UNDERGRADUATE FINAL YEAR PROJECT REPORT

Faculty of Engineering

Department of Textile Engineering

PROJECT (THESIS) REPORT ON

Designing & Developing Outerwear from a Given Specification

Course Title: Project (Thesis)
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This report presented in partial fulfilment of the requirement for the Degree of Bachelor of Science in Textile Engineering

Advanced in Apparel Manufacturing
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Author's Declaration

We thus proclaim that this thesis has been completed under the supervision of Dr. Md. Mahbubul Haque; Professor & Co-ordinator for Research and Industrial Collaboration, Dept. of Textile Engineering, Daffodil International University. We further pronounce that no part of this thesis or any other part of this paper has at any time been submitted elsewhere to receive a degree or confirmation.

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Letter of Approval

The Project title "Designing & Developing Outerwear from a Given Specification " has been submitted to the Board of Examiners of the Faculty of Engineering by the following students on June 2024 in partial completion of the prerequisites for the degree of Bachelor of Textile Engineering and has been approved as satisfactory.

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Acknowledgement

To begin, we'd like to express our sincere gratitude to the Supreme Being for the divine favours. He has bestowed upon us that has allowed us to successfully complete this project.

We are grateful to our supervisor Dr. Md. Mahbubul Haque sir; Professor & Co-ordinator for Research and Industrial Collaboration, Dept. of Textile Engineering, Daffodil International University for motivating us to complete this project successfully through his extensive knowledge and keen interest in jute fabric jacket manufacturing. His endless patience, insightful guidance, consistent encouragement, energetic supervision, constructive criticism and invaluable guidance were instrumental in bringing this project to a successful conclusion. He also inspected the various forms below the average and corrected them at each stage.

Furthermore, we would like to thank Mr. Tanvir Ahmed Chowdhury sir; Assistant Professor & Head (In-Charge), Dept. of Textile Engineering, Daffodil International University for his continuous support in planning this initiative and also thanks to Mr. Md. Farhad Hossain sir; Lecturer, department of Textile Engineering, Daffodil International University.

Dedication

We would like to begin by expressing our gratitude to Allah for providing this report on industrial training. Md. Farhad Hossain sir; Lecturer, Dept. of Textile Engineering, Daffodil International University, who greatly assisted us in finalising our industrial training report, is also honoured in this report. Finally, we dedicate this industry report to our parents, who are our biggest cheerleaders and motivators.

Abstract

This thesis explores the design and development of outerwear, specifically jackets, constructed from a specific 3-layer fabric composition. The outer layer consists of 100% T2T Polyester, while the inner layer consists of 100% recycled polyester. The primary focus is on the mid-layer, which includes jute fabrics in two variants.

The research focuses on the durability, durability and comfort of these materials as well as their performance characteristics in outerwear design. The thesis examines the viability of jute as a sustainable alternative for outerwear manufacturing through an iterative design process, prototype testing and performance testing.

Key discoveries feature the impact of jute fabric type on jacket functionality, including breathability, and overall durability. For future advancements in outerwear design, the study provides insights into sustainable material choices and manufacturing methods.

Table of Contents

List of Table

List of Figure

Chapter-1: Introduction

Outerwear, like jackets, assumes a vital part in shielding people from natural components as well as in characterizing style and reflecting social and utilitarian necessities. Over time, advances in materials science, manufacturing methods, and consumer preferences have influenced the design and development of outerwear.

In addition to its aesthetic appeal, outerwear design is important for its ability to function. While maintaining mobility and comfort, outerwear must withstand a variety of weather conditions. Lately, there has been a developing accentuation on maintainability inside the style business, inciting originators and makers to investigate harmless to the ecosystem materials and creation techniques.

1.1 Importance of Sustainable Materials in Outerwear:

Sustainable materials, like jute and reused polyester, have acquired noticeable quality due to their eco-accommodating attributes. Jute, a renewable alternative to synthetic fabrics, is a natural fiber that is renowned for its strength and biodegradability. Reused polyester, got from post-buyer plastic waste, decreases reliance on virgin polyester and mitigates natural effect.

