https://bbc.com/news/articles/c870j92p82wo
3. Haddix, P. L., & Shanks, R. M. Q. (2020). Production of prodigiosin pigment by *Serratia marcescens* is negatively associated with cellular ATP levels during high-rate, low-cell-density growth. *Canadian Journal of Microbiology*, *66*(3), 243–255. https://doi.org/10.1139/cjm-2019-0548
4. Miglani, K., Singh, S., Singh, D. P., & Krishania, M. (2023). Sustainable production of prodigiosin from rice straw derived xylose by using isolated *Serratia marcescens* (CMS 2): Statistical optimization, characterization, encapsulation & cost analysis. *Sustainable Food Technology*, *1*(6), 837–849.https://doi.org/10.1039/D3FB00100H
5. Chin, J. J. (2025, December 23). ISO 105-X12, C06, B02: Technical specifications and in-depth comparison of textile color fastness. *Begoodtex.*

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Integration of AI with central ERP for real time buyer communication and effective production tracking in RMG industry

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1.0 INTRODUCTION

Adoption of Enterprise Resource Planning (ERP) systems has become an essential tool in Bangladesh readymade garments industry (RMG) and textile for centralized data management, workflow synchronization, and improved decision-making. Most of the leading RMG and textile industries are now coordinate their production and share information via an ERP system [1-2]

Despite the widespread adoption of ERP systems, buyer and supplier typically remain outside of the integrated platform [3]. In practice, the communication primarily relay on manual emails, reports, informal channels and spreadsheet sharing between buyers and merchandisers [4] Merchandiser acts as a bridge of a typical buyer-producer interaction and extracted information from ERP system, translate into buyer specific updates, write corresponding email and share with buyers [5]. This continuous exchange includes both important decisions and day-to-day updates, such as product specification (e.g., color, size, and pricing) along with routine update on production progress such as cutting, sewing, finishing, and shipment scheduling. The routine job of a merchandiser requires tedious efforts, consume significant productive hours and results inefficiencies, unnecessary delays, synchronization gaps and limit traceability due to human error and time laggings [5].

Plenty of literatures tried to mitigate that limitation. Recent developments in the integration of Internet of Things (IoT) and machine learning have begun to reshape data management practices RMG sectors. Installed sensors can automatically capture production progress and transmit real-time operational data, thereby reducing dependence on manual data entry. This information can subsequently be entered into the central ERP system, which further analyzed to investigate production performance and process efficiency [6-7]. Furthermore, AI is currently extensively utilized with ERP system to transform these real-time data steams into new insights and support automated and dynamic decision-making facilities [8]. Few recent works emphasize that cloud-based ERP integration further facilitates seamless data sharing across organizational boundaries which can be accessed near real time [9-10].

However, the literatures remain limited to address how these systems can fully eliminate the need for manual communication. Hence the aim of this research is to develop and evaluate the performance of an AI integrated agent system with ERP for extracting production data according to buyer queries.

2.0 METHODOLOGY

The architecture is designed as a hybrid, service-oriented framework that integrates traditional ERP systems with modern conversational AI through a middleware layer.

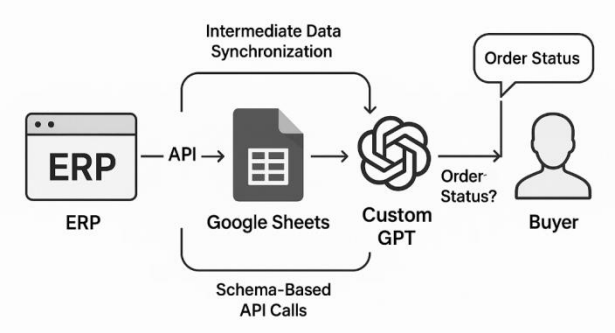

Figure 1: Adopted system architecture

At its core, the system follows a three-tier structure: data source (ERP), data mediation layer (Google Sheets), and interaction layer (Custom GPT) as shown in figure 1.

2.1 Experimental Set-up and Data Set

The experimental evaluation was conducted using a simulated dataset designed to replicate real-world ERP data structures in the RMG industry including multiple variables i.e., order identifiers, buyer, product specifications, production stages, quality status, and timelines.

2.2 Load Testing Methodology

Load testing was conducted to evaluate the scalability and robustness of the proposed system under varying operational conditions. A simulation framework was developed to generate concurrent user queries, mimicking multiple buyers accessing the system simultaneously.