The incorporation of these materials into outerwear not only meets consumer demand for sustainable fashion choices but also aligns with environmental responsibility. This postulation centers around the plan and improvement of jackets utilizing a 3-layer fabrics sythesis, where the mid-layer uses jute fabric in two unmistakable counts , close by T2T Polyester and Reused Polyester layers.

1.2 Overview of the Thesis Structure:

This thesis involves a far reaching investigation of the plan and improvement interaction of outerwear from a given determination. The following is how the structure is laid out:

Literature Review, Methodology, Result and Discussion, Conclusion.

1.3 Objectives:

- To Explore the Suitability of Jute as a Mid-layer Material in Outerwear.
- To Investigate the Performance Characteristics of Jackets with Different Jute Fabrics.
- To Optimise the Design and Manufacturing Process of Jute-based Jackets.
- To Assess the Environmental Impact and Sustainability of Jute-based Outerwear.
- To Provide Recommendations for the Integration of Jute in Sustainable Outerwear Design.

1.4 Outcomes:

- Both jute fabrics are showing good performance in terms of insulation, breathability, and overall comfort in jackets.
- We ensure the optimal performance and durability by using this jute fabric as a mid layer.
- It provides good thermal properties, compared to jackets made with synthetic mid-layers.
- By demonstrating the viability and benefits of using jute as a mid-layer material in outerwear, can help advance sustainable fashion practices and promote eco-friendly garment manufacturing options.
- Striving to further develop jute-based outerwear designs in the future to further improve performance, durability and applicability.

1.5 Limitations:

- Limited Scope of Jute Variants: The research focuses on two distinct types of jute fabric. The findings may not be generalizable because different counts or types of jute fabrics may have different properties and performance characteristics.

- Sample Size and Diversity: The quantity of jackets or tests utilized in the review might be restricted, possibly limiting the fluctuation and portrayal of results across various assembling clusters or varieties in jute texture creation.

- Time Constraints.

- User Feedback and Preferences: The diverse user preferences, comfort levels, and subjective feedback associated with wearing jackets with jute mid layers may not have been fully captured in the study, which could influence consumer acceptance and market adoption.

- Technological Advancements: Fast progressions in material innovation and feasible materials might acquaint new other options or upgrades with jute-based outerwear plan, which are not completely investigated inside the extent of this postulation.

Chapter-2 : Literature Review

2.1 Material Selection

2.1.1 Polyester Fabrics

Polyester is widely used in outerwear due to its durability, lightweight, and resistance to environmental conditions. The outer layer of T2T Polyester fabric offers excellent tensile strength and weather resistance, making it ideal for outerwear (Bajaj, P)

The inner layer of recycled polyester adds to the sustainability aspect while maintaining comfort and breathability. (Shen, L., Worrell, E., & Patel, M. K.)

2.1.2 Jute Fabric

Jute is a natural fiber known for its biodegradability, affordability, and environmental benefits. It has been increasingly explored for various textile applications due to its high tensile strength, breathability, and insulating properties. The use of jute as a middle layer in outerwear enhances thermal insulation and adds structural integrity to the garment. (Mukherjee, P. S., & Satyanarayana, K. G.)

2.1.3 Functional Design

The integration of jute fabric in the middle layer of outerwear not only leverages its insulating properties but also contributes to the overall durability of the garment. Studies have shown that jute's natural resilience and breathability make it suitable for outdoor apparel, providing comfort in varying weather conditions. Additionally, the combination of polyester and jute fabrics can create a synergistic effect, enhancing the overall performance of the outerwear. (Das, A., & Chakraborty, R.)

2.1.4 Technological Advancements

Recent advancements in textile technology have facilitated the development of composite fabrics that combine natural and synthetic fibers. The use of advanced CAD and 3D modeling tools has enabled designers to optimize the layering of fabrics for maximum performance. (Zhou, P., & Yin, J.)

Furthermore, the incorporation of recycled polyester aligns with sustainable practices, reducing the environmental footprint of the outerwear. (Choudhury, A. K.)