3.0 GPT DEVELOPMENT

The system is developed with a straightforward but strong notion: combining the ERP system's output to a connected Google Sheet in real time. Merchandisers update the ERP system as daily routine works. As soon as the raw data is inserted, it is pushed via a pre-built API into a connected Google Sheet. The sync procedure follows structures authenticated in aforementioned

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reported by several researchers, all of whom influence the feasibility of real-time ERP-to-Sheet pipelines. The conversational layer is created using OpenAI's Custom GPT feature. This interface is configured to respond strictly to production-related matters by querying the Google Sheet through the connected API.

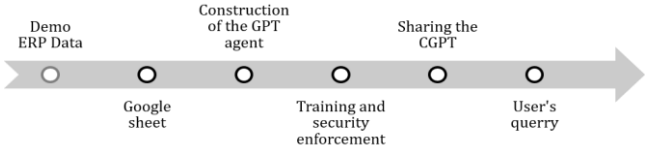

Figure 2: Data flow inside the GPT system

4.0 TEST & PERFORMANCE

4.1 Trial and Test

The trail, testing and query handling response confirmed that, the system performance is reliable in most cases. Especially the responses were accurate with specific order ID's and style number queries.

Table 1: Trial and test performance of the developed GPT

Test Case	Query	Expected Outcome	Result	Remarks
TC-01	"Update for Order OR-2025-010"	Return full structured update	✅ Success	Accurate and well-formatted
TC-02	"How many sewn for Style-19?"	Return sewing number	✅ Success	Correct parsing of style
TC-03	"Suggest me a big bazar"	Refuse to answer	✅ Success	GPT declined
TC-04	"Details for Style X999"	Return not found error	✅ Success	Handled invalid ID
TC-05	"Pending this month?"	Partial results	⚠ Partial	Ask exact match

4.2 Evaluation Metrics

Metric	Result
Accuracy (field-level)	: 90%
Response Time	: 1.7 seconds
Formatting Consistency	: 100%
Hallucination Rate	: 5%
Off topic Refusal	: 100%
API Failure Rate	: 2%

5.0 CONCLUSION

This study proposes an easy plugin, low-code, & AI powered communication system for the RMG sector which integrates ERP data with Google Sheets and builds a communication channel via custom GPT interface. The solution helps buyers to access real time FAQ updates via natural language queries which reduces manual follow-up emails, saves time & improves data transparency.

When the system was tested with demo data, there have been found high accuracy, fast response times, and strict adherence to data boundaries which makes the system practical and secure for SME use cases. Yet, its current design is limited to structured queries and relies on clean ERP data.

Future work should explore direct ERP-GPT plugin solution at the dashboard of the ERP system or fully AI integrated ERP software, fast response time, huge data scraping capability & more friendly user interface, & comparisons with existing communication tools. Overall, this approach shows a strong potential to enhance FAQ communication through accessible AI tools in resource-efficient environment.

REFERENCES

[1] Bradley J. Management based critical success factors in the implementation of Enterprise Resource Planning systems. International Journal of Accounting Information Systems. 2008 Sep 1;9(3):175-200.

[2] Habib MM, Chowdhury F, Sabah S, Shuvo TF, Raisa R. Investigating the technological impact on RMG supply chain: A Post-Pandemic Scenario. American Journal of Industrial and Business Management. 2025 Jul 14;15(7):974-94.

[3] Huan SH, Sheoran SK, Wang G. A review and analysis of supply chain operations reference (SCOR) model. Supply chain management: An international Journal. 2004 Feb 1;9(1):23-9.

[4] Siddiqui N, Limon GQ, Hossain MS, Mintoo AA. A Systematic review of ERP implementation strategies in the retail industry: integration challenges, success factors, and digital maturity models.

[5] Kudamanna L. Supply Chain Digitalization, Resilience, and Performance in the Apparel Sector of Sri Lanka.

[6] Kumar N. IoT-enabled real-time data integration in ERP systems. Int J Sci Res Sci Eng Technol. 2022;9(6):393-410.

[7] Wijesinghe S, Nanayakkara I, Pathirana R, Wickramarachchi R, Fernando I. Impact of IoT integration on enterprise resource planning (ERP) systems: A comprehensive literature analysis. In2024 International Research Conference on Smart Computing and Systems Engineering (SCSE) 2024 Apr 4 (Vol. 7, pp. 1-5). IEEE.

[8] Mhaskey SV. Integration of artificial intelligence (AI) in enterprise resource planning (ERP) systems: Opportunities, challenges, and implications. International Journal of Computer Engineering in Research Trends. 2024 Dec;11(12):1-9.

[9] Aitazaz F. Advanced AI/ML techniques for business intelligence in IoT-enabled manufacturing with ERP cloud integration [Internet]. 2023 Dec

[10] Mandava HA. Streamlining enterprise resource planning through digital technologies. Journal of Advanced Engineering Technology. ResearchGate. 2024.

Green Synthesis of AgNPs Using Plant Bioactives for Biomedical and Environmental Applications

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Abstract

This study focuses on the green synthesis of silver nanoparticles (AgNPs) using the plant-derived bioactive phytochemical compounds (e.g., japonicus, radix) as both reducing agent and capping ligand. The objective of this study was to evaluate the photocatalytic activity, heavy metal detection and antibacterial potential (against human pathogenic bacteria) of the green synthesized silver nanoparticles (G-AgNPs). key synthesis parameters were optimized using Taguchi statistical modeling to eliminate clumping, instability, and inconsistent properties. The robustness and predictive capability of the developed model was evaluated using ANOVA, regression analysis, response surface and contour plots, and residual diagnostics. Furthermore, the optimized condition was verified by instrumental characterization of (G-AgNPs). SEM, XRD, and zeta potential analysis were carried out on the G-AgNPs to determine the morphology, crystallinity, and stability, respectively. The metal-sensing capability of the G-AgNPs was evaluated against various metal ions. The nanoparticle demonstrated highly selective and sensitive colorimetric detection of mercury ion (Hg^{2+}) in aqueous media. Moreover, the photocatalytic activity of the G-AgNPs was evaluated by studying the degradation of methylene blue under sunlight irradiation. The G-AgNPs effectively degraded the dye. Furthermore, qualitatively antibacterial efficacy of the G-AgNPs against both Gram-negative and Gram-positive bacterial strains was determined using a zone of inhibition (ZOI) assay. The findings of this study suggest the potential biomedical (wound care, medical devices and drug delivery) and environmental (monitoring and treatment of effluent) applications of the G-NPs.

Keywords: Silver nanoparticle, Biosynthesis, Antimicrobial activity, Photocatalytic activity, Heavy metal detection

Increasing Energy Efficiency in a Stenter Machine Using Superheated Steam Drying Technology

Ayesha Akter
International Standard University

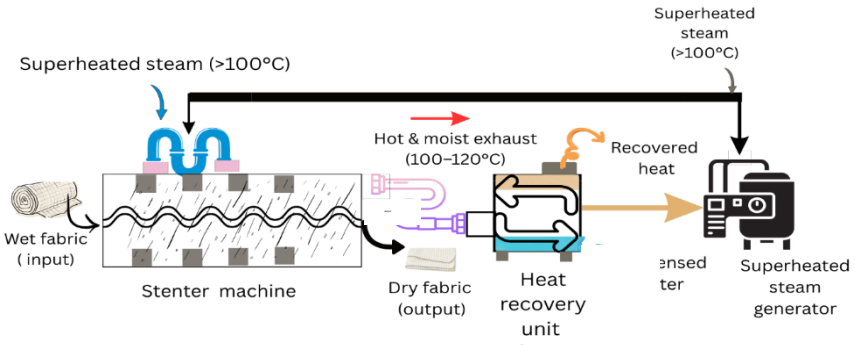
Highlights

- To implement superheated steam instead of conventional hot air in a stenter machine.
- To recover waste heat from the stenter exhaust and reuse in stenter machine.

Abstract

Ready-made garment (RMG) industry of Bangladesh plays a vital role in the export sector to support economic growth. Recently, this industry has been under pressure due to international carbon- related trade (such as the Carbon Border Adjustment Mechanism (CBAM)), gas and energy crisis. Now, it is a big challenge to reduce the excessive use of thermal energy, especially in the drying section. In general, conventional hot air is used in the stenter machine. But the stenter machine wastes a lot of thermal energy through the exhaust air. However, we will use superheated steam instead of conventional hot air in the stenter machine. Superheated steam drying technology can save more energy (up to 46.14%) compared to conventional hot air mechanisms (Jia *et al.*, 2018). This waste heat can be recovered and then used to preheat fresh air (Rakib *et al.*, 2017). The main objective of this review is to introduce Superheated Steam Drying (SSD) technology and waste heat recovery (WHR) systems in the drying process of a stenter machine.

Graphical Abstract



Keywords: Superheated steam drying, Waste heat recovery, Stenter machine, Energy efficiency.

1 Introduction

In the textile industry, maximum water and thermal energy are needed for the wet processing section. The stenter machine is one of them, where 30% of input thermal energy is lost without being reused (Kim *et al.*, 2024). While conventional stenter exhaust heat recovery saves a modest fraction of energy, our research focuses on replacing drying medium entirely with superheated steam drying to unlock higher efficiency and waste heat recovery potential. This proposed approach helps to achieve Sustainable Development Goals (SDGs) 7 and 12. Superheated steam may decrease the demand of external heat energy and fossil fuel. It can reduce thermal energy and increase energy efficiency to reuse waste heat. It is consistent with SDG 7 for energy efficiency and SDG 12 for resource-efficient, sustainable production.