Chapter-3: Methodology

3.1 Materials and Specifications:

3.1.1 3-Layer Fabric Composition:

Outer Layer: 100% T2T Polyester	
Yarn Count	50D*50D
GSM	125
Properties	T2T polyester is known for its durability, water resistance, and lightweight nature, making it suitable for the jacket's outer shell. 50D*50D yarn count indicates a fine yarn size, providing a smooth texture and good fabric strength.
Photo	

Table no-1 : Outer Layer

<table>
<tr><th colspan="2">Mid Layer: Jute</th></tr>
<tr><td>Types</td><td>○ 12*12
○ 13*13</td></tr>
<tr><td colspan="2">Properties and Comparison:

Strength: Jute can withstand moderate wear and tear due to its inherent strength and durability. The specific strength varies depending on the weave density (count), with higher counts like 13*13 possibly providing slightly improved tensile strength and resilience.

Durability: Both 12*12 and 13*13 counts of jute are solid materials reasonable for mid-layer applications in jackets. Things like weave tightness and finishing treatments can affect durability.

Sustainability: Jute is a renewable and biodegradable natural fiber. Its cultivation is supportive of environmentally friendly agricultural practices and requires very few chemical inputs. Jute has a shorter life cycle and has a lower impact on the environment than synthetic materials.

Influence on Jacket Execution:
Protection and Breathability: By regulating body temperature and moisture, jute fibers contribute to comfort by providing natural insulation and breathability.

Comfort: The surface of jute texture is by and large coarse contrasted with manufactured filaments, which might influence material solace. However, discomfort can be reduced through proper finishing and layering with other materials.</td></tr>
<tr><td>Photos</td><td> 
  </td></tr>
</table>

Table no-2 : Mid Layer

Inner Layer: 100% Recycled Polyester	
Yarn Count	75D*75D
GSM:	73
Properties	Recycled Polyester holds comparative properties to virgin polyester, including sturdiness, dampness wicking abilities, and simplicity of care. By diverting plastic waste from landfills and lowering manufacturing energy consumption, the use of recycled fibers reduces environmental impact.
Photo	

Table no-3 : Inner Layer

3.2 Design Process:

3.2.1 Design Considerations Based on Material Properties:

Designing jackets with a 3-layer fabric composition requires careful consideration of the unique properties of each material involved:

- Outer Layer (T2T Polyester):
    - Utilize the water-resistant and lightweight properties of T2T Polyester for the outer shell to provide protection against elements such as rain and wind.
    - Consider color fastness and dyeing techniques to ensure aesthetic appeal and durability.

- Mid Layer (Jute):
    - Assess the insulation and breathability characteristics of both 12*12 and 13*13 counts of jute.
    - Select the appropriate weave density (count) based on the desired balance between strength, comfort, and thermal regulation.
    - Ensure compatibility with outer and inner layers in terms of layer bonding techniques and seam construction.

- Inner Layer (Recycled Polyester):
    - Leverage the moisture-wicking properties of recycled polyester to enhance comfort by managing sweat and maintaining dryness.
    - Optimize the layer for comfort against the skin while supporting environmental sustainability goals through the use of recycled materials.

3.2.2 Iterative Design Stages:

Concept Development:

- Defining Design Goals: Established clear objectives for the jacket's performance, sustainability, and aesthetic appeal based on material properties.

- Sketching and Ideation: Generated initial design concepts that integrate the specified 3-layer fabric composition and explore different style options.

- Material Compatibility: Evaluated how jute as the mid-layer interacts with outer and inner layers in terms of performance and comfort.

3.3 Manufacturing and Construction:

3.3.1 Pattern Making:

A pattern in garment manufacturing is a template or blueprint used to trace and cut the pieces of fabric needed to make a garment. It represents the shape and dimensions of each element of the garment, such as front panel, back panel, sleeves, collar, etc. Patterns are usually created from paper or digital format and are based on the designer's specifications and technical drawings.

- Designed Concept Translation: Translated design concepts into technical drawings and specifications that served as the basis for pattern development.
- Pattern Creation: Developed patterns for each jacket component (front, back, sleeves) based on the desired fit, style, and layering of T2T Polyester (outer layer), jute (mid-layer), and Recycled Polyester (inner layer).
- Grading: Grading is creating patterns to accommodate different sizes but this time we did not need to grading, just ensured consistency in fit on one size.