2 Features of Superheated Steam

Superheated steam works at high temperatures (>100°C). It reduces fabric damage and color

degradation during the drying process, dries faster, and is energy efficient.

Table 1: *Comparison between Hot air drying and Superheated steam drying.*

Hot Air Drying	Superheated Steam Drying
Hot air is used as a drying medium. It can fade color (oxidation) due to having oxygen.	Superheated steam, which is above 100°C, is used as a drying and heating medium. It is non oxidizing, leading to uniform drying (Li, Liang and Bennamoun, 2016).
It is more challenging to recover latent heat from exhaust air, leading to increased fuel demand (Romdhana, Bonazzi and Esteban-Decloux, 2015).	Comparatively easy to reuse latent and sensible heat from exhaust steam through exhaust steam condensation or waste heat recovery (Liu *et al.*, 2013) (Jia *et al.*, 2018).

3 Superheated Steam Drying Technology

3.1 Mechanism

Superheated steam is used in the stenter machine. It transfers heat onto the wet fabric surface. The fabric moisture gets heated, evaporates, and releases as water vapor (with steam). As a result, the moisture content decreases and the fabric dries. Superheated steam can be more effective at heat transfer than hot air due to much higher heat transfer coefficient and thermal conductivity and overall heat transfer characteristics (Li, Liang and Bennamoun, 2016). At this time, steam and fabric containing moisture are mixed together, leading to exhaust steam.

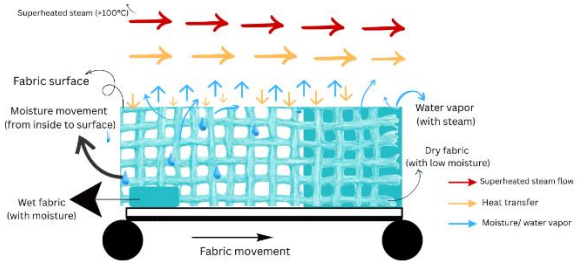


Figure 1: Superheated steam drying (at fabric level).

4 Proposed integrated Superheated Steam Drying with Waste Heat Recovery system

4.1 Proposed System Mechanism

This review proposes replacing hot air drying with superheated steam drying, integrated with heat recovery. First, steam generated in steam generator is heated using superheater and subsequently fed into the superheated steam drying chamber, where superheated steam evaporates moisture from the fabric. There, sensible and latent heat from exhaust steam will be recovered through feed water preheating to reduce thermal energy demand in steam generator. The condensate generated from exhaust steam will be returned to feed water system following appropriate quality testing and treatment. By supplying required extra heat steam is superheated again and directed to drying chamber. Thus, through the reuse of exhaust heat and condensate will create an opportunity to improve overall energy efficiency (Romdhana, Bonazzi and Esteban-Decloux, 2015)(Liu *et al.*, 2013).

4.2 Potential Applications

When used a high-speed superheated steam (100–120°C) in cotton fabric instead of conventional hot air resulted in moisture being reduced from 40-48% to 22-23% in the shock pre-drying method (Tarakçıoğlu and Cay, 2007). In this process, 75% drying energy savings were expected in textile (van Deventer, 1997). Superheated steam drying technology, such as a fluid bed and flash Dryer have significantly played a vital role in saving energy and reducing CO_2 emissions (Romdhana, Bonazzi and Esteban-Decloux, 2015). By using superheated steam instead of conventional hot air thermal energy consumption can potentially be reduced through exhaust heat recovery. However, the applicability depends on fabric composition, initial moisture

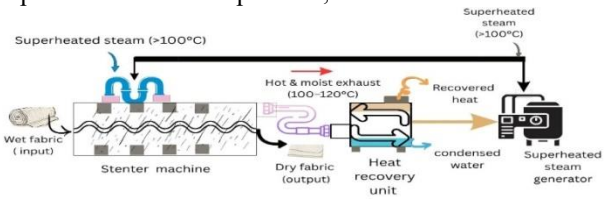


Figure 2: Proposed superheated steam drying with waste heat recovery.

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content, drying temperature, required finishing quality and production conditions.

4.3 Limitations

Stenter machine exhaust air contains oil, mist, and dust, which can create fouling on the surface of the heat exchanger and can prevent long-term operation (Kim *et al.*, 2024). The primary limitations of the proposed system include an increase in fabric moisture due to initial steam condensation, the potential alteration of fabric quality caused by temperature and residence time, and the steam system maintenance and contamination of heat exchanger. The main challenge in implementing this process is the lack of technical capacity and limited capital expenditure.

5 Conclusion

Considering the ongoing gas and fuel Crisis, existing textile methods need to minimize energy consumption. To evaluate the proposed Superheated Steam Drying (SSD) technology and waste heat recovery (WHR) systems, this can be implemented as a pilot project in a textile industry. Energy and fuel savings, CO_2 reduction, drying performance, and economic feasibility can be assessed through this project.

6 References

van Deventer, H.C. (1997) "Feasibility of energy efficient steam drying of paper and textile including process integration," *Applied Thermal Engineering*, 17(8), pp. 1035–1041. Available at: https://doi.org/10.1016/S1359-4311(97)00042-2.

Jia, Z. *et al.* (2018) "Newly designed superheated steam dryer bearing heat recovery unit: Analysis of energy efficiency and kinetics of Kelp drying," *Drying Technology*, 36(13), pp. 1619–1630. Available at: https://doi.org/10.1080/07373937.2017.1420080.

Kim, J. *et al.* (2024) "Advanced energy recovery systems design of stenter processes: Energy, exergy and Techno-economic analyses," *Energy*, 289, p. 130028. Available at: https://doi.org/10.1016/j.energy.2023.130028.

Li, J., Liang, Q.-C. and Bennamoun, L. (2016) "Superheated steam drying: Design aspects, energetic performances, and mathematical modeling," *Renewable and Sustainable Energy Reviews*, 60, pp. 1562–1583. Available at: https://doi.org/10.1016/j.rser.2016.03.033.

Liu, Y. *et al.* (2013) "A novel exergy recuperative drying module and its application for energy-saving drying with superheated steam," *Chemical Engineering Science*, 100, pp. 392–401. Available at: https://doi.org/10.1016/j.ces.2013.01.044.

Rakib, M.I. *et al.* (2017) "Waste-heat utilization – The sustainable technologies to minimize energy consumption in Bangladesh textile sector," *Journal of Cleaner Production*, 142, pp. 1867–1876. Available at: https://doi.org/10.1016/j.jclepro.2016.11.098.

Romdhana, H., Bonazzi, C. and Esteban-Decloux, M. (2015) "Superheated Steam Drying: An Overview of Pilot and Industrial Dryers with a Focus on Energy Efficiency," *Drying Technology*, 33(10), pp. 1255–1274. Available at: https://doi.org/10.1080/07373937.2015.1025139.

Tarakçıoğlu, I. and Cay, A. (2007) "Experimental study of a new shock pre-drying method for cotton fabrics," *International Journal of Energy Research*, 31(9), pp. 886–894. Available at: https://doi.org/10.1002/er.1289.

Hybrid Biobased Epoxy Composites Reinforced with Glass and Jute Fibers

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Abstract

This study presents the fabrication and characterization of hybrid biobased epoxy composites reinforced with raw jute fibers and crushed borosilicate glass particles using a cost-effective ambient-temperature hand-casting technique. A bisphenol-A liquid epoxy resin served as the matrix and was cured with an amine hardener at a 3:1 weight ratio for 24 hours at room temperature. The fabricated composites contained approximately 1.7-1.8 wt% jute fibers and 2.1 wt% borosilicate glass particles obtained from mechanically crushed thin glass sheets. After that surface morphology and interfacial interactions were analyzed using Scanning Electron Microscopy (SEM), while thermal behavior was investigated through simultaneous Differential Scanning Calorimetry and Thermogravimetric Analysis (DSC/TG). Mechanical performance was evaluated by uniaxial tensile testing. SEM observations revealed partial fiber-matrix adhesion, dispersed angular glass particles, and micro-void formation associated with the hand-casting process. Thermal analysis identified five exothermic degradation stages between 279°C and 518°C, with a major degradation peak at 439°C and a residual inorganic content of 20.68%. Tensile strengths ranged from 15.55 to 58.48 MPa due to non-uniform fiber distribution. These findings provide a baseline for improving sustainable epoxy composites through optimized fiber alignment and surface modification.

Keywords: Hybrid biobased epoxy composites; Jute fiber reinforcement; Borosilicate glass particles; Thermal characterization (DSC/TG); Mechanical properties.