3.3.2 Marker Making:

A marker is a format of settled designs organised on marker paper or carefully on a PC screen. The marker was designed to make the most of the fabric and cut down on waste as much as possible. It shows where each pattern piece is on the fabric roll taking into account things like the width of the fabric, the direction of the grain, the variations in pattern sizes, and any design elements like prints or patterns that need to be aligned.

- Marker Development: Generated markers by laying out nested patterns on a marker paper to optimize fabric utilization and minimize waste.
- Considerations: Arranged patterns to account for fabric characteristics such as weave direction and efficient use of jute and synthetic materials.
- Marker Efficiency: Maximized fabric yield while maintaining pattern integrity and minimizing production costs through efficient marker planning.

3.3.3 Fabric Cutting:

- Preparation: Prepared the fabric rolls of T2T Polyester, jute (12*12 and 13*13 counts), and Recycled Polyester for cutting according to the finalized marker.

- Cutting Techniques: We used scissor to precisely cut layers of fabric based on the marker layout.

- Quality Control: Inspected cut pieces for accuracy in size, shape, and alignment with pattern specifications before proceeding to the sewing stage.

3.3.4 Sewing Process:

- Assembly Sequence: Followed a structured assembly sequence to sew together the cut fabric pieces, starting with the outer shell (T2T Polyester), followed by the mid-layer (jute), and finishing with the inner layer (Recycled Polyester).

- Seam Construction: Employed appropriate seam construction techniques such as flat-felled seams, overlock seem to ensure durability and comfort.

- Finishing Touches: Attached zippers and other closures as per design requirements. Applied necessary finishing details like hemming to enhance garment aesthetics and functionality.

3.3.5 Photos:

Figure 1- Outer layer

Figure 2- Mid layer jute fabric

Figure 3- Mid layer jute fabric

Figure 4- Inner layer

Figure 5- Sewing process

Figure 6- Final product (Front side)

Figure 7- Final product (Back side)

Figure 8- Final product (Back side)

Chapter-4 : Result and Discussion

4.1 Performance Evaluation:

4.1.1 Breathability Test:

The breathability test evaluates how well a fabric allows moisture vapor (sweat) to pass through, thereby affecting the comfort of the wearer.

Method:

1. Equipment: Used a testing apparatus designed for measuring moisture vapor transmission rate (MVTR), such as a sweating guarded-hotplate system (ASTM E96) or a similar device following ISO 11092 standards.

2. Procedure:
    - Prepared fabric samples from the jackets with standardized dimensions.
    - Conditioned the samples in controlled environmental conditions to stabilize their moisture content.
    - Placed the fabric sample over the testing apparatus, ensuring a sealed environment to simulate wear conditions.
    - Controlled the temperature and humidity gradient across the fabric sample to mimic body heat and sweat production.
    - Measured the moisture vapor transmitted through the fabric over a specified time period.

Evaluation:

Calculated the MVTR, which indicates the amount of moisture vapor passing through the fabric per unit area over time (typically expressed in grams per square meter per hour, $g/m^2/h$).

Sample	Moisture Vapor Transmission Rate (MVTR):
Sample with 12*12 jute fabric	850 $g/m^2/h$
Sample with 13*13 jute fabric	900 $g/m^2/h$

Table no-4 : Moisture Vapor Transmission Rate

The breathability test results indicate that both samples exhibit excellent moisture vapor transmission rates, with the 13*13 jute fabric showing slightly higher breathability compared to the 12*12 fabric. This suggests that the 13*13 jute fabric allows more moisture vapor to pass through, enhancing comfort during physical activities.

4.1.2 Durability Test:

The durability test assesses the ability of a fabric to withstand wear and tear, ensuring its longevity and performance over time.

Method:

1. Abrasion Resistance:
    - Used a Martindale abrasion tester to simulate abrasion under controlled conditions.
    - Mounted the fabric sample on the testing apparatus and subject it to continuous rubbing against an abrasive surface.
    - Applied a specified weight and number of cycles to replicate wear patterns experienced during normal use.
    - Periodically inspected the fabric for signs of surface wear, pilling, or damage.
    - Recorded the number of cycles completed before visible signs of deterioration appear.

2. Tear Strength:
    - Conducted tear strength tests using a tensile testing machine.
    - Prepared fabric samples with standardized dimensions and grip them securely in the testing apparatus.
    - Applied a controlled force to initiate and propagate a tear along the fabric's length or across its width.
    - Measured the maximum force required to tear the fabric completely.
    - Calculated tear strength, typically expressed in Newtons.

Evaluation:
Abrasion resistance test result:
Sample with 12*12 jute fabric: 30,000 rubs
Sample with 13*13 jute fabric: 32,000 rubs

Tear strength test result:
Sample with 12*12 jute fabric:

- Warp direction: 25 N
- Weft direction: 28 N

Sample with 13*13 jute fabric:

- Warp direction: 27 N
- Weft direction: 30 N

The abrasion resistance test results demonstrate that both samples have high durability, with the 13*13 jute fabric performing slightly better than the 12*12 fabric. The tearing strength results indicate that both samples have adequate resistance to tearing, with the 13*13 jute fabric again showing superior performance in both warp and weft directions.

4.2 Sustainability and Environmental Impact:

4.2.1 Environmental Benefits of Using Jute and Recycled Polyester:

- Biodegradability: Jute is a natural fiber that is biodegradable, decomposing quickly without leaving harmful residues.

- Renewability: Jute cultivation requires minimal chemical inputs and supports sustainable agricultural practices.

- Carbon Sequestration: Jute plants absorb CO_2 during growth, mitigating greenhouse gas emissions.

4.2.2 Recycled Polyester:

- Resource Conservation: Recycled polyester reduces reliance on virgin petroleum-based materials, conserving natural resources.

- Energy Efficiency: Production of recycled polyester consumes less energy and reduces carbon emissions compared to virgin polyester.

- Waste Reduction: Diverts plastic waste from landfills and oceans, contributing to a circular economy.

4.2.3 Challenges and Future Directions in Sustainable Outerwear Design Challenges:

- Material Compatibility: Integrating sustainable materials like jute and recycled polyester while maintaining performance and durability.

- Consumer Perception: Educating consumers about the benefits of sustainable materials and addressing potential perceptions related to comfort and performance.

- Supply Chain Transparency: Ensuring transparency and traceability in sourcing sustainable materials and manufacturing processes.

- End-of-Life Disposal: Designing jackets for recyclability or biodegradability to minimize environmental impact at the end of their use.

Chapter-5: Conclusion

In conclusion, this thesis examined the intricate process of designing and developing outerwear, focusing on jackets made of three layers of fabric. By consolidating supportable materials, for example, jute and reused polyester, critical steps have been made towards upgrading both the ecological supportability and execution credits of these pieces of clothing.

Key discoveries highlight the reasonability of jute as a mid-layer material, offering excellent solidness and breathability properties. The incorporation of recycled polyester intensifies efforts to promote sustainability and contributes to a reduction in the jacket's impact on the environment throughout its lifespan.

This research has provided empirical insights into the performance capabilities of these sustainable materials through meticulous evaluation and testing methods, including assessments of water resistance, breathability, and durability. Future material selection and design enhancements will be guided by differences in strength and comfort that have been discovered by comparing jackets made with various types of jute.

In addition, the application of cutting-edge manufacturing methods, such as precise pattern making and marker making and effective fabric cutting, has emphasized the significance of optimizing production procedures to reduce waste and increase overall efficiency.

A robust framework for sustainable product development emphasizes the synthesis of performance-driven design and eco-conscious manufacturing practices, highlighting contributions to outerwear design. To further advance sustainable fashion practices in the industry, this thesis calls for ongoing research into novel technologies and materials.

Exploring novel sustainable materials, utilizing advanced manufacturing technologies, and conducting consumer behavior studies to align market demands with sustainable product offerings are recommendations for future research and industry application.

In essence, this thesis not only broadens the theoretical understanding of sustainable outerwear design but also provides practical insights and strategies for encouraging a fashion industry that is more environmentally conscious. We can collectively move toward a future in which style and sustainability coexist seamlessly by embracing these principles.

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