1. Introduction

The growing demand for lightweight, durable, and eco-friendly materials has spurred interest in polymer composites reinforced with natural fibers and inorganic fillers [1]. Natural fibers particularly jute is highly attractive as reinforcing agents due to their easy availability, low cost, and renewable nature [2]. For Bangladesh, jute is especially significant, given its well-established role in both the agricultural and industrial sectors [3]. Incorporating jute into a polymer matrix can reduce reliance on conventional synthetic reinforcements and pave the way for the development of high-value-added materials [4]. Epoxy resin is widely used in structural components, protective coatings, adhesives, and various engineering applications, owing to its strong adhesion, dimensional stability, and chemical resistance [5, 6]. However, its performance depends on the characteristics of the reinforcing agents, the quality of interfacial bonding, and the fabrication conditions [7]. Employing a 'hybrid' reinforcement system combining natural fibers with glass particles allows for the integration of the fibrous structure of jute with the rigidity and thermal stability provided by inorganic fillers [8]. Despite these potential advantages, challenges such as poor dispersion of the constituents, weak bonding between the fibers and the matrix, and the formation of voids within the material can limit the performance of such composites [9]. Therefore, this study investigates the structure, thermal behavior, and tensile properties of hybrid epoxy composites reinforced with raw jute fibers and pulverized borosilicate glass particles. The findings provide preliminary insights into how a hybrid reinforcement system and fabrication quality influence the performance of these composites.

2. Materials and Methods

2.1 Materials

Bisphenol-A-based liquid epoxy resin and an amine hardener have been used as the polymer matrix system. Raw jute fibers serve as the natural reinforcement material, while the borosilicate glass particles were obtained by mechanically pulverizing thin glass sheets. The epoxy resin and hardener were

mixed in a 3:1 weight ratio. The prepared composites contain approximately 1.7–1.8 wt% jute fibers and 2.1 wt% borosilicate glass particles.

2.2 Composite Fabrication

The hybrid composites were fabricated using a 'hand-casting' technique at ambient temperature. Jute fibers and pulverized glass particles were incorporated into a mixture of epoxy resin and a hardener, combined in specific proportions. The resulting mixture was then poured into a suitable mold and left to cure at room temperature for 24 hours. This production method was selected due to its simplicity and cost-effectiveness. However, the manual mixing and casting process can lead to an uneven distribution of materials and the potential formation of tiny voids (microvoids) within the composite.

2.3 Characterization

Surface morphology and fiber-matrix interactions were examined using scanning electron microscopy (SEM). Thermal behavior was investigated through simultaneous differential scanning calorimetry and thermogravimetric analysis (DSC/TG) to identify thermal events, degradation stages, and residual mass. Mechanical performance was evaluated using uniaxial tensile testing, with tensile strength expressed in megapascals (MPa).

3. Results and Discussion

3.1 Surface Morphology and Interfacial Characteristics

SEM observations revealed partial adhesion between the jute fibers and the epoxy matrix. Although contact between the reinforcement and the matrix was evident in some areas, the observed morphology suggests that the interfacial bonding was not uniformly effective. Insufficient interfacial adhesion can promote stress concentration and accelerate premature failure under tensile loading.

Borosilicate glass particles were dispersed throughout the matrix and exhibited an angular morphology resulting from mechanical crushing; however, their distribution was not entirely uniform. Small voids were also observed, likely caused by air entrapment during mixing, incomplete wetting of the reinforcement, or the manual casting process. These structural characteristics indicate that improved mixing, controlled casting, and surface treatment of the reinforcement could enhance the quality of the composite.

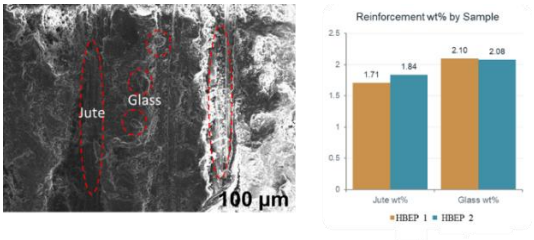

Figure 1: Surface morphology and interfacial characteristics of hybrid biobased epoxy composites.

3.2 Thermal Behavior

DSC/TG analysis, five exothermic degradation stages were identified within the temperature range of 279–518 °C. A primary degradation peak was observed at 439 °C, indicating a significant thermal event within this range. The presence of multiple degradation stages suggests that the composite undergoes a complex thermal degradation process, which may involve various components or distinct degradation mechanisms.

Following the thermal analysis, an inorganic residue of 20.68% was obtained. This residue may consist of inorganic components derived from the glass, as well as other thermally stable constituents. However, to determine the specific contribution of each component, it is necessary to compare these results with the thermal behavior of the pure epoxy matrix and the individual reinforcement materials. While these findings provide an initial insight into the thermal response of the composite, they are insufficient to definitively conclude that its thermal stability is superior to that of unreinforced epoxy.

3.3 Tensile Properties

The measured tensile strengths ranged from 15.55 to 58.48 MPa. This broad variation indicates that mechanical performance was sensitive to differences in reinforcement distribution, interfacial bonding, and possible defect formation. Jute fibers can contribute to load transfer when adequately wetted and bonded to the matrix, while glass particles may influence stiffness and stress distribution.

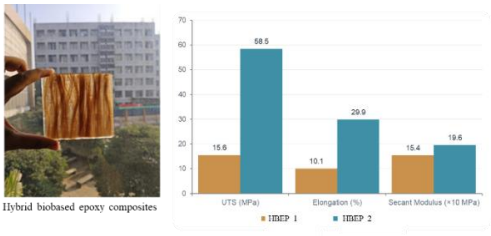

Figure 2: Mechanical performance of hybrid biobased epoxy composites.

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Nevertheless, the presence of reinforcement does not automatically guarantee improved tensile strength. Fiber orientation, fiber length, particle dispersion, void content, and specimen-to-specimen variability can significantly influence the measured response. The observed strength variation therefore highlights the importance of controlling fabrication parameters and establishing a reproducible reinforcement architecture. Further comparative testing against neat epoxy and single-reinforcement composites is necessary to quantify the individual and combined contributions of jute fibers and glass particles.

4. Conclusion

A hybrid epoxy composite, reinforced with raw jute fibers and crushed borosilicate glass particles, has been successfully fabricated using a standard ambient-temperature hand-casting technique. SEM analysis revealed partial fiber-matrix adhesion, angular glass particles, and microvoids, suggesting potential for improving interfacial bonding and processing quality. Thermal analysis identified five exothermic degradation stages between 279 °C and 518 °C, with a primary degradation peak at 439 °C and a residual inorganic content of 20.68%. Tensile strength varied from 15.55 MPa to 58.48 MPa, reflecting the influence of reinforcement distribution and potential structural defects. Future research should explore fiber surface modification, controlled fiber orientation, improved particle dispersion, and optimized curing conditions. Comparative testing of neat epoxy, jute-reinforced epoxy, glass-filled epoxy, and the hybrid composite will provide a robust basis for evaluating the synergy between the reinforcing components. Further mechanical, thermal, and durability testing is also required to establish its suitability for specific engineering applications. Finally, this preliminary study demonstrates an effective method for integrating inorganic glass particles with renewable jute reinforcement in an epoxy composite and identifies key processing factors for further performance optimization.

References

1. Akter, M., M.H. Uddin, and H.R. Anik, *Plant fiber-reinforced polymer composites: a review on modification, fabrication, properties, and applications.* Polymer Bulletin, 2024. **81**(1): p. 1-85.
2. Habib, A., et al., *Recent developments in the modification and fabrication of jute fibre-reinforced composites for structural applications.* Discover Sustainability, 2025. **6**(1): p. 1107.
3. Yasmin, S. and M. Moniruzzaman, *Forecasting of area, production, and yield of jute in Bangladesh using Box-Jenkins ARIMA model.* Journal of Agriculture and Food Research, 2024. **16**: p. 101203.
4. Raman, A., et al., *2D Nanofillers in Natural Fiber Composites: bridging sustainability and high-performance materials.* Advanced Sustainable Systems, 2026. **10**(2): p. e00897.
5. Gobiraman, A., S. Nagaraja, and V. Sathiyamoorthi, *Epoxy resin as matrix for polymer composites: factors influencing the properties of polymers and their composites*, in *Epoxy-based biocomposites*. 2023, CRC Press. p. 1-19.
6. Zaghloul, M.M.Y., M.M.Y. Zaghloul, and M. Fuseini, *Recent progress in epoxy nanocomposites: corrosion, structural, flame retardancy and applications—a comprehensive review.* Polymers for Advanced Technologies, 2023. **34**(11): p. 3438-3472.
7. Liu, L., et al., *Improving interfacial properties of hierarchical reinforcement carbon fibers modified by graphene oxide with different bonding types.* Composites Part A: Applied Science and Manufacturing, 2018. **107**: p. 616-625.
8. Mohammed, M., et al., *A review on the advancement of renewable natural fiber hybrid composites: prospects, challenges, and industrial applications.* J. Renew. Mater, 2024. **12**(7): p. 1237-1290.
9. Olonisakin, K., et al., *Key improvements in interfacial adhesion and dispersion of fibers/fillers in polymer matrix composites; focus on pla matrix composites.* Composite Interfaces, 2022. **29**(10): p. 1071-1120.

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- Enhanced institutional participation



2017
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- Knowledge exchange initiatives



2024
- International speakers and participation
- Sustainability and innovation themes
- Expanded global collaboration

Building Global Partnerships for a Sustainable Textile Future



2025
Continuing Excellence
- Strong international participation
- Research impact and networking
- Future-focused textile innovation

Research Innovation Colloboration for a Better Tomorrow

OUR IMPACT

11+
Years
of Conference History

6
Conference Editions
Hundreds of Research Presentations

International Research Collaboration
Participants from across the globe

Academic & Industry Partners
Knowledge Exchange and Innovation

Sustainability Focus
Textile Research for a Better Future

People | Ideas | Textiles | A Sustainable Tomorrow

CRISAT TRAINING PROGRAMME - FOR ALL DISCIPLINE

For students, teachers, researchers & fashion enthusiasts | Admission ongoing every month

1. Level 1 — Research Skill and Academic Writing Training
2. Level 1 — Digital Fashion Design (3D CAD) Training (Basic)
3. Level 2 — Writing Research Proposal for Higher Studies (Masters & PhD)
4. Level 2 — Writing Traditional Review Targeting Journal Publications
5. Level 2 — Digital Fashion Design (3D CAD) Training (Advanced)
6. Level 3 — Writing Systematic Review Targeting Journal Publications
7. Level 3 — Digital Fashion (3D CAD) Research Targeting Journal Publications
8. Level 4 — Certificate in Digital Fashion and Apparel Merchandising

Textile Research Conference (TRC)
Promoting Research, Innovation and Sustainable Development in Textiles

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Empowering the Future Researchers Across All Disciplines

Build Your Skills Advance Your Research Journey

- Expert Guidance
- 100% Online
- Certificate Provided
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1 Level 1 Research Skills and Academic Writing Training



Gain practical, hands-on experience in general research skills and academic writing through 4 weeks of online sessions, reading and writing assignments.

Start: Every Month
Class Time: Saturday, 7/8/9 pm

25% discount for a group registration of at least 2 participants.

2 Level 1 Digital Fashion Design (3D CAD) Training (Basic)



Learn the basics of 3D design software through 4 weeks of online sessions (1 hour per week). Perfect for those interested in digital fashion for research and professional purposes.

Start: Every Month
Class Time: Saturday, 7/8/9 pm

You must have a good computer/laptop and high-speed internet connection to attend this training.

3 Level 2 Writing Research Proposal for Higher Studies (Masters & PhD)



Learn to write an effective research proposal without using AI tools. Covers research skills, academic writing and step-by-step proposal development. Includes thoroughly research viewpoint, local for scholarships/ funding and study abroad aspirants.

Start: Every Month
Class Time: Friday or Saturday Evenings

You must complete Level 1 (Research Skills and Academic Writing) first or have proven equivalent skills.

4 Level 2 Writing Traditional Review targeting Journal Publications



A specialised 8-session programme (4 lectures + 4 group tutorials) for textile and fashion students and teachers. Focuses on group work and practical exercises to publish a traditional review in a Scopus-indexed journal.

Start: Every Month
Class Time: Friday or Saturday Evenings

You must complete Level 1 (Research Skills and Academic Writing) first or have proven equivalent skills.

5 Level 2 Digital Fashion Design (3D CAD) Training (Advanced)



An 8-session programme (1 hour per week) for textile and fashion students and teachers. Focuses on group work and practical exercises targeting a publication in a Sccpus-indexed journal.

Start: Every Month
Class Time: Friday or Saturday Evenings

You must complete Level 1 or have proven equivalent skills to join this Level 2 training.

6 Level 3 Writing Systematic Review targeting Journal Publications



An 8-session programme (1 hour per week) for textile and fashion students and teachers. Focuses on group work and practical exercises to publish a systematic review in a Scopus-indexed journal.

Start: Every Month
Class Time: Friday or Saturday Evenings

You must complete Level 1 (Research Skill and Academic Writing) first or have proven equivalent skills.

7 Level 3 Digital Fashion (3D CAD) Research targeting Journal Publications



An 8-session programme (1 hour per week) for textile and fashion students and teachers. Focuses on group work and practical exercises to publish a Scopus-indexed journal.

StarEvery Month
Class Time: Friday or Saturday Evenings

You must complete Level 1 or have proven equivalent skills to join this Level 2 training.

CRISAT batch starts every month

Apply Now: https://forms.gle/thFbac2Xmgdka5nP6

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Best Wishes from CENTRO

Title Sponsor of DFCC 2026

CRISAT - CENTRO
DIGITAL FASHION CATWALK COMPETITION



CENTRO is **delighted** to be the **Title Sponsor** of the **CRISAT-CENTRO Digital Fashion Catwalk Competition (DFCC) 2026**, held in conjunction with the 7th Textile Research Conference (TRC 2026).

We wish all participants great success in showcasing their creativity, innovation, and talent in shaping the future of digital fashion.

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